ISSN 1993-7989 (print)
ISSN 1993-7997 (online)
ISSN-L 1993-7989

НАУКОВО-МЕТОДИЧНИЙ ЖУРНАЛ

ТЕОРІЯ ТА МЕТОДИКА ФІЗИЧНОГО ВИХОВАННЯ

[Physical Education Theory and Methodology]
[Teorìâ ta Metodika Fìzičnogo Vihovannâ]

№ 2 · Том 23 · квітень 2023

Адреса журналу в Інтернет:
https://tmfv.com.ua
https://doi.org/10.17309/tmfv.2023.2

/ ОВС ТОВ
Харків
Україна

ISSN 1993-7989 (print)
ISSN 1993-7997 (online)
ISSN 1993-7989-L

Теорія та методика фізичного виховання
Physical Education Theory and Methodology
Teorìâ ta Metodika Fìzičnogo Vihovannâ
Abbreviated key-title: Teor. metod. fiz. vihov.

Науково-методичний журнал
Scientific-methodological journal

Шість випусків на рік. Заснований у 2000 році
Six issues per year. Established in 2000

https://www.tmfv.com.ua. E-mail: tmfv@tmfv.com.ua

Журнал зареєстровано в міжнародних каталогах періодичних видань та базах даних:

Scopus; SCImago (SJR); Ulrichsweb Global Serials Directory; DOAJ (Directory of Open Access Journals); CrossRef; ROAD (Directory of Open Access scholarly Resources); ERIH PLUS; WorldCat; Open Science Directory (EBSCO information services); PBN (Polish Scholarly Bibliography); PKP Index (A database of scientific & scholarly literature); Google Scholar; Index Copernicus; Open Academic Journals Index; Bielefeld Academic search Engine; Open Ukrainian Citation Index (OUCI)

ISSN 1993-7989 (print)
ISSN 1993-7997 (online)
ISSN 1993-7989-L

Теорія та методика фізичного виховання

Науково-методичний журнал

Квітень 2023. Том 23, № 2
https://doi.org/10.17309/tmfv.2023.2

Зміст

ОРИГІНАЛЬНІ НАУКОВІ СТАТТІ

ISSN 1993-7989 (print)
ISSN 1993-7997 (online)
ISSN 1993-7989-L

Physical Education Theory and Methodology

Scientific-methodological journal

April 2023. Vol. 23, Num. 2
https://doi.org/10.17309/tmfv.2023.2

Contents

ORIGINAL SCIENTIFIC ARTICLES

Теорія та методика фізичного виховання
Physical Education Theory and Methodology
Teorìâ ta Metodika Fizičnogo Vihovannâ

ISSN 1993-7989 (print)
ISSN 1993-7997 (online)
ISSN-L 1993-7989

ORIGINAL SCIENTIFIC ARTICLE

INFORMATION EXPOSURE OF ATHLETIC PERFORMANCE, IDOLIZING AND SPORTSMANSHIP ON SPORTS FAN STUDENTS

Hanny Hafiar[1ACDE], Ari Agung Prastowo[1BDE], Putri Limilia[1BDE], Kholidil Amin[1ACD] and Akhmad Olih Solihin[2ABD]

[1]Universitas Padjadjaran
[2]STKIP Pasundan

Authors' Contribution: A – Study design; B – Data collection; C – Statistical analysis; D – Manuscript Preparation; E – Funds Collection

Corresponding Author: Hanny Hafiar, E-mail: hanny.hafiar@unpad.ac.id
Accepted for Publication: January 27, 2023
Published: April 28, 2023

DOI: 10.17309/tmfv.2023.2.01

Abstract

Background. Teenagers who are into sports seek information about their sport, including information about their idol athletes. Idol athletes use social media platforms to distribute information to build their brand image among their fans. One of the social media platforms currently widely used by teenagers as well as by athletes to establish the athletes' brand is Instagram. One type of information about athletes spread on Instagram includes aspects of athletic performance. Referring to the athlete brand image model, they reveal that athletic performance contains elements of sportsmanship. Sportsmanship is a material embedded in sports education as well as an attitude that each adolescent should develop.

Study purpose. The purpose of this study was to elicit an overview of the effect of exposure to information about athletic performance on social media as well as its relationship with idolizing and the formation of sportsmanship values within themselves, both expressed directly and through online media.

Materials and methods. The respondents of this study were 580 adolescents who actively took part in sports activity units at their respective schools and universities. This study applied means to compare followed by simple regression analysis.

Results. The results show that adolescents prefer information that contains elements of sportsmanship, and rivalry. Exposure to information related to athletic performance disseminated by athletes through social media affects adolescents' idolizing attitudes. Idolizing attitude also affects adolescents' sportsmanship shown directly, however, it does not significantly affect sportsmanship being expressed through social media.

Conclusions. Adolescents in different sociodemographic categories have different preferences in selecting information related to athletic performance from their idolized athletes on social media. The formation of sportsmanship in adolescents can be supported by their exposure to information that is related to athletic performance.

Keywords: athletic performance, sportsmanship, sports education, idolizing, social media.

Introduction

The sport has been transformed into an industry and popular culture. The development of mass media has paralleled this into a mass culture industry. Socially, through the media, the sport has become the background of social identity, even fueling the emotions of its fans, becoming fanatics. The phenomenon of fanaticism can occur because fans are passive and pathological victims of the media (Syahputra, 2016). In Indonesia, fanaticism in sports, especially football teams, has become a social problem of its own.

A significant number of clashes between fans have caused material losses and even deaths. Several studies have been produced on the phenomenon of fanaticism in sports. One of them states social media can arouse a sense of love for clubs (including favorite athletes), as well as resentment towards opposing clubs (Bajari, 2017). The love for the favorite club and hatred for the opposing club escalates into an attitude of militancy from the fans. Some football clubs in Indonesia have types of fans described as thugs, rioters, and agents of chaos (Fuller, 2015), who are far from the values of sportsmanship.

This condition certainly is contradicting the common understanding that sport teaches sportsmanship. It is because sports education for adolescents teaches lessons about teamwork, perseverance, and competition (Huston & McKeon, 2017), including sportsmanship. Therefore, one suggestion given in this research is to foster teenage supporters by instilling sportsmanship (Alim et al., 2020). Hence, this study intends to answer this call by conducting research related to sportsmanship among adolescents, especially high school and university students.

Sport has been acknowledged as part of the educational process in forming adolescents to be equipped with the skills to cooperate, negotiate, learn to find solutions, and resolve moral conflicts. Sport is said to help people to learn to display virtues, including fairness, responsibility, team loyalty, teamwork, conformity, and doing what is needed for the common good. It is believed that the positive values people have when engaging in sporting activities support their behavior in public (Lata & Mondello, 2010). The positive values in question include sportsmanship.

The information received by these individuals can influence the establishment of attitudes within individuals. Therefore, there is an expectation that the model information containing sportsmanship sourced from significant others as communicators can encourage the formation of sportsmanship spirit within the communicant. Popular athletes are individuals who have the potential to provide role models for adolescents, especially athletes who are idolized.

An athlete's popularity can be associated with a certain brand image. In connection with the Athlete's brand image, a study examining the behavior of sports team supporters states that brand love and brand personality have a significant effect on brand loyalty (Suhaemi, 2021). Consequently, fans' love and loyalty to a favorite athlete or team can be directed to form sportsmanship and fair play (Nevzat, 2015) in fans through the dissemination of information from the athletic performance aspect which also contains elements of sportsmanship (Arai et al., 2014), through social media. Especially to their adolescent fans.

As individuals, adolescents go through experiences of self-development in every aspect of their lives. An opinion states that sometimes adolescents view sports celebrities are heroic celebrities, and they are more intense in idolizing sports celebrities than other celebrities (Hyman & Sierra, 2010). At the same time, adolescents are also learning to develop their values, such as sportsmanship in a social bond. One aspect that can be used in fostering social bonds is participation and involvement in conventional activities, such as sports (Vermillion, 2014). Socialization and values formation through the field of physical culture and sport for learners in micro and macro environments are related to school, family, and community factors (Krutsevich et al., 2021), as well as the media.

Considering that adolescents receive more information from social media and all learning activities that used to be done offline are now available online, including reading articles, and books, watching films/videos, following social media posts, etc. (Lukianets & Lukianets, 2020). On the other hand, athlete brand formation can also be done on social media (Linsner et al., 2021; Na et al., 2020) through Instagram followers (Hasaan et al., 2016), so information about the athlete's performance can be disseminated by popular athletes through Instagram social media to strengthen their brand as idol athletes while stimulating the development of their fans' sportsmanship attitudes.

Recently, there has been a phenomenon of conflict among sports fans (e.g. football) that occurs in the real world (clashes between the spectators in stadiums) and online (hate speech wars between fanatical fans). The phenomenon of hate speech wars and bullying each other on social media between these fanatical fans show an expression of the lack of fan attitudes in upholding sportsmanship values.

The aim of this study is to determine the exposure of information about athletic performance on social media, as well as its relationship with idolizing and the creation of sportsmanship values within themselves, both expressed directly and through online media. The proposed research objectives include: adolescents' preferences based on sociodemographic to the type of athletics performance information, the relationship between athletics performance variables, idolizing, and sportsmanship among adolescents, and the influence of athletics performance variables on idolizing, and idolizing variables on sportsmanship among adolescents.

Materials and methods

Study participants

The study participants were high school and university students in DKI Jakarta and West Java provinces, Indonesia. The population was those who were actively involved in sports activities. G*power was used to determine the minimum sample size. The size of z, d, the confidence interval, and the sample proportion base on similar research. The required sample size was 384 (Dida et al., 2021), however, the responses from respondents reached 580. The total number of respondents based on sociodemographic categories is presented in Table 1.

The study was conducted in accordance with the ethical principles of the Helsinki Declaration for human research and was approved by the Research Ethics Committee of the Universitas Padjadjaran.

Study organization

This study used a survey research design. We conducted an online survey by distributing a Google form link to a number of WhatsApp groups of sports activity units in schools and universities and included informed consent at the beginning of the questionnaire.

The questionnaire contained several questions comprising items/constructs that related to the measured variables. The questions asked to adopt similar research with the same indicators (Arai et al., 2014). Some questions include Athletic performance Information; information that presents athletics expertise, competition style, sportsmanship, and rivalry (Arai et al., 2013). As for idolizing, we adopted indicators from previous research (Biskup & Pfister, 1999) with indicators of physical ability, appearance, and social behavior.

Furthermore, we asked questions about the variable of sportsmanship displayed directly; we adopted from

Table 1. Information preferences related to athletics performance elements (athletics competence, competition style, sportsmanship, and rivalry) are based on sociodemographic (gender, age, region of origin, economic status, and exposure to information from social media)

Sociodemographic	Category	Athletics competence	Competition style	Sportsman-ship	Rivalry
Gender	Male (n=204)	10.838	10.765	10.877*	10.784
	Female (n=376)	10.601	10.516	11.029	11.157*
Age	Adolescent (n=166)	10.639	10.536	10.886*	10.801
	Early adulthood (n=414)	10.703	10.630	11.012	11.116*
Region	Rural (n=399)	10.649	10.526	10.932	10.962*
	Urban (n=181)	10.762	10.773	11.072	11.166*
Economy	Lower (331)	10.625	10.601	11.003*	10.864
	Middle (n=206)	10.762	10.650	10.893	11.218*
	Upper (n=43)	10.767	10.395	11.163	11.349*
Social media exposure	Low (n=163)	10.460	10.748	11.172	11.239*
	High (n=417)	10.772	10.547	10.899	10.942*

*highest score

similar research (Nevzat, 2015), which is termed fair play. Indicators of this variable include those relating to respect towards teammates, respect conventions, gamesmanship, and cheating. As for the items to measure sportsmanship in online media, we adopted the concept of instigation adapted to the context of online media from previous research (Dwyer et al., 2016) which applies to the concepts examined in this study.

Statistical analysis

Each item was measured using a Likert scale. Point values range from 1 "strongly disagree to 7 strongly agree" and the reverse value for negative questions. In order to avoid potential problems that might be missed, the researcher conducted a pre-test. The pilot study was conducted among 30 respondents who were asked to respond to the questionnaire to ensure its validity of the questionnaire. Furthermore, the researcher also conducted academic discussions with peers. The researcher made some changes to the sentence structure and checked the display format of the questionnaire so that they can access it properly through mobile phone and computer screens.

The purpose of this study is to provide an overview of the exposure to information that contains athletic performance displayed by idol athletes in their social media. This exposure is hypothesized to have a relationship with idolizing, which is a mediating factor in the formation of adolescent sportsmanship attitudes expressed in person and through online media.

Researchers used SPSS version 22. In order to answer the first research objective, researchers calculated the mean of each type of athletics performance information, namely athletics expertise, competition style, sportsmanship, and rivalry (Arai et al., 2013) based on sociodemographic categories. In addition, the researchers conducted a correlation test between the variables studied, namely information related to athletics performance, idolizing, and sportsmanship attitudes. Finally, the researcher conducted a regression analysis of the athletics performance information variable on idolizing and the idolizing variable on sportsmanship attitudes.

Results

Information preference based on sociodemographic

The researcher computed comparative means to determine information preferences based on sociodemographic. Research results regarding the information preferences shown by respondents related to athletics performance elements based on sociodemographic illustrate of information containing elements of sportsmanship, and rivalry is preferred by respondents over information containing elements of athletics competence, and competition style. The results of the calculation and comparison of means are presented in Table 1.

The data in Table 1 shows that although the Mean values between each type of information are not too far apart, the respondents prefer the type of information that contains elements of rivalry to the type of information that contains elements of sportsmanship. It showed this result by the female gender group, early adulthood, from urban and rural areas, middle-and upper economy, and respondents who received low and high exposure to social media information.

Correlation

Further, researchers calculated bivariate correlations to identify correlations between variables of athletics performance (AP), idolizing (ID), sportsmanship shown in person (OFFSP), and sportsmanship expressed through social media (ONSP). The results of the correlation calculation between variables are presented in Table 2.

The results of the study in table 2 show a significant correlation between the variables of athletics performance

Table 2. Correlation analysis results

Var	AP	ID	OFFSP	ONSP
AP	1			
ID	0.246**	1		
OFFSP	0.500**	0.566**	1	
ONSP	0.392**	0.069	0.367**	1

(AP) with idolizing (ID), and sportsmanship shown directly (OFFSP), as well as sportsmanship expressed through social media (ONSP). However, the variables idolizing (ID), and sportsmanship expressed through social media (ONSP) did not show a significant correlation. So the researcher continued the calculation of partial regression analysis.

Regression analysis

In this section, researchers conducted regression analyses to answer several proposed hypotheses, including:

H_1: there is an influence of athletics performance (AP) on idolizing (ID)

H_2: there is an influence of idolizing (ID) on sportsmanship shown directly (OFFSP)

H_3: there is an influence of idolizing (ID) on sportsmanship expressed through social media (ONSP)

H_4: there is an influence of sportsmanship shown directly (OFFSP) on sportsmanship expressed through social media (ONSP).

Researchers conducted statistical analyses using Statistical Product and Service Solution (SPSS) software. We used a simple linear regression test to analyze the data.

Table 3. R Square Results

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
AP-ID	0.246	0.060	0.059	5.3774
ID-OFFSP	0.566	0.320	0.319	10.9697
ID-ONSP	0.069	0.005	0.003	6.4813
OFFSP-ONSP	0.367	0.135	0.133	6.0437

Table 3 shows the R Square value, which is the determinant coefficient defined as the ability value of the independent variable to explain the dependent variable. The highest R Square value is shown by the independent variable idolizing (ID) in explaining the dependent variable sportsmanship shown directly (OFFSP). The lowest R Square value is shown by the independent variable idolizing (ID) in explaining the dependent variable sportsmanship expressed through social media (ONSP).

Table 4 shows the calculation based on ANOVA or F-test. If F-count> F-table and Sig <0.5 then it means that the independent variables proposed in a model can predict the dependent variable being tested. Based on the regression analysis results in table 4, we can see that the F-test results of the calculation of each independent variable in models 1, 2, and 4 can predict the dependent variable being tested. To test the hypothesis, the researcher conducted a t-value test.

Based on the hypothesis, test criteria stated that if the t-count> t-table value and sig <0.5, then H_0 is rejected and Hi is accepted. The t-test results in table 5 show that H_1, H_2, and H_4 are accepted, and H_3 is rejected.

Discussion

Research results show that athletic performance is a significant predictor of shaping idolization. Adolescents who are active in sports activities have idols from among athletes. It is likely that the athletes they idolize are athletes who come from the sport they are involved in. This is under the research that states that sport has a significant role in selecting idols from among athletes (Ilić, 2013). We found a positive relationship between idolizing and sportsmanship.

The potential cause of this result is because the information containing athletic performance also contains

Table 4. F-test Results

Model		Sum of Squares	df	Mean Square	F	Sig.
1. AP-ID	Regression	1074.908	1	1074.908	37.17	.000*
	Residual	16713.815	578	28.917		
	Total	17788.722	579			
2. ID-OFFSP	Regression	32745.483	1	32745.483	272.12	.000*
	Residual	69552.715	578	120.333		
	Total	102298.198	579			
3. ID-ONSP	Regression	115.492	1	115.492	2.75	.098
	Residual	24280.515	578	42.008		
	Total	24396.007	579			
4. OFFSP-ONSP	Regression	3283.783	1	3283.783	89.90	.000*
	Residual	21112.224	578	36.526		
	Total	24396.007	579			

*sig < 0.05

Table 5. t-test Results

Hypothesis	Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Desicion
		B	Std. Error	Beta			
H_1	AP*ID	0.259	0.042	0.246	6.097	0.000*	accepted
H_2	ID*OFFSP	1.357	0.082	0.566	16.496	0.000*	accepted
H_3	ID*ONSP	0.081	0.049	0.069	1.658	0.098	rejected
H_4	OFFSP*ONSP	0.179	0.019	0.367	9.482	0.000*	accepted

*sig < 0.05

elements of sportsmanship. Because sportsmanship is indeed one indicator of athletic performance (Arai et al., 2014). Apart from forming idolization, a previous study stated that athletic performance positively influenced fan loyalty (Mahmoudian et al., 2021). So the athletes who are developing their brand image among fans should consider disseminating information related to athletic performance to increase the love and loyalty of their fans.

Athletic performance is included in the athlete's on-field attributes (Hasaan & Fişne, 2021). There are several aspects that affect athletic performance (Watt & Hogan, 2018). One of them is communicating with a significant other because communicating with family and friends can have a positive impact on athletic performance (Hayes et al., 2019).

For an adolescent who is in the phase of psychological and social development, the figure and character of the idol will color the shaping of his attitudes and values, including the shaping of sportsmanship. This is because various aspects of value orientation formation have relevance to activities in physical culture and sports (Bakiko et al., 2022). A positive value orientation will at least prevent someone from cheating. This is in line with the opinion that behavioral control and perceived moral obligations significantly predict the intention and motivation of an athlete's deviant behavior in sports (Kang et al., 2021).

In this era of information openness, it can spread misconduct behavior among athletes through interpersonal mechanisms and through the media. Either verbal or non-verbal (Vveinhardt, 2017). In the sports world, deviant behavior that is currently rife includes racist verbal violence shown even when the athlete is competing and broadcast live on television. This condition is quite concerning, considering that some of their fans are adolescents who are still forming their personalities, including learning to be sportsmanlike people.

In the world of sports, the concept of sportsmanship is still difficult to understand. Because on the one hand, most people consider sports as a vehicle to build a strong character. But in the end, the perception of strength leads to a victory-orientated mental attitude (Lata & Mondello, 2010). Whereas victory is the result that must be got through a long process.

This creates its own risks when considering the number of adolescents who idolize the athletes. Adolescents who initially only idolize sports celebrities can shift into fans who have unhealthy obsessions (Hyman & Sierra, 2010) as showing excessive support and imitation. Especially if the idol athlete exhibits "win at all costs" behavior. Then it is not impossible if many adolescent sports participants will adopt a similar mentality (Lata & Mondello, 2010). This is because sports are not only about skill and winning, but also about prioritizing how to work together as a professional team (Dijkstra et al., 2014).

This research has several implications. First, it directs adolescents to choose idols more carefully. Although adolescence is a phase where the peer group position is considered more dominant (Raviv et al., 1996). However, at this point, the role of the family is needed in directing adolescents to choose idols and adopt role models from their idols.

The further implication of this study is to provide consideration to educational institutions in sport, especially higher education. Although studies of both the intellectual and life skills benefits of athletic participation have been conducted in several empirical studies, athletic-centered curricula have not traditionally been offered for academic credit in higher education (Molly & Weight, 2019).

This study has several limitations, including not measuring the level of influence of each variable in adolescent groups based on demographics and social ethnography. In relation to the use of information through digital media, there is a health study that states that various results from searching for information on the Internet are most strongly predicted by gender (Rice, 2006). Another study found that boys and girls showed differences in indicators of self-esteem, physical development, and priority in the choice of value orientation (Bakiko et al., 2022). So for future research, we recommend it to test the exposure of athletic performance information on the formation of adolescent attitudes in several categories, for example, based on gender.

Conclusions

The information preferences shown by respondents related to athletics performance elements (athletics competence, competition style, sportsmanship, and rivalry) based on sociodemographic (gender, age, region of origin, economic status, and exposure to information from social media) illustrate that information containing elements of sportsmanship, and rivalry is preferred by respondents than information containing elements of athletics competence. Respondents prefer the type of information that contains elements of rivalry to the type of information that contains elements of sportsmanship. There are different preferences shown by each group in the sociodemographic category. The female gender, early adulthood, urban and rural, middle and upper economic groups, and respondents who received low and high exposure to social media information preferred information containing rivalry elements, while the male gender and lower economic status groups preferred information containing sportsmanship elements.

The information exposure related to athletics performance disseminated by athletes through social media affects the attitude of idolization by adolescents. Idolizing attitudes also affect adolescent sportsmanship shown directly, however, it does not significantly affect sportsmanship expressed through social media. However, sportsmanship shown directly affects sportsmanship expressed by adolescents through social media. Therefore, the researcher suggested to future researchers to examine the simultaneous effect among the concepts examined in this study.

Acknowledgment

We acknowledge the support received from the Universitas Padjadjaran, Research University (RU) Grant (2203/UN6.3.1/PT.00/2022).

Conflict of interest

The authors state that there is no conflict of interests.

References

Syahputra, I. (2016). Terbentuknya Identitas Fans Sepak Bola sebagai Budaya Massa dalam Industri Media. *Informasi, 46*(2), 205. https://doi.org/10.21831/informasi.v46i2.11377

Bajari, A. (2017). Language Provocation on Football Fanatic Fans (Study of Virtual Communication Ethnography on Facebook

of Football Fans Club in Indonesia). *Proceedings of the 3rd World Conference on Media and Mass Communication,* 2, 1-12. https://doi.org/10.17501/medcom.2017.2101

Fuller, A. (2015). Approaching football in Indonesia. *Soccer and Society, 16*(1), 140-148. https://doi.org/10.1080/14660970.2014.954387

Huston, J. L., & McKeon, P. O. (2017). Ethics of youth sports: Protecting our future. *International Journal of Athletic Therapy and Training, 22*(1), 33-37. https://doi.org/10.1123/ijatt.2016-0019

Alim, A., Adam, I., Kurniawati, M., Widyani, N. R., Nugroho, S. D., Cahyono, J. E., & Amalia, S. R. (2020). Football fans space training as a media for character development in preventing negative fanaticism of The Kalasan 1 junior high school football supporters. *International Journal Humanitarian Responsibilities, Education & Sport Sciences (IJHRESS), 1*(1), 31-36. https://journal.uny.ac.id/index.php/ijhress/article/view/35305

Lata, J., & Mondello, M. (2010). An Analysis of Goal Achievement Orientation and Sport Morality Levels of Division I-A Nonrevenue Collegiate Athletes. *Journal for the Study of Sports and Athletes in Education, 4*(1), 69-94. https://doi.org/10.1179/ssa.2010.4.1.69

Suhaemi, M. (2021). The Effect Brand Love And Brand Personality On Brand Loyalty (Study On Member Fans Club Football Manchester United In Indonesia). *Management, Business and Social Science (IJEMBIS) Peer Reviewed-International Journal, 1*(2), 209-218. https://cvodis.com/ijembis/index.php/ijembis

Nevzat, M. (2015). The validity and reliability of Turkish version of fair play questionnaire in Physical Education (FPQ-PE) and an implementation. *Educational Research and Reviews, 10*(17), 2469-2480. https://doi.org/10.5897/err2015.2402

Arai, A., Ko, Y. J., & Ross, S. (2014). Branding athletes: Exploration and conceptualization of athlete brand image. *Sport Management Review,* 17, 97-106. https://doi.org/10.1016/j.smr.2013.04.003

Hyman, M. R., & Sierra, J. J. (2010). Idolizing sport celebrities: A gateway to psychopathology? *Young Consumers, 11*(3), 226-238. https://doi.org/10.1108/17473611011074296

Vermillion, M. (2014). Sport Participation and Adolescent Deviance: A Logistic Analysis. *Social Thought and Research, 28*(316), 227-258. https://doi.org/10.17161/str.1808.5228

Krutsevich, T., Marchenko, O., Trachuk, S., Panhelova, N., Napadij, A., & Dovgal, V. (2021). The configuration of educational factors in the family in terms of their impact on the formation of interest in sports in middle school children. *Physical Education Theory and Methodology, 21*(2), 101-106. https://doi.org/10.17309/TMFV.2021.2.01

Lukianets, H., & Lukianets, T. (2020). Global communication competence: A framework of intercultural skills development in sport and tourism higher education. *Physical Education Theory and Methodology, 20*(2), 77-85. https://doi.org/10.17309/tmfv.2020.2.03

Linsner, A., Sotiriadou, P., Hill, B., & Hallmann, K. (2021). Athlete brand identity, image and congruence: A systematic literature review. *International Journal of Sport Management and Marketing, 21*(1-2), 103-133. https://doi.org/10.1504/IJSMM.2021.114166

Na, S., Kunkel, T., & Doyle, J. (2020). Exploring athlete brand image development on social media: the role of signalling through source credibility. *European Sport Management Quarterly, 20*(1), 88-108. https://doi.org/10.1080/16184742.2019.1662465

Hasaan, A., Kerem, K., Biscaia, R., & Agyemang, K. J. A. (2016). Athlete brand construction: A perspective based on fans' perceptions. *Motriz: Revista de Educacao Fisica, 22*(3), 144-159. https://doi.org/10.1590/S1980-6574201600030005

Arai, A., Ko, Y. J., & Kaplanidou, K. (2013). Athlete brand image: Scale development and model test. *European Sport Management Quarterly, 13*(4), 383-403. https://doi.org/10.1080/16184742.2013.811609

Biskup, C., & Pfister, G. (1999). I would like to be like her/him: Are Athletes role-models for boys and girls? *European Physical Education Review, 5*(3), 199-218. https://doi.org/10.1177/1356336X990053003

Dwyer, B., LeCrom, C., & Greenhalgh, G. P. (2016). Exploring and Measuring Spectator Sport Fanaticism. *Communication and Sport,* 1-28. https://doi.org/10.1177/2167479516679411

Ilić, J. (2013). Sports idols of senior athletes. *Sportlogia, 9*(1), 8-14. https://doi.org/10.5550/sgia.130901.en.002i

Mahmoudian, A., Sadeghi Boroujerdi, S., Mohammadi, S., Delshab, V., & Pyun, D. Y. (2021). Testing the impact of athlete brand image attributes on fan loyalty. *Journal of Business and Industrial Marketing, 36*(2), 244-255. https://doi.org/10.1108/JBIM-10-2019-0464

Hasaan, A., & Fişne, M. (2021). Understanding the dimensions of athlete brand authenticity. *Pensar En Movimiento: Revista de Ciencias Del Ejercicio y La Salud, 19*(2), e47119. https://doi.org/10.15517/pensarmov.v19i2.47119

Watt, R., & Hogan, S. (2018). Are athletes on the right track? The effect of availability of an all-weather athletics track on athletics performance. *Sport in Society, 21*(3), 546-557. https://doi.org/10.1080/17430437.2017.1346626

Hayes, M., Filo, K., Riot, C., & Geurin, A. (2019). Athlete perceptions of social media benefits and challenges during major sport events. *International Journal of Sport Communication, 12*(4), 449-481. https://doi.org/10.1123/ijsc.2019-0026

Bakiko, I., Krutsevich, T., & Trachuk, S. (2022). Effect of Physical Development Self-Assessment Indicators on Value Orientation Structure Formation in Senior School Age Students. *Physical Education Theory and Methodology, 22*(2), 151-157. https://doi.org/10.17309/tmfv.2022.2.01

Kang, S., Kim, I., & Lee, K. (2021). Predicting Deviant Behaviors in Sports Using the Extended Theory of Planned Behavior. *Frontiers in Psychology, 12*(September), 1-9. https://doi.org/10.3389/fpsyg.2021.678948

Vveinhardt, J. (2017). *Different forms of deviant behaviour among athletes: what are the consequences?* May, 11-14.

Dijkstra, H. P., Pollock, N., Chakraverty, R., & Alonso, J. M. (2014). Managing the health of the elite athlete: A new integrated performance health management and coaching model. *British Journal of Sports Medicine, 48*(7), 523-531. https://doi.org/10.1136/bjsports-2013-093222

Raviv, A., Bar-Tal, D., Raviv, A., & Ben-Horin, A. (1996). Adolescent idolization of pop singers: Causes, expressions, and reliance. *Journal of Youth and Adolescence, 25*(5), 631-650. https://doi.org/10.1007/BF01537358

Molly, H., & Weight, E. A. (2019). Education through Athletics: Interest in an Athletics Performance Curriculum. *Journal of Applied Sport Management, 11*(4), 15-28. https://doi.org/10.18666/jasm-2019-v11-i4-9608

Rice, R. E. (2006). Influences, usage, and outcomes of Internet health information searching: Multivariate results from the Pew surveys. *International Journal of Medical Informatics, 75*(1), 8-28. https://doi.org/10.1016/j.ijmedinf.2005.07.032

ІНФОРМАЦІЙНИЙ ВПЛИВ СПОРТИВНИХ ПОКАЗНИКІВ, ПРОЦЕСУ СТВОРЕННЯ КУМИРІВ І СПОРТИВНОЇ МАЙСТЕРНОСТІ НА УЧНІВ І СТУДЕНТІВ-ФАНАТІВ РІЗНИХ ВИДІВ СПОРТУ

Ханнь Хафіар [1ACDE], Арі Агун Прастово[1BDE], Путрі Лімілія[1BDE], Холіділ Амін[1ACD], Ахмад Оліх Соліхін[2ABD]

[1]Університет Паджаджаран
[2]Педагогічний коледж Пасундан в Чімахі

Авторський вклад: A – дизайн дослідження; B – збір даних; C – статаналіз; D – підготовка рукопису; E – збір коштів

Реферат. Стаття: 7 с., 5 табл., 31 джерело.

Історія питання. Підлітки, які займаються спортом, шукають інформацію про свій вид спорту, а також інформацію про своїх спортсменів-кумирів. Спортсмени-кумири використовують платформи соціальних мереж для поширення інформації з метою створення свого образу бренду спортсмена серед своїх фанатів. Однією з платформ соціальних мереж, якою зараз широко користуються підлітки, а також спортсмени для створення свого бренду спортсмена, є Instagram. Один із видів інформації про спортсменів, що поширюється в Instagram, включає аспекти спортивних показників. Звертаючись до моделі образу бренду спортсмена, вони виявляють, що спортивні показники містять елементи спортивної майстерності. Спортивна майстерність є одним із матеріалів, закладених у спортивне виховання, а також ставленням, яке має розвивати в собі кожен підліток і юнак.

Мета дослідження. Метою цього дослідження було отримання огляду щодо впливу інформації про спортивні показники в соціальних мережах, а також її зв'язку зі створенням кумирів і формуванням цінностей спортивної майстерності в них самих, як безпосередньо, так і через онлайн-мережі.

Матеріали та методи. Учасниками цього дослідження були 580 підлітків і юнаків, які активно брали участь у спортивних секціях у своїх відповідних школах та університетах. У цьому дослідженні застосовували засоби порівняння з подальшим простим регресійним аналізом.

Результати. Результати показують, що підлітки та юнаки віддають перевагу інформації, яка містить елементи спортивної майстерності та суперництва. Інформація про спортивні показники, яку спортсмени поширюють через соціальні мережі, впливає на ставлення підлітків до створення кумирів. Ставлення до створення кумирів також впливає на спортивну майстерність підлітків, яка демонструється безпосередньо, однак воно не суттєво впливає на спортивну майстерність, яка виражається через соціальні мережі.

Висновки. Підлітки та юнаки в різних соціально-демографічних категоріях мають різні переваги у виборі інформації, пов'язаної зі спортивними показниками, яку їхні спортсмени-кумири розміщують у соціальних мережах. Формуванню спортивної майстерності підлітків і юнаків можна сприяти шляхом їх ознайомлення з інформацією, яка стосується спортивних показників.

Ключові слова: спортивні показники, спортивна майстерність, спортивне виховання, створення кумирів, соціальні мережі.

Information about the authors:

Hafiar, Hanny: hannyhafiar@gmail.com; https://orcid.org/0000-0003-2265-274X; Faculty of Communication Science, Universitas Padjadjaran, Jl. Raya Bandung Sumedang KM. 21, Hegarmanah, Kec. Jatinangor, Kabupaten Sumedang, Jawa Barat 45363, Indonesia.

Prastowo, Ari Agung: ari.agung@unpad.ac.id; https://orcid.org/0000-0002-2651-2296; Faculty of Communication Science, Universitas Padjadjaran, Jl. Raya Bandung Sumedang KM. 21, Hegarmanah, Kec. Jatinangor, Kabupaten Sumedang, Jawa Barat 45363, Indonesia.

Limilia, Putri: p.limilia@unpad.ac.id; https://orcid.org/0000-0003-1744-863X; Faculty of Communication Science, Universitas Padjadjaran, Jl. Raya Bandung Sumedang KM. 21, Hegarmanah, Kec. Jatinangor, Kabupaten Sumedang, Jawa Barat 45363, Indonesia.

Amin, Kholidil: kholidil20001@mail.unpad.ac.id; https://orcid.org/0000-0003-3030-9634; Faculty of Communication Science, Universitas Padjadjaran, Jl. Raya Bandung Sumedang KM. 21, Hegarmanah, Kec. Jatinangor, Kabupaten Sumedang, Jawa Barat 45363, Indonesia.

Solihin, Akhmad Olih: yoyoolih@gmail.com; https://orcid.org/0000-0002-2745-5000; Study Program of Physical Education, Health, and Recreation, STKIP Pasundan Cimahi, Jl. Permana No.32B, Citeureup, Kec. Cimahi Utara, Kota Cimahi, Jawa Barat 40512, Indonesia.

Cite this article as: Hafiar, H., Prastowo, A.A., Limilia, P., Amin, K., & Solihin, A.O. (2023). Information Exposure of Athletic Performance, Idolizing and Sportsmanship on Sports Fan Students. *Physical Education Theory and Methodology, 23*(2), 155-161. https://doi.org/10.17309/tmfv.2023.2.01

Received: 29.07.2022. Accepted: 27.01.2023. Published: 28.04.2023

Теорія та методика фізичного виховання
Physical Education Theory and Methodology
Teorìâ ta Metodika Fìzičnogo Vihovannâ

ISSN 1993-7989 (print)
ISSN 1993-7997 (online)
ISSN-L 1993-7989

ORIGINAL SCIENTIFIC ARTICLE

EXPERIENCED VS INEXPERIENCED DISABLED SWIMMERS: TRAINING LOAD AND RECOVERY IN PREPARATION PERIOD

Kunjung Ashadi[1ABCD], Oktia Woro Kasmini Handayani[1ACD], Hari Setijono[2ACD], Tri Rustiadi[1ACD], Sugiharto[1ACD] and Soegiyanto[1ACD]

[1]Universitas Negeri Semarang
[2]Universitas Negeri Surabaya

Authors' Contribution: A – Study design; B – Data collection; C – Statistical analysis; D – Manuscript Preparation; E – Funds Collection

Corresponding Author: Oktia Woro Kasmini Handayani, E-mail: oktia2016@mail.unnes.ac.id
Accepted for Publication: January 27, 2023
Published: April 28, 2023

DOI: 10.17309/tmfv.2023.2.02

Abstract

The study purpose was to analyse the training load and recovery of experienced and inexperienced swimmers with disabilities.

Materials and methods. The study subjects consisted of seven swimming athletes with disabilities at the provincial level who underwent training camps in preparation for the Indonesia Paralympics Games. The groups of athletes were divided based on their level of training and experience in national championships. For thirteen weeks, the athletes monitored their training load and recovery rate. Borg CR-10 was used to measure the internal training load, while the athlete's recovery rate was measured using Total Quality Recovery (TQR). IBM SPSS Statistics version 22 was used to analyse normality and test differences between the two groups. The Mann-Whitney test was used to test the significance of the RPE Borg CR-10, while the unpaired T-test was used to test the significance of the TQR.

Results. The Borg CR-10 mean for the experienced athlete group was 7.78±0.47, while it was 8.28±0.56 ($p<0.05$) for the inexperienced athlete group. The RPE mean for the experienced athlete group was 18.24±1.47, while it was 18.52±1.57 ($p>0.05$) for the inexperienced athlete group. Furthermore, the Borg RPE shows the training load of experienced athletes of 17.12±1.03, which is lower than the average RPE of inexperienced athletes of 18.21±1.24, and also the TQR average of experienced athletes was of 18.24±1.47, while it was of 18.52 ±1.55 ($p<0.05$) in case of inexperienced athletes.

Conclusions. Experienced para-swimmers had a significantly different training load than inexperienced para-athletes. In addition, the training load of experienced para athletes was also significantly different compared to the recovery rates of experienced and inexperienced para swimmers.

Keywords: monitoring, training, disability, periodisation, swimming, athlete.

Introduction

The balance of training load and recovery is essential for athletes to achieve high performance sustainably (Kellmann et al., 2018). Training load is the cumulative load experienced by an athlete from one or more training sessions over a while. Meanwhile, recovery is an athlete's recovery activity after experiencing a training load so that his condition returns to normal (Schwellnus et al., 2016). Therefore, monitoring the training load and recovery during the training process is essential to achieve balance.

Training load can be known through measurement, either internally or externally. Internal training load-measuring tools include the rating of perceived exertion (RPE), pulse and lactate measurements (McGuigan, 2017). External training load was measured using the Global Positioning System (GPS), time motion analysis, accelerometers and power meters; (Halson, 2014; McGuigan, 2017; McLaren et al., 2016). When compared between the internal and external training loads, a systematic study shows that the internal training load has a stronger relationship with performance than the external training load (Fox, Stanton, Sargent, Wintour, & Scanlan, 2018).

Athletes need sufficient training load to get a stimulus or stimulation for their body to experience the process of increasing physical capacity. Therefore, giving a training

load that is too light does not encourage positive adaptation and risks reducing the performance (Bourdon et al., 2017). On the other hand, a training load that is too large is at risk of causing a decrease in performance, overreaching, and an increased risk of illness or injury, and if it occurs for a long time, it will cause overtraining (Hulin et al., 2014).

Concerning training load, the results of the study show that coaches and athletes have different assessments of training load in training sessions (Foster, Heimann et al., 2001; Rodríguez-Marroyo et al., 2014). The risk of an inappropriate training load results in a decrease in physical condition or, on the other hand, even an increase in non-functional overreaching, overtraining, and risk of injury and illness (Doeven et al., 2017; Nässi et al., 2017). For this reason, monitoring can help correct this (McGuigan, 2017).

There is a considerable risk when athletes experience an increase in their training load, resulting in a temporary decrease in physical and mental abilities. Therefore, recovery has a strategic role in accelerating the recovery of physical and mental adaptation to be ready for the next training activity and reducing the risk of injury in the long term (Bishop, Jones, & Woods, 2008). For this reason, a recovery program is needed, both physically and mentally, to assist the process of physical and mental repair and regeneration so that athletes are fully recovered and physically and mentally ready to receive the following training program (Kellman & Beckmann, 2018).

Ideally, to improve performance in the sports coaching process, it is crucial and routine to monitor the training load and recovery. Knowing the training load and recovery data can be used to make decisions to continue or change the training load in the next exercise and maintain or provide a different portion of the recovery to achieve physical and mental balance super-compensation. Research on monitoring training load and recovery has been carried out in various sports (Andrade et al., 2021; Sansone et al., 2020; Tiernan et al., 2020a; Wilke et al., 2020). Likewise, in the sport of swimming (Collette et al., 2018; Pollock et al., 2019). Furthermore, further research on training load (Sinnott-O'Connor et al., 2018) and recovery in persons with disabilities has also been carried out (Rosa et al., 2020). However, there is still no investigation into training load and recovery associated with experienced and inexperienced disabled swimmers. Therefore, this research was conducted to study the comparative conditions of training load and recovery for experienced and inexperienced disabled swimming athletes.

Materials and methods

Study participants

The subjects in this study were all provincial-level disabled swimming athletes who underwent training camps in the preparation phase of training for the Indonesian National Paralympic Week, amounting to seven people. Three swimmers with a swimming history of more than ten years and who have jumped more than once at the National Paralympic Week are listed as experienced athletes, while the less experienced athlete group consists of four swimmers with less than five years of flying hours which never have and poor experience. National Paralympics.

Study organization

For thirteen weeks, athletes monitored their training load and recovery rate. Borg CR-10, with a scale of 0-10, is used as an internal training load measurement tool (Rodríguez-Zamora et al., 2014). In addition, the level of recovery quality was measured using a Total Quality Recovery (TQR) questionnaire with a scale of 0-20 (Kenttä & Hassmén, 1998). Before recording the data at the beginning of the training, all athletes understood the procedure for assessing the rating of perceived exertion based on the perceived subjective training load, recovery education and how to fill out a total quality recovery questionnaire based on the daily recovery pattern. In addition, athletes have also given verbal form consent as a form of approval. This research complies with the Declaration of Helsinki and has been declared ethically acceptable by the health research ethics committee of Airlangga University's School of Medicine No. 266/EC/KEPK/FKUA/2021.

During the training process, athletes were asked to rate their training load for each session consisting of 13 sessions per week. Each athlete is, at the latest, to give a Borg CR-10 assessment 15 minutes after the training session ends (FOSTER et al., 2001). Furthermore, each athlete was asked to honestly answer the training load about the quality of recovery he experienced daily. The Borg CR-10 and TQR data results were analysed, and the average value was calculated weekly for 13 weeks.

Statistical analysis

IBM SPSS Statistics version 22 was used to analyse normality and test differences between the two groups. Shapiro Wilk test for data normality, Mann Whitney test was used to test the significance of the RPE Borg CR-10 for both groups, while the unpair T-test was used to test the TQR significance for groups of experienced and inexperienced athletes, and the Kruskal Wallis test for the RPE Borg CR-10 and TQR group of experienced and inexperienced athletes.

Results

Data about the profiles of para-swimming athletes who are the subjects in this study are presented in Table 1.

Based on table 1, it is known that based on the age aspect, it is known that overall more athletes are under 20 years old than athletes over 20 years old. The dominance of athletes aged less than 20 years was seen in the group of experienced athletes. Overall, the youngest athlete's age is 16 years, while the oldest athlete's age is 47 years. The average age of the experienced athlete group was 27.33±17.04, while the average age of the inexperienced athlete group was 23.50±7.94. Furthermore, in terms of gender, most research subjects are male. It was also evident in both groups. Next, based on the type of disability, it is known that most research subjects experience physical disorders. It is also the same for the inexperienced athlete group, but on the contrary, the experienced athlete group is dominated by visually impaired athletes. It was moving on to the training load data shown in Figure 1.

Based on the data in Figure 1 regarding the comparison of weekly RPE between trained and untrained athletes,

Table 1. Profile of Research Subject

Parameter		Group		Overall Subject of Research
		Experienced	Inexperienced	
Age	<20 years old	66.67%	50%	58.33%
	>20 years old	33.33%	50%	41.67%
Sex	Male	66.67%	75%	70.83%
	Female	33.33%	25%	29.17%
Disability	Physical Impairment	33.33%	100%	66.66%
	Visual Impairment	66.67%	0%	33.34%

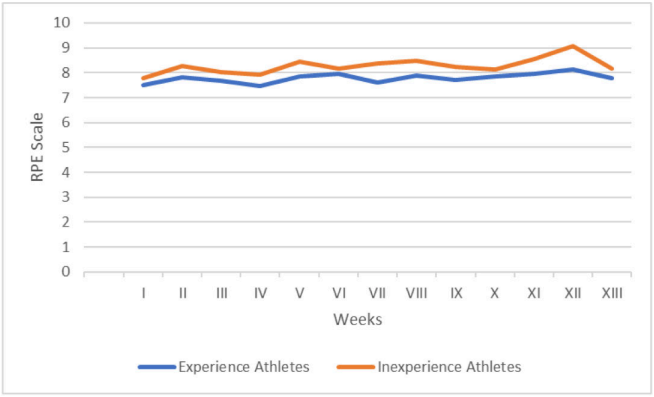


Fig. 1. Comparison of RPE Borg CR-10 Weekly Score Experienced and Inexperienced
Description: average weekly training load value based on Borg CR-10

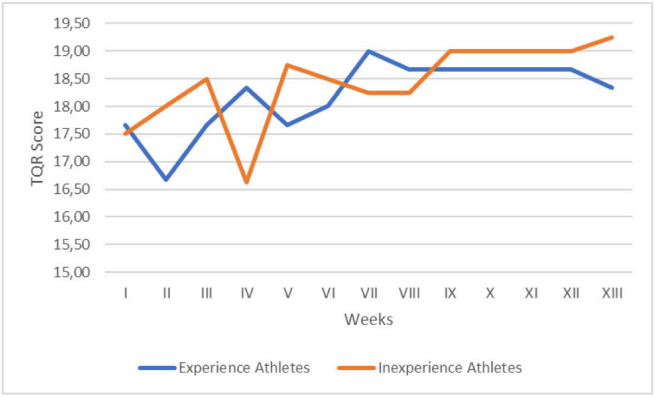


Fig. 2. Comparison of the weekly TQR Score for the Experience and Inexperience groups
Description: average weekly recovery scores based on TQR Kentta 20 Scale

it is known that the untrained athlete group has a higher average weekly RPE value than the trained athlete group. Furthermore, the calculation results show that the average RPE value for 13 weeks for the trained athlete group is 7.78 ± 0.47, while the untrained athlete group is 8.28 ± 0.56. Therefore, it ensures that the untrained group of athletes felt a higher training load during the training process than the trained group. Furthermore, based on the Mann-Whitney test with a significance level of 0.05, it is known that the p-value is 0.000 <0.05, which means that there is a significant difference between the RPE of the experienced and inexperienced athlete groups. Therefore, during 13 weeks of training, it was found that the inexperienced athlete group had a significantly higher training load than the experienced athlete group. Furthermore, the comparison of weekly TQR values between groups of experienced and inexperienced athletes is shown in Figure 2.

Based on the data in Figure 2 regarding the comparison of weekly TQR scores for groups of trained and untrained athletes, it is known that the data for the two groups seem to intersect with a range of values between 16.50-19. Furthermore, the calculation results show that the average TQR value for 13 weeks for the trained athlete group is 18.24±1.47, while the untrained athlete group is 18.52±1.57. Both groups have an excellent average recovery pattern, but the untrained athlete group scores slightly higher than the trained athlete group. Furthermore, an unpaired T-test was conducted to determine the significance level of the difference in the recovery rate between the two groups. The unpaired T-test results with a significance level of 0.05 showed a p-value of 0.265> 0.05. It shows no significant difference in TQR scores between the experienced and non-experienced groups. During 13 weeks of training, it was found that the inexperienced athlete group had a slightly higher recovery rate than the experienced athlete group but not significantly.

Furthermore, to compare the RPE and TQR scores, the RPE CR-10 was converted to Borg on a scale of 6-20. RPE with a Borg scale of 6-20 and a Borg scale of 0-10 have a strong relationship and significance and can be converted to each other (Arney et al., 2019; Hutchinson et al., 2021) and recreationally active participants with paraplegia (PARA. Therefore, to get the data transformation to the Borg scale 06-20, the calculation results of the existing RPE CR-10 are multiplied by 2,21. This data conversion is carried out so that there is a similarity in the pattern of the maximum limit value on the RPE and TQR, which is 20 points. The results of the comparison of RPE and TQR for experienced and inexperienced athletes are presented in Figure 3.

Figures 3 and 4 show that the RPE Borg score of experienced athletes is 17.12 ± 1.03, which looks lower than the RPE Borg of inexperienced athletes with an average of 18.21 ± 1.24, and the TQR of experienced athletes is 18. 24±1.47 and inexperienced at 18.52±1.55. Furthermore, to determine the significance of the difference between the RPE Borg and TQR scores of experienced and inexperienced athletes, the Kruskal Wallis test was carried out with a significance level of 0.05. Therefore, based on the test results, it is known that the p-value is 0.000 <0.05. Therefore, it shows a significant difference between the RPE Borg of the

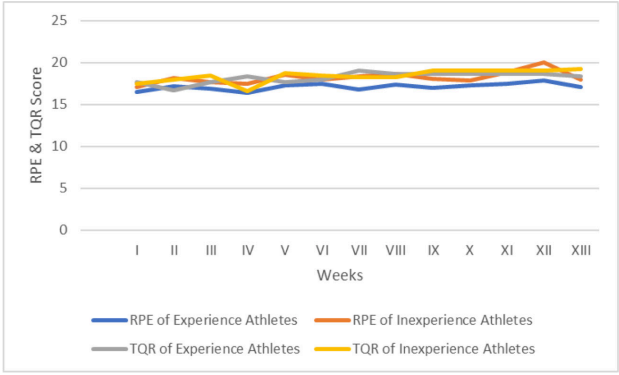


Fig. 3. Comparison of Average Weekly RPE Borg and TQR scores of experienced and inexperienced athletes
Description: Average weekly value of training load based on Borg 6-20 scale and recovery based on TQR Kentta 20 Scale

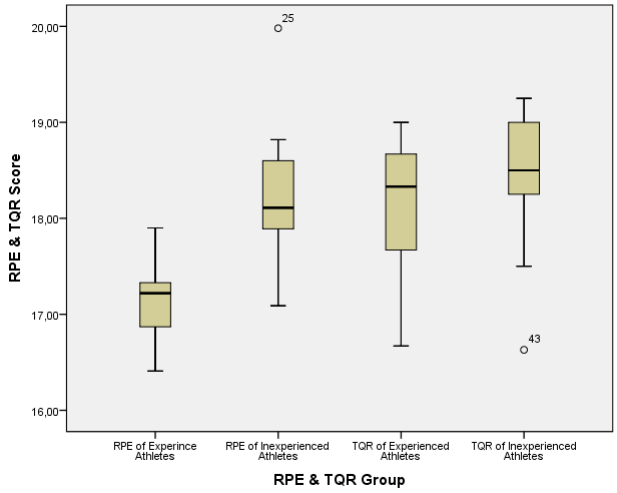


Fig. 4. Comparison of the Average RPE Borg Overall Score and TQR groups of experienced and inexperienced athletes
Description: comparison of the mean±standard deviation of training load and recovery of experienced and inexperienced para athletes

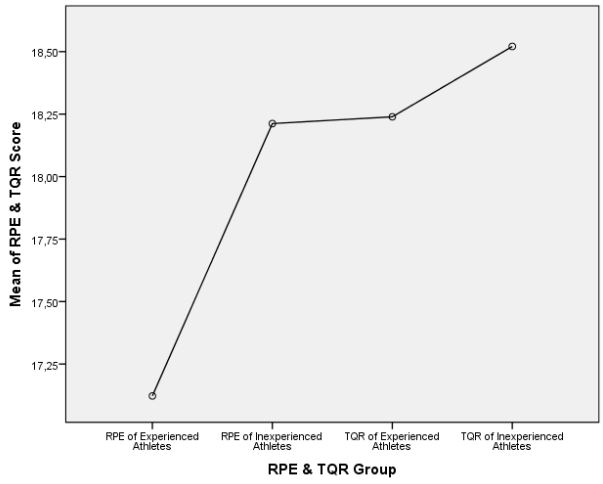


Fig. 5. Comparison of Average RPE and TQR Overall Scores of experienced and inexperienced athletes
Description: comparison of the mean of training load and recovery of experienced and inexperienced para athletes

experienced athlete group compared to the RPE Borg and TQR of the inexperienced athlete group and the TQR of the experienced athlete group. For more detail, the significant difference is shown in Figure 5.

Based on the average score for 13 weeks shown in Figure 5, it is known that the RPE Borg score for the experienced athlete group looks significantly different and is below the Borg RPE and TQR for the inexperienced athlete group the experienced athlete's TQR.

Discussion

Athletes need sufficient training load so that their bodies get the right and progressive stimulation according to the training period so that they can experience an increase in physical capacity from time to time. Measuring the training load of athletes can be done in various ways, counting questionnaires, journal, physiological checking and straight observation (Borresen & Ian Lambert, 2009). One tool that is easy to use is RPE. The use of RPE is based on the consideration that it has high validity and reliability, is inexpensive and is the most widely used as an internal training tool (Halson, 2014; Paulson, Mason, Rhodes, & Goosey-Tolfrey, 2015; Sams et al., 2020). However, the use of RPE in young athletes should also be done with caution because of their lack of reliable ability to measure perceived load and effort (Bourdon et al., 2017). To avoid errors and misperceptions of data entry, all athletes in this study were educated to assess the training load at the beginning of the training period. As a result, there was a shared perception of the limits of the correct range of values according to the load experienced before finally giving an assessment based on the perceived training load.

The findings of this study indicate that in the preparation period, the less experienced athletes had a significantly greater average training load than the group of experienced swimmers. There are several arguments for why inexperienced athletes experience higher training loads. First, it is because experienced athletes have a higher technical quality. The high quality of movement techniques impacts increasing work efficiency so that athletes can mobilise energy efficiently in completing training programs. This is in line with research results which show that technical parameters have a significant effect on swimming results (Strzała & Tyka, 2009). In competitive swimming, stroke technique is one factor that affects energy costs converted into speed (Barbosa, Fernandes, Keskinen, & Vilas-Boas, 2008). In addition, the more excellent the physical ability, the athlete does not feel tired quickly and does not experience a significant decrease in swimming technique. When a swimmer experiences fatigue, there is a reduction in stroke length on both arms, especially in external rotation and joint position on the dominant arm due to fatigue (Matthews, Green, Matthews, & Swanwick, 2017). It is much different compared to the group of inexperienced swimmers. Limitations of physical ability and imperfect swimming techniques cause inexperienced athletes to spend more energy to complete the existing training program with higher levels of fatigue than experienced athletes. This study's results align with the results of several previous studies. The difference in strength performance between beginner and elite athletes is influenced by the quality of the training experience and

muscle ability and aerobic endurance (McKendry et al., 2020; Mersmann, Charcharis, Bohm, & Arampatzis, 2017).

Furthermore, the results of research (Ferioli et al., 2018) state that in the periodisation of preparation, professional athletes have greater strength and power than athletes with lower levels. In addition, elite athletes experience lower levels of inflammation and oxidative stress than athletes with lower levels (Al-Muraikhy et al., 2021). It shows that, in general, experienced athletes have the better physical condition than inexperienced athletes.

In the preparation period, when athletes experience a significant and drastic increase in load, this causes the risk of injury (Hulin et al., 2014). In addition, during the preparation period, athletes tend to experience an increase in training load, fatigue, creatine kinase levels and psychological stress (Horta, Bara Filho, Coimbra, Miranda, & Werneck, 2019; Selmi, Ouergui, Castellano, Levitt, & Bouassida, 2020a). Psychophysiological stress can occur in athletes both at the training and competition stages. This stress increase can negatively impact recovery rates and performance (Sinnott-O'Connor et al., 2018). Therefore, the balance between training load and recovery rate is critical for athletes to achieve high performance sustainably (Kellman et al., 2018).

Recovery plays a vital role in the coaching process. The quality of good recovery will impact the balance of the exercise. The body needs the recovery phase to adapt to stress and improve physical and psychological qualities (Romero, Minson, & Halliwill, 2017). Inadequate recovery can lead to decreased performance and increased risk of injury and disease (Tiernan, Lyons, Comyns, Nevill, & Warrington, 2020b). Even in elite athletes, recovery management's essential role is very influential in achieving achievement (Peake, Neubauer, Walsh, & Simpson, 2017).

This study's findings indicate no significant difference in recovery patterns between experienced and inexperienced athletes. Both groups had a reasonable recovery rate with scores above 16 points, and the inexperienced athlete group had a slightly higher average score than the experienced athlete group. It seems to happen because, at the beginning of training, athletes have been educated about the importance of recovery. It is in line with the results of research (Doherty, Madigan, Nevill, Warrington, & Ellis, 2021), which states the need for athletes to receive education about recovery patterns. At the beginning of this training period, athletes are taught various recovery strategies. It is in line with the research results showing that using a combined recovery strategy is more effective than a simple approach to recovery strategy (Crowther, Sealey, Crowe, Edwards, & Halson, 2019; Pimenta et al., 2015). One important sub-section of recovery is adequate sleep. Sleep plays a vital role in athlete performance and recovery (Bonnar, Bartel, Kakoschke, & Lang, 2018). In addition to getting an education about recovery, while athletes stay in the dormitory, a curfew and a collection of cell phones make athletes sleep regularly. This intervention pattern has an impact on the athletes' sleep patterns. It is in line with the research results showing that sleep hygiene education and interventions can positively change athletes' sleep behaviour (Caia, Scott, Halson, & Kelly, 2018; de Mello et al., 2020).

Monitoring training load and recovery is an important thing to do in sports training. By monitoring the training load, the coach can get a picture of information about the response experienced by athletes in connection with the given program (Duggan, Moody, Byrne, Cooper, & Ryan, 2021). In addition, monitoring recovery can also provide an overview of overreaching conditions, the magnitude of recovery needs and the prevention of injury, illness and overtraining (Bourdon et al., 2017). Athletes' training load response and recovery data is a sensitive and valuable monitoring tool for coaches to regulate load balance and recovery rates in achieving increased performance by paying attention to health (Selmi, Ouergui, Castellano, Levitt, & Bouassida, 2020b).

This study's findings indicate a significant difference between the average training load of experienced athletes compared to the training load and recovery of inexperienced athletes and the recovery rate of experienced athletes. This difference in training load occurs because experienced athletes have the higher physical ability and movement efficiency than inexperienced athletes. On the other hand, all groups of athletes had a good recovery pattern thanks to education and control regarding the implementation of recovery during 13 weeks of training to support high performance. An essential result of this study showed that both groups experienced a heavy training load, but a reasonable recovery rate offset this during the training process. Furthermore, the limitations of this study are the limited number of samples and the periodisation of the preparation only. In the future, comparative studies can be carried out with a more significant number of samples in one whole exercise period with a more diverse variety of research subjects.

Conclusions

Differences in the experience level of para-swimming athletes significantly impact the comparison of the amount of training load. However, the recovery pattern that can be adjusted makes the two groups have a recovery rate that tends to be good and does not differ significantly. This study highlights that the significant difference in the simultaneous combination of training load and recovery between the two groups lies in the level of training load efficiency for the experienced para-athlete group compared to other variables. Further studies of these two groups of athletes in a broader variable scale and varying in full training periodisation are needed to provide a more comprehensive picture in the future.

Acknowledgement

The author would like to thank all the leaders of the Universitas Negeri Surabaya and the postgraduate leadership of the Universitas Negeri Semarang in connection with the policy of completing this article. Besides that, the authors thank the chairman of the National Paralympic Committee of Indonesia (NPCI) East Java Province for permission to collect data and all coaches and para-athletes training camp members.

Conflict of interest

All authors declare no conflicts of interest

References

Kellmann, M., Bertollo, M., Bosquet, L., Brink, M., Coutts, A. J., Duffield, R., … Beckmann, J. (2018). Recovery and performance in sport: Consensus statement. *International Journal of Sports Physiology and Performance, 13*(2), 240-245. https://doi.org/10.1123/ijspp.2017-0759

Schwellnus, M., Soligard, T., Alonso, J.-M., Bahr, R., Clarsen, B., Dijkstra, H. P., … Engebretsen, L. (2016). APPENDIX A Terminology and Definitions for Landslides. *British Journal of Sports Medicine, 50*(17), 1030. Retrieved from https://bjsm.bmj.com/content/50/17/1030

McGuigan, M. (2017). Monitoring Training and Performance in Athletes. Auckland: Human Kinetics Publishers Inc.

Halson, S. L. (2014). Monitoring Training Load to Understand Fatigue in Athletes. *Sports Medicine,* 44, 139-147. https://doi.org/10.1007/s40279-014-0253-z

McLaren, S. J., Weston, M., Smith, A., Cramb, R., & Portas, M. D. (2016). Variability of physical performance and player match loads in professional rugby union. *Journal of science and medicine in sport, 19*(6), 493-497.

Fox, J. L., Stanton, R., Sargent, C., Wintour, S. A., & Scanlan, A. T. (2018, December 1). The Association Between Training Load and Performance in Team Sports: A Systematic Review. *Sports Medicine.* Springer International Publishing. https://doi.org/10.1007/s40279-018-0982-5

Bourdon, P. C., Cardinale, M., Murray, A., Gastin, P., Kellmann, M., Varley, M. C., … Cable, N. T. (2017). Monitoring athlete training loads: Consensus statement. *International Journal of Sports Physiology and Performance, 12*(August 2018), 161-170. https://doi.org/10.1123/IJSPP.2017-0208

Hulin, B. T., Gabbett, T. J., Blanch, P., Chapman, P., Bailey, D., & Orchard, J. W. (2014). Spikes in acute workload are associated with increased injury risk in elite cricket fast bowlers. *British Journal of Sports Medicine, 48*(8), 708-712. https://doi.org/10.1136/bjsports-2013-092524

Foster, C., Heimann, K. M., Esten, P. L., Brice, G., & Porcari, J. P. (2001). Differences in perceptions of training by coaches and athletes. *S Afri J Sports Med, 8*(June), 3-7.

Rodríguez-Marroyo, J. A., Medina, J., García-López, J., García-Tormo, J. V., & Foster, C. (2014). Correspondence between training load executed by volleyball players and the one observed by coaches. *Journal of Strength and Conditioning Research, 28*(6), 1588-1594. https://doi.org/10.1519/JSC.0000000000000324

Doeven, S. H., Brink, M. S., Frencken, W. G. P., & Lemmink, K. A. P. M. (2017). Impaired Player–Coach Perceptions of Exertion and Recovery During Match Congestion. *International Journal of Sports Physiology and Performance, 12*(9), 1151-1156. https://doi.org/10.1123/ijspp.2016-0363

Nässi, A., Ferrauti, A., Meyer, T., Pfeiffer, M., & Kellmann, M. (2017). Psychological tools used for monitoring training responses of athletes. *Performance Enhancement and Health, 5*(4), 125-133. https://doi.org/10.1016/j.peh.2017.05.001

Bishop, P. A., Jones, E., & Woods, A. K. (2008). Recovery from training: A brief review. *Journal of Strength and Conditioning Research, 22*(3), 1015-1024. https://doi.org/10.1519/JSC.0b013e31816eb518

Kellman, J., & Beckmann, J. (2018). *Sport, Recovery, and Performance.* Routledge. Retrieved from https://www.researchgate.net/publication/321170740_Kellmann_J_Beckmann_J_Eds_2018_Sport_Recovery_and_Performance_Abingdon_Routledge

Andrade, D. M., Fernandes, G., Miranda, R., Reis Coimbra, D., & Bara Filho, M. G. (2021). Training Load and Recovery in Volleyball During a Competitive Season. *Journal of Strength and Conditioning Research, 35*(4), 1082-1088. https://doi.org/10.1519/jsc.0000000000002837

Sansone, P., Tschan, H., Foster, C., & Tessitore, A. (2020). Monitoring Training Load and Perceived Recovery in Female Basketball: Implications for Training Design. *Journal of Strength and Conditioning Research*, *34*(10), 2929-2936. https://doi.org/10.1519/JSC.0000000000002971

Tiernan, C., Lyons, M., Comyns, T., Nevill, A. M., & Warrington, G. (2020a). Investigation of the relationship between salivary cortisol, training load, and subjective markers of recovery in elite rugby union players. *International Journal of Sports Physiology and Performance, 15*(1), 113-118. https://doi.org/10.1123/ijspp.2018-0945

Wilke, C. F., Wanner, S. P., Santos, W. H. M., Penna, E. M., Ramos, G. P., Nakamura, F. Y., & Duffield, R. (2020). Influence of faster and slower recovery-profile classifications, self-reported sleep, acute training load, and phase of the microcycle on perceived recovery in futsal players. *International Journal of Sports Physiology and Performance, 15*(5), 648-653. https://doi.org/10.1123/ijspp.2019-0201

Collette, R., Kellmann, M., Ferrauti, A., Meyer, T., & Pfeiffer, M. (2018). Relation between training load and recovery-stress state in high-performance swimming. *Frontiers in Physiology, 9*(JUL). https://doi.org/10.3389/fphys.2018.00845

Pollock, S., Gaoua, N., Johnston, M. J., Cooke, K., Girard, O., & Mileva, K. N. (2019). Training regimes and recovery monitoring practices of Elite British swimmers. *Journal of Sports Science and Medicine, 18*(3).

Sinnott-O'Connor, C., Comyns, T. M., Nevill, A. M., & Warrington, G. D. (2018). Salivary biomarkers and training load during training and competition in Paralympic swimmers. *International Journal of Sports Physiology and Performance, 13*(7), 839-843. https://doi.org/10.1123/ijspp.2017-0683

Rosa, J. P. P., Silva, A., Rodrigues, D. F., Menslin, R., Araújo, L. T., Vital, R., … de Mello, M. T. (2020). Association Between Hormonal Status, Stress, Recovery, and Motivation of Paralympic Swimmers. *Research Quarterly for Exercise and Sport, 91*(4), 652-661. https://doi.org/10.1080/02701367.2019.1696929

Rodríguez-Zamora, L., Iglesias, X., Barrero, A., Torres, L., Chaverri, D., & Rodríguez, F. A. (2014). Monitoring internal load parameters during competitive synchronized swimming duet routines in elite athletes. *Journal of Strength and Conditioning Research, 28*(3), 742–751. https://doi.org/10.1519/JSC.0b013e3182a20ee7

Kenttä, G., & Hassmén, P. (1998). Overtraining and Recovery A Conceptual Model. *Sports Med,* 26.

Foster, C., Florhaug, J. A., Franklin, J., Gottschall, L., Hrovatin, L. A., Parker, S., … Dodge, C. (2001). A New Approach to Monitoring Exercise Training. *Journal of Strength and Conditioning Research, 15*(1), 109-115. https://doi.org/10.1519/00124278-200102000-00019

Arney, B. E., Glover, R., Fusco, A., Cortis, C., de Koning, J. J., van Erp, T., … Foster, C. (2019). Comparison of rating of perceived exertion scales during incremental and interval exercise. *Kinesiology, 51*(2), 150-157. https://doi.org/10.26582/K.51.2.1

Hutchinson, M. J., Kouwijzer, I., de Groot, S., & Goosey-Tolfrey, V. L. (2021). Comparison of two Borg exertion scales for monitoring exercise intensity in able-bodied participants, and those with paraplegia and tetraplegia.

Spinal Cord, 59(11), 1162-1169. https://doi.org/10.1038/s41393-021-00642-4

Borresen, J., & Ian Lambert, M. (2009). The quantification of training load, the training response and the effect on performance. *Sports Medicine, 39*(9), 779-795. https://doi.org/10.2165/11317780-000000000-00000

Paulson, T. A. W., Mason, B., Rhodes, J., & Goosey-Tolfrey, V. L. (2015). Individualized Internal and External Training Load Relationships in Elite Wheelchair Rugby Players. *Frontiers in Physiology, 6*(DEC), 388. https://doi.org/10.3389/fphys.2015.00388

Sams, M. L., Wagle, J. P., Sato, K., DeWeese, B. H., Sayers, A. L., & Stone, M. H. (2020). Using the Session Rating of Perceived Exertion to Quantify Training Load in a Men's College Soccer Team. *Journal of Strength and Conditioning Research, 34*(10), 2793-2799. https://doi.org/10.1519/JSC.0000000000003793

Strzała, M., & Tyka, A. (2009). Physical Endurance, Somatic Indices and Swimming Technique Parameters as Determinants of Front Crawl Swimming Speed at Short Distances in Young Swimmers. *Medicina Sportiva, 13*(2), 99-107. https://doi.org/10.2478/v10036-009-0016-3

Barbosa, T. M., Fernandes, R. J., Keskinen, K. L., & Vilas-Boas, J. P. (2008). The influence of stroke mechanics into energy cost of elite swimmers. *European Journal of Applied Physiology, 103*(2), 139-149. https://doi.org/10.1007/s00421-008-0676-z

Matthews, M. J., Green, D., Matthews, H., & Swanwick, E. (2017). The effects of swimming fatigue on shoulder strength, range of motion, joint control, and performance in swimmers. *Physical Therapy in Sport,* 23, 118-122. https://doi.org/10.1016/j.ptsp.2016.08.011

McKendry, J., Joanisse, S., Baig, S., Liu, B., Parise, G., Greig, C. A., & Breen, L. (2020). Superior Aerobic Capacity and Indices of Skeletal Muscle Morphology in Chronically Trained Master Endurance Athletes Compared With Untrained Older Adults. *The Journals of Gerontology: Series A, 75*(6), 1079-1088. https://doi.org/10.1093/GERONA/GLZ142

Mersmann, F., Charcharis, G., Bohm, S., & Arampatzis, A. (2017). Muscle and tendon adaptation in adolescence: Elite volleyball athletes compared to untrained boys and girls. *Frontiers in Physiology, 8*(JUN), 417. https://doi.org/10.3389/FPHYS.2017.00417

Ferioli, D., Bosio, A., Bilsborough, J. C., Torre, A. La, Tornaghi, M., & Rampinini, E. (2018). The Preparation Period in Basketball: Training Load and Neuromuscular Adaptations. *International Journal of Sports Physiology and Performance, 13*(8), 991-999. https://doi.org/10.1123/IJSPP.2017-0434

Al-Muraikhy, S., Ramanjaneya, M., Dömling, A. S., Bettahi, I., Donati, F., Botre, F., … Elrayess, M. A. (2021). High Endurance Elite Athletes Show Age-dependent Lower Levels of Circulating Complements Compared to Low/Moderate Endurance Elite Athletes. *Frontiers in Molecular Biosciences,* 8. https://doi.org/10.3389/fmolb.2021.715035

Horta, T. A. G., Bara Filho, M. G., Coimbra, D. R., Miranda, R., & Werneck, F. Z. (2019). Training Load, Physical Performance, Biochemical Markers, and Psychological Stress During a Short Preparatory Period in Brazilian Elite Male Volleyball Players. *Journal of Strength and Conditioning Research, 33*(12), 3392-3399. https://doi.org/10.1519/JSC.0000000000002404

Selmi, O., Ouergui, I., Castellano, J., Levitt, D., & Bouassida, A. (2020a). Effect of an intensified training period on well-being indices, recovery and psychological aspects in professional soccer players. *Revue Europeenne de Psychologie Appliquee, 70*(6). https://doi.org/10.1016/j.erap.2020.100603

Romero, S. A., Minson, C. T., & Halliwill, X. R. (2017). The cardiovascular system after exercise. *Journal of Applied Physiology, 122*(4), 925-932. https://doi.org/10.1152/japplphysiol.00802.2016

Tiernan, C., Lyons, M., Comyns, T., Nevill, A. M., & Warrington, G. (2020b). Investigation of the relationship between salivary cortisol, training load, and subjective markers of recovery in elite rugby union players. *International Journal of Sports Physiology and Performance, 15*(1), 113-118. https://doi.org/10.1123/ijspp.2018-0945

Peake, J. M., Neubauer, O., Walsh, N. P., & Simpson, R. J. (2017). Recovery of the immune system after exercise. *Journal of Applied Physiology, 122*(5), 1077-1087. https://doi.org/10.1152/japplphysiol.00622.2016

Doherty, R., Madigan, S. M., Nevill, A., Warrington, G., & Ellis, J. G. (2021). *The sleep and recovery practices of athletes. Nutrients, 13*(4). https://doi.org/10.3390/NU13041330

Crowther, F. A., Sealey, R. M., Crowe, M. J., Edwards, A. M., & Halson, S. L. (2019). Effects of Various Recovery Strategies on Repeated Bouts of Simulated Intermittent Activity. *Journal of Strength and Conditioning Research, 33*(7), 1781-1794. https://doi.org/10.1519/JSC.0000000000002396

Pimenta, E., Barbosa Coelho, D., Capettini, L., Gomes, T., Pussieldi, G., Ribeiro, J., … Silami-Garcia, E. (2015). Analysis of creatine kinase and alpha-actin concentrations in soccer pre-season. [Análise das concentrações de creatina quinase e alfa -actina no futebol pré-temporada]. *Revista Brasileira de Ciência e Movimento: RBCM, 23*(4), 5-14. Retrieved from http://search.ebscohost.com/login.aspx?direct=true&db=s3h&AN=112029788&site=ehost-live

Bonnar, D., Bartel, K., Kakoschke, N., & Lang, C. (2018, March 1). Sleep Interventions Designed to Improve Athletic Performance and Recovery: A Systematic Review of Current Approaches. *Sports Medicine.* Springer International Publishing. https://doi.org/10.1007/s40279-017-0832-x

Caia, J., Scott, T. J., Halson, S. L., & Kelly, V. G. (2018). The influence of sleep hygiene education on sleep in professional rugby league athletes. *Sleep Health, 4*(4), 364-368. https://doi.org/10.1016/J.SLEH.2018.05.002

de Mello, M. T., Simim, M. A. de M., Narciso, F. V., Rosa, J. P. P., Rodrigues, D. F., Freitas, L. de S. N., … Silva, A. (2020). Duration and quality of sleep in sprint and recovery performances among elite swimmers. *Revista Brasileira de Medicina Do Esporte, 26*(2). https://doi.org/10.1590/1517-869220202602220003

Duggan, J. D., Moody, J. A., Byrne, P. J., Cooper, S., & Ryan, L. (2021). *Training Load Monitoring Considerations for Female Gaelic Team Sports: From Theory to Practice*.

Selmi, O., Ouergui, I., Castellano, J., Levitt, D., & Bouassida, A. (2020b). Effect of an intensified training period on well-being indices, recovery and psychological aspects in professional soccer players. *Revue Europeenne de Psychologie Appliquee, 70*(6). https://doi.org/10.1016/j.erap.2020.100603

ПОРІВНЯННЯ ДОСВІДЧЕНИХ І НЕДОСВІДЧЕНИХ ПЛАВЦІВ З ІНВАЛІДНІСТЮ: ТРЕНУВАЛЬНЕ НАВАНТАЖЕННЯ ТА ВІДНОВЛЕННЯ В ПІДГОТОВЧИЙ ПЕРІОД

Кунджун Ашаді[1ABCD], Октіа Воро Касміні Хандаяні[1ACD], Харі Сетіджоно[2ACD], Трі Рустіаді[1ACD], Сугіхарто[1ACD], Соегіянто[1ACD]

[1]Сурабайський державний університет
[2]Семарангський державний університет

Авторський вклад: A – дизайн дослідження; B – збір даних; C – статаналіз; D – підготовка рукопису; E – збір коштів

Реферат. Стаття: 8 с., 1 табл., 5 рис., 50 джерел.

Метою дослідження було проведення аналізу тренувального навантаження та відновлення досвідчених і недосвідчених плавців з інвалідністю.

Матеріали та методи. Учасниками дослідження були сім спортсменів-плавців з інвалідністю регіонального рівня, які проходили тренувальні збори в рамках підготовки до Паралімпійських ігор в Індонезії. Групи спортсменів були розподілені за рівнем підготовки та досвідом участі в національних чемпіонатах. Протягом тринадцяти тижнів спортсмени відстежували своє тренувальне навантаження та ступінь відновлення. Для вимірювання внутрішнього тренувального навантаження використовували шкалу Борга CR-10, а ступінь відновлення спортсмена вимірювали за допомогою шкали Загального якісного відновлення (TQR). Для аналізу нормальності та перевірки відмінностей між двома групами використовували програмне забезпечення IBM SPSS Statistics версії 22. Для перевірки статистичної значущості показника суб'єктивно сприйманої напруженості (RPE) за шкалою Борга CR-10 використовували критерій Манна-Уітні, а для перевірки статистичної значущості показника шкали Загального якісного відновлення (TQR) використовували двохвибірковий t-критерій Стьюдента для незалежних вибірок.

Результати. Середнє значення показника за шкалою Борга CR-10 для групи досвідчених спортсменів становило 7,78±0,47, тоді як для групи недосвідчених спортсменів воно становило 8,28±0,56 ($p<0,05$). Середнє значення показника суб'єктивно сприйманої напруженості (RPE) у групі досвідчених спортсменів становило 18,24±1,47, а в групі недосвідчених спортсменів воно становило 18,52±1,57 ($p>0,05$). Крім того, показник RPE за шкалою Борга показує, що тренувальне навантаження досвідчених спортсменів становить 17,12±1,03, що є нижчим за середній показник RPE недосвідчених спортсменів 18,21±1,24, а також середній показник шкали Загального якісного відновлення (TQR) для досвідчених спортсменів становить 18,24±1,47, а для недосвідчених — 18,52±1,55 ($p<0,05$).

Висновки. Досвідчені параплавці мали статистично значуще відмінне тренувальне навантаження, ніж недосвідчені параспортсмени. Крім того, тренувальне навантаження досвідчених параспортсменів також статистично значуще відрізнялося порівняно зі ступенями відновлення досвідчених і недосвідчених параплавців.

Ключові слова: відстежування, тренування, інвалідність, періодизація, плавання, спортсмен.

Information about the authors:

Ashadi, Kunjung: kunjungashadi@gmail.com; https://orcid.org/0000-0002-9540-4096; Doctoral Program of Sports Education, Universitas Negeri Surabaya, Jl. Lidah Wetan, Lidah Wetan, Kec. Lakarsantri, Kota SBY, Jawa Timur 60213, Indonesia.

Handayani, Oktia Woro Kasmini: oktia2016@mail.unnes.ac.id; https://orcid.org/0000-0002-6151-5708; Department of Public Health Science, Universitas Negeri Semarang, Sekaran, Kec. Gn. Pati, Kota Semarang, Jawa Tengah 50229, Indonesia.

Setijono, Hari: harisetijono@yahoo.co.id; https://orcid.org/0000-0001-8305-4933; Department of Sport Science, Faculty of Sport Science, Universitas Negeri Surabaya, Jl. Lidah Wetan, Lidah Wetan, Kec. Lakarsantri, Kota SBY, Jawa Timur 60213, Indonesia.

Rustiadi, Tri: trirustiadi@mail.unnes.ac.id; https://orcid.org/0000-0001-9140-0357; Department of Physical Education, Sports and Recreation, Universitas Negeri Semarang, Sekaran, Kec. Gn. Pati, Kota Semarang, Jawa Tengah 50229, Indonesia.

Sugiharto: sugiharto@um.ac.id; https://orcid.org/0000-0002-2561-9921; Department of Sports Science, Universitas Negeri Semarang, Sekaran, Kec. Gn. Pati, Kota Semarang, Jawa Tengah 50229, Indonesia.

Soegiyanto: soegiyanto.ks@mail.unnes.ac.id; https://orcid.org/0000-0002-6853-0716; Department of Sports Science, Universitas Negeri Semarang, Sekaran, Kec. Gn. Pati, Kota Semarang, Jawa Tengah 50229, Indonesia.

Cite this article as: Ashadi, K., Handayani, O.W.K., Setijono, H., Rustiadi, T., Sugiharto, Soegiyanto (2023). Experienced VS Inexperienced Disabled Swimmer: Training Load and Recovery in Preparation Period. *Physical Education Theory and Methodology, 23*(2), 162-169. https://doi.org/10.17309/tmfv.2023.2.02

Received: 17.10.2022. Accepted: 27.01.2023. Published: 28.04.2023

Теорія та методика фізичного виховання
Physical Education Theory and Methodology
Teorìâ ta Metodika Fìzičnogo Vihovannâ

ISSN 1993-7989 (print)
ISSN 1993-7997 (online)
ISSN-L 1993-7989

ORIGINAL SCIENTIFIC ARTICLE

DEVELOPMENT OF PHYSICAL EDUCATION LEARNING OUTCOMES ASSESSMENT INSTRUMENTS FOR VOLLEYBALL MATERIALS BASED ON GAME PERFORMANCE ASSESSMENT INSTRUMENT

Galih Dewanti[1ABCDE], Soni Nompembri[1BDE], Widiyanto[1BCE], Amri Hartanto[1ABCDE] and Afeb Chesa Arianto[1ADE]

[1]Yogyakarta State University

Authors' Contribution: A – Study design; B – Data collection; C – Statistical analysis; D – Manuscript Preparation; E – Funds Collection

Corresponding Author: Hartanto, Amri, E-mail: amri777724@gmail.com
Accepted for Publication: January 27, 2023
Published: April 28, 2023

DOI: 10.17309/tmfv.2023.2.03

Abstract

Study purpose. The basic assumption of this development is that there is no Game Performance Assessment Instrument (GPAI) based on physical education (PE) learning outcome assessment, so researchers are trying to develop the instrument. The teacher has not used the GPAI instrument in assessing the PE learning outcomes for volleyball material. The purpose of the study was to develop a valid and reliable assessment of PE learning outcomes for volleyball based on GPAI.

Materials and methods. This type of research is research and development. The subjects used were PE learning expert lecturers and volleyball expert lecturers with a minimum qualification of 5 Doctoral degrees. The field test was conducted on 18 junior high school students. The instrument uses a questionnaire with a score of 1-4 with the terms "Very Appropriate (score 4)", "Agreed (score 3)", "Not Appropriate (score 2)", and "Very Not Appropriate (score 1)". The validity data analysis technique uses Aiken validity, and reliability tests are carried out using Intraclass Correlation Coefficients.

Results. Based on the results of the research and the results of the data analysis that has been carried out, it is concluded that the instrument for assessing the learning outcomes of PE on volleyball material in Junior High School based on GPAI that was developed is valid and reliable, with V Aiken ≥ 0.87. Furthermore, the reliability of the PE learning outcomes assessment instrument for volleyball material in GPAI-based junior high schools was 0.797 in the "High" category.

Conclusions. The researcher hopes that the resulting product in the form of an assessment of PE learning outcomes for volleyball material in junior high schools based on the GPAI can be a guide or reference for evaluating students on volleyball material.

Keywords: learning outcomes assessment instrument, physical education, volleyball, GPAI.

Introduction

One of the compulsory subjects taught is physical education. Physical education has a comprehensive goal that includes physical, cognitive, affective, emotional, social and moral aspects (Chng & Lund, 2018; Ciotto & Gagnon, 2018). Assessment in physical education has an important role in the learning process (Borghouts et al., 2017). The purpose of the assessment is to find out how successful the teacher is in the successful implementation of the learning process, which can provide feedback for the teacher in planning the next learning process (Alena et al., 2019; Nieminen et al., 2021; Snead & Freiberg, 2019). The current physical education teacher must make and use various forms of appropriate assessments in a lesson according to the material and situation at hand (Tolgfors, 2018). Of course, an appropriate evaluation system is needed so that students can clearly describe and demonstrate all the achievements that have been obtained by students in the learning process in accordance with the actual situation in the field.

One of the physical education materials at school is volleyball. The volleyball game has several basic techniques, service, passing, smash, and block (Junior, 2018; Zonifa, 2020; Pekas et al., 2019). So far, the instruments used by

teachers to assess volleyball skills in students are only in the form of individual volleyball technical skills tests. The teacher conducts an upper passing test, a lower passing test, a smash test, and a service test. The assessment of students' playing skills basically requires careful observation during the game. Without exception the evaluation of physical education subjects, thus students are always in a controlled state, so that students have an overview of the volleyball playing skills that will be carried out. Assessment of student learning outcomes in physical education learning refers to process assessment and product assessment (learning outcomes). The learning process can be said to be effective if the behavior changes that occur in students at least reach the optimal level.

Teachers must also be able to closely study student interactions during group learning (García-López & Gutiérrez, 2015). Griffin has created an assessment instrument called the Game Performance Assessment Instrument (GPAI). GPAI is a multi-dimensional system designed to measure the ability to play in a particular sports (Barquero-Ruiz et al., 2020; Dania et al., 2021). The five-game elements of the GPAI, decision-making (decision making), skill execution (skill execution), support (support), game performance (game performance), game involvement (game involvement), are used to assess students' game performance, and these are individually evaluated elements of video game playing tapes (Ben Khalifa et al., 2020; Bergmann et al., 2022; Mahedero et al., 2021).

The GPAI instrument was developed to measure "game performance behavior that demonstrates tactical understanding, as well as a player's ability to solve tactical problems by selecting and applying appropriate skills" (Guijarro et al., 2021). To characterize gameplay performance in the game invasion, it is necessary to identify game components that cannot specifically be observed performance (Araújo et al., 2019). The GPAI test is a convenient assessment instrument for assessing execution skills, learner support, and decision-making strategies (García-Ceberino et al., 2020).

GPAI is essential in various games, such as volleyball, soccer, basketball, softball, rugby, or field hockey. Measuring a single component of game performance, together with other experts (i.e., coach, teacher) with knowledge in all four game categories (invasion, net/wall, strike and attack, and target), demonstrated seven tactical components (baseline, adjustment, decision making, execution) (skills, support, cover, guard/mark) related to effective playing performance (Lund & Kirk, 2019). Two advantages of using the GPAI are to evaluate a person's ability in sports, such as (a) the GPAI is easily adapted for various types of sports, and physical activities, (b) the GPAI can measure skills in processing the ball, but also skills without mastering the ball (measuring skills in ball processing) (offensive or defensive) (Aryanto et al., 2020).

This research develops a valid and reliable GPAI volleyball learning instrument. The development of valid and reliable instruments will assist teachers and other learners in peer assessment in classroom settings. In addition, connecting what is taught with what will be assessed helps students to focus on what is essential, making the teaching-learning cycle better (Ibáñez et al., 2019). Physical education teachers need an instrument for assessing physical education learning outcomes for volleyball in junior high schools based on GPAI so that they get more detailed results in the evaluation. The aim is to assist teachers and coaches in observing and recording performance behavior during the game.

Materials and methods

Study participants

The subjects used were physical education learning expert lecturers and volleyball expert lecturers with a minimum qualification of 5 Doctoral degrees at Yogyakarta State University. The field test was conducted on 18 students of Junior High School. The instrument uses a questionnaire with a score of 1-4 with the provisions of "Very Appropriate (score 4)", "Agreed (score 3)", "Not Appropriate (score 2)", and "Very Not Appropriate (score 1)". There are 20 questionnaire grids. Assessment of physical education learning outcomes for volleyball based on GPAI using indicators Decision Making (DM) (5 items), Skill Execution (SE) (5 items), Support (S) (5 items), Guard/Mark (G/M) (5 items), Base (B) (5 items). More details are presented in Table 1.

The study was conducted in accordance with the ethical principles of the Helsinki Declaration for human research and was approved by the Research Ethics Committee of the Yogyakarta State University.

Study organization

This type of research is research and development. Research and Development is a research method used to produce specific products, and test their effectiveness of these products (Amran et al., 2018). This research follows a cyclical step. Among the current development models, one of the learning product design models often used in research and development is the Lee and Owens development model, namely ADDIE (Analysis, Design, Development, Implementation, and Evaluation) (Aka, 2019).

Statistical analysis

Data from the assessment results by expert validators and practitioners from the assessment instrument validation sheet were analyzed to determine the content validity of the authentic assessment instrument. The content validity of the instrument was analyzed using Aiken Validity. The formula proposed by Aiken is as follows (Aiken, 1985):

$$V\ Aiken = \sum s\ /\ n[c-1]$$

S = r – lo
Lo = lowest rating score (eg 1)
C = highest rating score (eg 4)
r = the score given by the assessor

The reliability test was carried out using the Intraclass Correlation Coefficients (ICC) reliability. This reliability test shows the level of agreement between experts or raters in assessing each indicator on the instrument. The ICC will provide an overview in the form of a score about the degree of agreement given by the expert or rater (Douglass et al., 2021).

Table 1. Assessment grid for physical education learning outcomes for volleyball based on GPAI

Assessment Aspect	Indicator	Sub Indicator	No Item
Decision Making (DM)	Making the right decisions on basic movements in volleyball games	Passing	1
		Spike	2
		Blocking	3
		The accuracy of the use of basic movements	4,5
Skill Execution (SE)	Efficient execution of selected skills	Passing down	6, 7, 8
		Top pass	9
		Spike	10
		Blocking	11
Support (S)	Provide proper support for teammates during the game	Cooperation	12, 13
		Responsibility	14, 15
Guard/Mark (G/M)	Keep your opponent right when defending	Supervise the movement of the opponent and do Blocking	16
		Cover	17
		Back defense	18
Base (B)	Return to the original position according to their respective tasks, either attacking or defending	Responsibility	19
		Cover	20

Results

After validation by experts, there are various suggestions for improvement. Offers for improvement from experts become a reference for researchers to make improvements to the products developed. Product revisions were carried out on the product development assessment of physical education learning outcomes for volleyball based on GPAI based on input and advice from experts.

Table 2. Aiken validity analysis

No	Σ s	n	C-1	Aiken
1	14	5	3	0.93
2	14	5	3	0.93
3	14	5	3	0.93
4	14	5	3	0.93
5	14	5	3	0.93
6	14	5	3	0.93
7	14	5	3	0.93
8	15	5	3	1.00
9	14	5	3	0.93
10	14	5	3	0.93
11	14	5	3	0.93
12	14	5	3	0.93
13	13	5	3	0.87
14	14	5	3	0.93
15	13	5	3	0.87
16	14	5	3	0.93
17	14	5	3	0.93
18	14	5	3	0.93
19	14	5	3	0.93
20	14	5	3	0.93

The assessment carried out by experts on the physical education learning outcomes assessment instrument for volleyball based on GPAI uses a questionnaire and is intended to find the validity coefficient based on the Aiken Validity. The results of the expert assessment are in Table 2.

Based on Table 2 above, the Aiken Validity value for items 1-20 is V Aiken 0.87. These results indicate that all items of the GPAI-based assessment instrument for developing physical education learning outcomes for volleyball in junior high school based on GPAI are valid.

Next, calculate the reliability of the GPAI learning outcomes assessment instrument for volleyball based on GPAI using ICC. Based on Table 3 above, it shows the ICC output with inter-rater reliability, rxx = 0.797. These results indicate that the reliability of the physical education learning outcomes assessment instrument for volleyball in junior high schools based on GPAI is in the "High" category.

The final product in the form of an assessment instrument for physical education learning outcomes for volleyball based on GPAI is then disseminated. The product dissemination stage is intended so that the product can be used in various components and can be used by teachers to assess the learning outcomes of physical education volleyball material in junior high school. The product will be packaged in a soft file in the form of Microsoft Word or Portable Document Format (PDF) and designed to be easy to use. The product is also disseminated through various media, so that it can be accessed easily, so that teachers can use it effectively and efficiently to assess the learning outcomes of physical education on volleyball material.

Based on the results of the analysis, it shows that the assessment of expert judgment on the assessment instrument for physical education learning outcomes for volleyball in junior high schools is based on GPAI, all items are valid, with

Table 3. Results of Intraclass Correlation Coefficients (ICC) Reliability

	Intraclass Correlation[a]	95% Confidence Interval		F Test with True Value 0			
		Lower Bound	Upper Bound	Value	df1	df2	Sig
Single Measures	0.164[b]	0.032	0.667	4.928	4	76	0.001
Average Measures	0.797[c]	0.399	0.976	4.928	4	76	0.001

Table 4. The final product of the physical education learning outcome assessment instrument for volleyball based on GPAI

Aspect	Statement Items	4	3	2	1
Decision Making	Students are able to give the ball to a friend who is in an empty room to make it easier to attack				
	Students are able to make the right decisions to cross the ball into an empty opponent's area				
	Students are able to make the right decisions to cover attacks from opponents				
	Students are able to receive services with various/one of the basic movements so that the ball does not fall on its own field				
	Students are able to receive smashes with various/one of the basic movements so that the ball does not fall on its own field				
Skill Execution	Students are able to receive/receive service by passing down well				
	Students pass the ball accurately by using the basic motion of passing down to other friends				
	Students are able to receive the opponent's smash using down passing well				
	Students pass the ball accurately by using the basic motion of passing over to other friends				
	Students are able to hit hard and hit the target into the opponent's defense				
	Students are able to perform basic blocking movements when opposing players spike				
Support	Students always pay attention to the opponent's service when receiving the first ball				
	Students are always ready to receive the second or third ball				
	Students provide support in the form of shouting to friends who receive the ball				
	The closest player always approaches the friend who is receiving the ball				
Guard/Mark	In a defensive position when the ball is on the opponent's side, the student in front is in a position to monitor the movement of the opponent's spiker and prepare to block the opponent's attack				
	In a defensive position, students who are in the back position are ready to cover a friend who is blocking				
	Students who are in the back position are always ready to defend if the opponent spikes hard				
Base	At the time of the first serve made by the opponent, students occupy their respective rotation positions				
	In an attacking situation, the student in the back position covers the spiker who tries to pass the ball into the opponent's area and then prepares to receive it back if the spike results can be blocked by the opponent.				

V Aiken ≥ 0.87. Furthermore, the reliability of the physical education learning outcomes assessment instrument for volleyball in junior high schools based on GPAI is 0.797 in the "High" category.

The results of the final product of the physical education learning outcomes assessment instrument for volleyball based on GPAI are in Table 4.

After an assessment is made based on the volleyball game indicators based on the game performance assessment instrument (GPAI), it can be calculated student learning outcomes with the formula:

$$\frac{\sum score}{\sum score\ maximum} \times 100\%$$

The example of the assessment table and the assessment criteria given to students to assess the physical education learning outcomes of volleyball games are in Tables 5 and 6.

The field test was conducted on 18 students of Junior High School. At the large-scale trial stage, the teacher assesses students' volleyball abilities using the instruments that have been developed. Previously, the researcher explained how to use the physical education learning outcomes assessment instrument for volleyball based on GPAI. The results of the assessment are in Table 7.

When displayed in the form of Assessment Norms, the physical education learning outcomes assessment instrument for volleyball based on GPAI in the field test is presented in Table 8.

Based on Table 8 above, it shows that physical education learning outcomes in volleyball material at GPAI-based Junior High Schools in large-scale trials were in the "very low" category of 16.67% (3 students), "low" of 44.44 % (8 students), "high" 38.89% (7 students), and "very high" 0.00% (0 students). Based on an average score of 58.13,

Table 5. Table of assessment of physical education learning outcomes for volleyball materials based on GPAI

No	Name	DM	SE	S	G/M	B	Total	Score
1								
2								
3								
Total Score								
Mean								

Table 6. Criteria for physical education learning outcomes for volleyball game materials

No	Score Interval	Criteria
1	72-100	Very good
2	63-71	Good
3	44-62	Poor
4	25-43	Very Poor

Table 7. Results of the assessment of physical education learning outcomes in volleyball material

No	Name	DM	SE	S	G/M	B	Total	Score
1	AA	12	16	11	9	5	53	66,25
2	AB	10	10	6	4	4	34	42,50
3	AC	9	11	7	5	2	34	42,50
4	AD	12	15	9	6	4	46	57,50
5	AE	14	12	8	7	4	45	56,25
6	AF	13	15	12	9	6	55	68,75
7	AG	13	16	11	7	4	51	63,75
8	AH	10	10	7	4	3	34	42,50
9	AI	10	15	9	6	4	44	55,00
10	AJ	14	15	9	7	6	51	63,75
11	AK	13	12	8	6	4	43	53,75
12	AL	12	12	8	6	6	44	55,00
13	AM	15	18	12	9	6	60	75,00
14	AN	13	13	8	9	4	47	58,75
15	AO	13	18	9	8	6	54	67,50
16	AP	11	14	9	6	6	46	57,50
17	AQ	13	18	11	9	6	57	71,25
18	AR	12	10	8	5	4	39	48,75
Total								1046,25
Average								58,13

Table 8. Norms of assessment of physical education learning outcomes material GPAI-based volleyball on field tests

No	Score Intervals	Criteria	Frequency	Percentage
1	72-100	Very high	0	0.00%
2	63-71	High	7	38.89%
3	44-62	Low	8	44.44%
4	25-43	Very Low	3	16.67%
Total			18	100%

the physical education learning outcomes assessment instrument for volleyball based on GPAI is in a low category.

Discussion

In developing test instruments, it is necessary to pay attention to the four basic concepts that exist, Validity, Reliability, Objectivity, and Norms (Cabrera et al., 2021). Valid means the instrument can be used to measure what should be measured (Supena et al., 2021; Sürücü & Maslakçi, 2020; Clark & Watson, 2019), reliable means an instrument which, when used several times to measure the same object, will produce the same data (Hayes & Coutts, 2020; Elliott et al., 2020). Instrument validation is a fundamental stage in instrument development and evaluation. Validity is the accuracy of the test on its components and the suitability of the score with its interpretation. The validation process includes gathering evidence to show the scientific basis for interpreting the score as stated in the purpose of using the assessment instrument. In other words, the score of the assessment results can be interpreted according to the purpose of using the instrument. However, the step to get the right interpretation is to validate the instrument first.

There are several ways to prove the validity of an instrument, most of which are grouped into 3 categories: content, based on criteria, and constructs (Suartama et al., 2019). An instrument is said to be valid if the content of the assessment instrument is comprehensive, relevant, and does not go beyond the limits of the measurement objective. Determining the content of the instrument is considered valid and can be proven based on a rational analysis of the content of the instrument, whose assessment is based on individual subjective considerations. The right individuals to determine content validity are those who are considered experts in the components being measured so that the results obtained can be accounted for. The validity of using Aiken has a high value, so it can be concluded that the use of Aiken provides a good level of validity and reliability.

The GPAI-based learning outcome assessment instrument for volleyball materials in Junior High School based on GPAI has criteria that are adjusted to the results of students' volleyball playing abilities. A high-quality skills assessment must be accompanied by clear, meaningful, and credible assessment criteria (Chen et al., 2017). Physical education teachers need to clearly describe the goals and assessment criteria and use developmental and age-appropriate assessments to ensure the educative nature of assessment in learning in addition to evaluation (Starck et al., 2018). Learning that can encourage students to be actively involved in improving motor skills. Accurate and comprehensive skill assessment is becoming increasingly important because it will provide an understanding of the relationship between motor ability level and the health (Logan et al., 2017). The use of assessment rubrics is very important in learning to moderate student learning outcomes and can be considered the most significant aspect for accurate and consistent assessment (Grainger & Weir, 2016). Assessment can be viewed as an ongoing part of teaching that occurs during the learning process, i.e., the main purpose of assessment is to provide feedback to students and teachers.

The GPAI is designed to measure game performance behaviors that demonstrate tactical understanding, as well as

a player's ability to solve tactical problems by selecting and applying appropriate skills. Criteria such as decision-making, skill execution, support, and adjustment are assessed during short games, sometimes through peer scoring (Backman et al., 2021). The product of this research is different from Mitchell et al., (2020) which uses a Likert scale of 1-5, while this study uses a modified scale of 1-4. Assessment of physical education learning outcomes for volleyball based on GPAI using indicators Decision Making (DM) (5 items), Skill Execution (SE) (5 items), Support (S) (5 items), Guard/Mark (G/M) (5 items), Base (B) (5 items). The advantage of GPAI is its flexibility. This research is adapted to the sport of volleyball, with descriptions and assessment criteria for students.

The results of this study are different from Ben Khalifa et al., (2020); Bergmann et al., (2022); Mahedero et al., (2021), they used five-game elements from GPAI, namely decision-making, skill execution, support, game performance game involvement, used to assess students' game performance. Furthermore, Mitchell et al. (2020) recommend seven tactical components (basic, adjustment, decision-making, skill execution, support, cover, guard/mark) related to effective game performance.

The results of the development of the Assessment of physical education learning outcomes for volleyball based on GPAI are a simple form of the test required to determine students' volleyball playing abilities. This is necessary because students' volleyball abilities are not the same. When the ability to play volleyball is known with certainty, the learning process or practice will be easier for grouping. The author hopes that this research can become a recommendation for further research to develop an Assessment of physical education learning outcomes based on GPAI, so that the physical education learning process becomes better.

Conclusions

Based on the results of the research and the results of the data analysis that has been carried out, it is concluded that the instrument for assessing the learning outcomes of physical education on volleyball material in Junior High School based on GPAI that was developed is valid and reliable, with V Aiken ≥ 0.87. Furthermore, the reliability of the physical education learning outcomes assessment instrument for volleyball material in GPAI-based junior high schools was 0.797 in the "High" category.

This research can help teachers and trainers in observing and recording performance behavior during the game. The observed aspects include behavior that reflects the player's ability to solve tactical game problems by making decisions, making body movements that are in accordance with the demands of the game situation, carrying out the type of skill he chooses.

The researcher hopes that the resulting product in the form of an assessment of physical education learning outcomes for volleyball material in GPAI-based junior high schools can be a guide or reference for evaluating students on volleyball material. Suggestions for future research, it takes time for the process of development, identification, and validation longer time to improve product quality. This GPAI-based volleyball learning outcome assessment instrument needs to be developed again to make it better.

Acknowledgment

This research is supported by Yogyakarta State University.

Conflict of interest

We know of no conflicts of interest associated with this publication, and there has been no significant financial support for this work that could have influenced its outcome. As the corresponding author, I confirm that the manuscript has been read and approved for submission by all the named authors.

References

Chng, L. S., & Lund, J. (2018). Assessment for learning in physical education: The what, why and how. *Journal of Physical Education, Recreation & Dance, 89*(8), 29-34. https://doi.org/10.1080/07303084.2018.1503119

Ciotto, C. M., & Gagnon, A. G. (2018). Promoting social and emotional learning in physical education. *Journal of Physical Education, Recreation & Dance, 89*(4), 27-33. https://doi.org/10.1080/07303084.2018.1430625

Borghouts, L. B., Slingerland, M., & Haerens, L. (2017). Assessment quality and practices in secondary PE in the Netherlands. *Physical Education and Sport Pedagogy, 22*(5), 473-489. https://doi.org/10.1080/17408989.2016.1241226

Alena, H., Danka, L., & Henryk, N. (2019). Teacher self-assessment as a part of quality management. *Science for Education Today, 9*(2), 156-169. https://doi.org/10.15293/2658-6762.1902.11

Nieminen, J. H., Asikainen, H., & Rämö, J. (2021). Promoting deep approach to learning and self-efficacy by changing the purpose of self-assessment: A comparison of summative and formative models. *Studies in Higher Education, 46*(7), 1296-1311. https://doi.org/10.1080/03075079.2019.1688282

Snead, L. O., & Freiberg, H. J. (2019). Rethinking student teacher feedback: Using a self-assessment resource with student teachers. *Journal of Teacher Education, 70*(2), 155-168. https://doi.org/10.1177/0022487117734535

Tolgfors, B. (2018). Different versions of assessment for learning in the subject of physical education. *Physical Education and Sport Pedagogy, 23*(3), 311-327. https://doi.org/10.1080/17408989.2018.1429589

Junior, N. K. M. (2018). Specific periodization for the volleyball: a training organization. *MOJ Sports Med, 2*(3), 108-111. https://doi.org/10.15406/mojsm.2018.02.00056

Zonifa, G. (2020). A volleyball skills test instrument for advanced-level students. *Journal of Physical Education & Sport,* 20. https://doi.org/10.7752/jpes.2020.s3297

Pekas, D., Mačak, D., & Zobenica, A. K. (2019). Small-sided games are more effective than instructional training for improving vertical jump performance and passing in young volleyball players. *EQOL J,* 11, 13-21. https://doi.org/10.31382/eqol.190602

García-López, L. M., & Gutiérrez, D. (2015). The effects of a sport education season on empathy and assertiveness. *Physical Education and Sport Pedagogy, 20*(1), 1-16. https://doi.org/10.1080/17408989.2013.780592

Barquero-Ruiz, C., Arias-Estero, J. L., & Kirk, D. (2020). Assessment for tactical learning in games: A systematic review. *European Physical Education Review, 26*(4), 827-847. https://doi.org/10.1177/1356336X19889649

Dania, A., Kaltsonoudi, K., Ktistakis, I., Trampa, K., Boti, N., & Pesce, C. (2021). Chess training for improving executive functions and invasion game tactical behavior of college student athletes: a preliminary investigation. *Physical Education and Sport Pedagogy,* 1-17. https://doi.org/10.1080/17408989.2021.1990245

Ben Khalifa, W., Zouaoui, M., Zghibi, M., & Azaiez, F. (2020). Effects of verbal interactions between students on skill

development, game performance and game involvement in soccer learning. *Sustainability, 13*(1), 160. https://doi.org/10.3390/su13010160

Bergmann, F., Meier, C., & Braksiek, M. (2022). Involvement and performance of U9 soccer players in 7v7 and 5v5 matches during competition. *German Journal of Exercise and Sport Research, 52*(1), 125-134. https://doi.org/10.1007/s12662-021-00752-4

Mahedero, M. P., Calderón, A., Hastie, P., & Arias-Estero, J. L. (2021). Grouping students by skill level in mini-volleyball: effect on game performance and knowledge in sport education. *Perceptual and Motor Skills, 128*(4), 1851-1871. https://doi.org/10.1177/00315125211021812

Guijarro, E., MacPhail, A., Arias-Palencia, N. M., & González-Víllora, S. (2021). Exploring game performance and game involvement: effects of a sport education season and a combined sport education—teaching games for understanding unit. *Journal of Teaching in Physical Education,* 1, 1-14. https://doi.org/10.1123/jtpe.2020-0170

Araújo, R., Hastie, P., Lohse, K. R., Bessa, C., & Mesquita, I. (2019). The long-term development of volleyball game play performance using Sport Education and the Step-Game-Approach model. *European Physical Education Review, 25*(2), 311-326. https://doi.org/10.1177/1356336X17730307

García-Ceberino, J. M., Antúnez, A., Ibáñez, S. J., & Feu, S. (2020). Design and validation of the instrument for the measurement of learning and performance in football. *International Journal of Environmental Research and Public Health, 17*(13), 4629. https://doi.org/10.3390/ijerph17134629

Lund, J. L., & Kirk, M. F. (2019). *Performance-based assessment for middle and high school physical education.* Human Kinetics Publishers.

Aryanto, B., Sukoco, P., & Lumintuarso, R. (2020). The validity of construct analysis on assessment instrument of basketball skill for senior high school in Yogyakarta City. *International Journal of Human Movement and Sports Sciences, 8*(5), 193-198. https://doi.org/10.13189/saj.2020.080506

Ibáñez, S. J., Martinez-Fernández, S., Gonzalez-Espinosa, S., García-Rubio, J., & Feu, S. (2019). Designing and validating a basketball learning and performance assessment instrument (BALPAI). *Frontiers in Psychology,* 1595. https://doi.org/10.3389/fpsyg.2019.01595

Amran, A., Ananda, A., & Khairani, S. (2018). Effectiveness of integrated science instructional material on pressure in daily life theme to improve digital age literacy of students. *Journal of Physics: Conference Series, 1006*(1), 12031. https://doi.org/10.1088/1742-6596/1006/1/012031

Aka, K. A. (2019). Integration Borg & Gall (1983) and Lee & Owen (2004) models as an alternative model of design-based research of interactive multimedia in elementary school. *Journal of Physics: Conference Series, 1318*(1), 12022. https://doi.org/10.1088/1742-6596/1318/1/012022

Aiken, R. C. (1985). *Stiff computation* (Vol. 169). Oxford University Press Oxford.

Douglass, H., Lowman, J. J., & Angadi, V. (2021). Defining roles and responsibilities for school-based tele-facilitators: Intraclass correlation coefficient (ICC) ratings of proposed competencies. *International Journal of Telerehabilitation, 13*(1). https://doi.org/10.5195/ijt.2021.6351

Cabrera, L., Sokolow, J., & Cabrera, D. (2021). Developing and validating a measurement of systems thinking: The systems thinking and metacognitive inventory (STMI). *Routledge Handbook of Systems Thinking,* 1-42. https://doi.org/10.13140/RG.2.2.28639.38566

Supena, I., Darmuki, A., & Hariyadi, A. (2021). The influence of 4C (Constructive, Critical, Creativity, Collaborative) learning model on students' learning outcomes. *International Journal of Instruction, 14*(3), 873-892. https://doi.org/10.29333/iji.2021.14351a

Sürücü, L., & Maslakçi, A. (2020). Validity and reliability in quantitative research. *Business & Management Studies: An International Journal, 8*(3), 2694-2726. https://doi.org/10.15295/bmij.v8i3.1540

Clark, L. A., & Watson, D. (2019). Constructing validity: New developments in creating objective measuring instruments. *Psychological Assessment, 31*(12), 1412. https://doi.org/10.1037/pas0000626

Hayes, A. F., & Coutts, J. J. (2020). Use omega rather than Cronbach's alpha for estimating reliability. *But…. Communication Methods and Measures, 14*(1), 1-24. https://doi.org/10.1080/19312458.2020.1718629

Elliott, M. L., Knodt, A. R., Ireland, D., Morris, M. L., Poulton, R., Ramrakha, S., Sison, M. L., Moffitt, T. E., Caspi, A., & Hariri, A. R. (2020). What is the test-retest reliability of common task-functional MRI measures? New empirical evidence and a meta-analysis. *Psychological Science, 31*(7), 792-806. https://doi.org/10.1177/0956797620916786

Suartama, I. K., Setyosari, P., & Ulfa, S. (2019). Development of an instructional design model for mobile blended learning in higher education. *International Journal of Emerging Technologies in Learning, 14*(16). https://doi.org/10.3991/ijet.v14i16.10633

Chen, F., Lui, A. M., Andrade, H., Valle, C., & Mir, H. (2017). Criteria-referenced formative assessment in the arts. *Educational Assessment, Evaluation and Accountability, 29*(3), 297-314. https://doi.org/10.1007/s11092-017-9259-z

Starck, J. R., Richards, K. A. R., & O'Neil, K. (2018). A conceptual framework for assessment literacy: Opportunities for physical education teacher education. *Quest, 70*(4), 519-535. https://doi.org/10.1080/00336297.2018.1465830

Logan, S. W., Barnett, L. M., Goodway, J. D., & Stodden, D. F. (2017). Comparison of performance on process-and product-oriented assessments of fundamental motor skills across childhood. *Journal of Sports Sciences, 35*(7), 634-641. https://doi.org/10.1080/02640414.2016.1183803

Grainger, P., & Weir, K. (2016). An alternative grading tool for enhancing assessment practice and quality assurance in higher education. *Innovations in Education and Teaching International, 53*(1), 73-83. https://doi.org/10.1080/14703297.2015.1022200

Backman, E., Tidén, A., Wiorek, D., Svanström, F., & Pihl, L. (2021). "Things that are taken from one culture don't necessarily work well in another culture." Investigating epistemological tensions through preservice teachers' views on the assessment of a games course in Swedish PETE. *Cogent Education, 8*(1), 1940636. https://doi.org/10.1080/2331186X.2021.1940636

Mitchell, S., Mitchell, S. A., Oslin, J., & Griffin, L. L. (2020). *Teaching sport concepts and skills: A tactical games approach.* Human Kinetics Publishers.

Ben Khalifa, W., Zouaoui, M., Zghibi, M., & Azaiez, F. (2020). Effects of verbal interactions between students on skill development, game performance and game involvement in soccer learning. *Sustainability, 13*(1), 160. https://doi.org/10.3390/su13010160

Bergmann, F., Meier, C., & Braksiek, M. (2022). Involvement and performance of U9 soccer players in 7v7 and 5v5 matches during competition. *German Journal of Exercise and Sport Research, 52*(1), 125-134. https://doi.org/10.1007/s12662-021-00752-4

Mahedero, M. P., Calderón, A., Hastie, P., & Arias-Estero, J. L. (2021). Grouping students by skill level in mini-volleyball: effect on game performance and knowledge in sport education. *Perceptual and Motor Skills, 128*(4), 1851-1871. https://doi.org/10.1177/00315125211021812

РОЗРОБКА ІНСТРУМЕНТІВ ОЦІНЮВАННЯ РЕЗУЛЬТАТІВ НАВЧАННЯ ФІЗИЧНОГО ВИХОВАННЯ ДЛЯ ВОЛЕЙБОЛЬНИХ МАТЕРІАЛІВ НА ОСНОВІ ІНСТРУМЕНТУ ОЦІНЮВАННЯ РЕЗУЛЬТАТИВНОСТІ ГРИ

Галіх Деванті[1ABCDE], Соні Номпембрі[1BDE], Відіянто Амрі Хартанто[1BCE], Афеб Чеса Аріанто[1ADE]

[1]Джок'якартський державний університет

Авторський вклад: A – дизайн дослідження; B – збір даних; C – статаналіз; D – підготовка рукопису; E – збір коштів

Реферат. Стаття: 8 с., 8 табл., 5 рис., 42 джерела.

Мета дослідження. Основне припущення цієї розробки полягає в тому, що не існує інструменту оцінювання результативності гри (ІОРГ), побудованого на оцінюванні результатів навчання фізичного виховання (ФВ), тому дослідники намагаються розробити такий інструмент. Вчитель не використовував інструмент ІОРГ для оцінювання результатів навчання ФВ для волейбольного матеріалу. Мета дослідження полягала в тому, щоб розробити валідну та надійну оцінку результатів навчання ФВ для волейболу на основі ІОРГ.

Матеріали та методи. Це дослідження належить до типу «дослідження та розробка». Суб'єктами були викладачі-експерти з навчання ФВ та викладачі-експерти з волейболу з мінімальною кваліфікацією 5 докторських ступенів. Польове тестування проводили на 18 учнях середніх класів. В інструменті використовується опитувальник із оцінкою 1–4 бали з термінами «Дуже доречно (4 бали)», «Згоден (3 бали)», «Не доречно (2 бали)» та «Дуже не доречно (1 бал)». Техніка аналізу даних валідності використовує валідність Ейкена, а перевірки надійності проводять за допомогою коефіцієнтів внутрішньогрупової кореляції.

Результати. На основі результатів дослідження та результатів проведеного аналізу даних зроблено висновок, що розроблений інструмент для оцінювання результатів навчання ФВ на матеріалі волейболу в середній школі на основі ІОРГ є валідним і надійним, при цьому показник валідності Ейкена становить $V \geq 0{,}87$. Крім того, надійність інструменту оцінювання результатів навчання ФВ для волейбольного матеріалу в середніх школах на базі ІОРГ становила 0,797 у категорії «Висока».

Висновки. Автор дослідження сподівається, що отриманий результат у формі засобу оцінювання результатів навчання ФВ для матеріалу з волейболу в середніх школах на основі ІОРГ може бути посібником або довідником для оцінювання учнів з матеріалу з волейболу.

Ключові слова: інструмент оцінювання результатів навчання, фізичне виховання, волейбол, ІОРГ.

Information about the authors:

Dewanti, Galih: galih.dewanti@uny.ac.id; https://orcid.org/0000-0001-5185-7360; Department of Sports Science, Faculty of Sport Science, Universitas Negeri Yogyakarta, Jl. Colombo Yogyakarta No.1, Karang Malang, Caturtunggal, Kec. Depok, Kabupaten Sleman, Daerah Istimewa Yogyakarta 55281, Indonesia

Nompembri, Soni: soni_nopembri@uny.ac.id; https://orcid.org/0000-0002-9094-6451; Department of Sports Science, Faculty of Sport Science, Universitas Negeri Yogyakarta, Jl. Colombo Yogyakarta No.1, Karang Malang, Caturtunggal, Kec. Depok, Kabupaten Sleman, Daerah Istimewa Yogyakarta 55281, Indonesia

Widiyanto: widiyanto_uny@yahoo.com; https://orcid.org/0000-0003-1510-9896; Department of Sports Science, Faculty of Sport Science, Universitas Negeri Yogyakarta, Jl. Colombo Yogyakarta No.1, Karang Malang, Caturtunggal, Kec. Depok, Kabupaten Sleman, Daerah Istimewa Yogyakarta 55281, Indonesia

Hartanto, Amri: amry7766@yahoo.com; https://orcid.org/0000-0002-6276-2495; Department of Sports Science, Faculty of Sport Science, Universitas Negeri Yogyakarta, Jl. Colombo Yogyakarta No.1, Karang Malang, Caturtunggal, Kec. Depok, Kabupaten Sleman, Daerah Istimewa Yogyakarta 55281, Indonesia

Arianto, Afeb Chesa: afsariant.chesa@gmail.com; https://orcid.org/0000-0001-5356-3243; Department of Sports Science, Faculty of Sport Science, Universitas Negeri Yogyakarta, Jl. Colombo Yogyakarta No.1, Karang Malang, Caturtunggal, Kec. Depok, Kabupaten Sleman, Daerah Istimewa Yogyakarta 55281, Indonesia.

Cite this article as: Dewanti, G., Nompembri, S., Widiyanto, Hartanto, A., & Arianto, A.C. (2023). Development of Physical Education Learning Outcomes Instruments for Volleyball Materials Based on Game Performance Assessment Instrument. *Physical Education Theory and Methodology, 23*(2), 170-177. https://doi.org/10.17309/tmfv.2023.2.03

Received: 12.11.2022. Accepted: 27.01.2023. Published: 28.04.2023

Теорія та методика фізичного виховання
Physical Education Theory and Methodology
Teorìâ ta Metodika Fìzičnogo Vihovannâ

ISSN 1993-7989 (print)
ISSN 1993-7997 (online)
ISSN-L 1993-7989

ORIGINAL SCIENTIFIC ARTICLE

CAPTURING STREET SOCCER GAME PERFORMANCES AND WORKLOAD DURING HOMELESS WORLD CUP

Rizki Mulyawan[1ABC], Sumaryanti[1ABC] and Sigit Nugroho[1BCD]

[1]Universitas Negeri Yogyakarta

Authors' Contribution: A – Study design; B – Data collection; C – Statistical analysis; D – Manuscript Preparation; E – Funds Collection

Corresponding Author: Mulyawan, Rizki, E-mail: rizkimulyawan@uny.ac.id
Accepted for Publication: January 27, 2023
Published: April 28, 2023

DOI: 10.17309/tmfv.2023.2.04

Abstract

Study purpose. This study intended to convert the description of the strategies utilized in street soccer matches to international competitions.

Materials and methods. Descriptive quantitative study was used that determined the participants by random sampling of the entire population. It acquired eight Indonesian national team athletes for the Homeless World Cup (HWC). The data was gathered from the six most important HWC matches, including those versus Zimbabwe, Israel, Romania, Brazil, Egypt, and the Netherlands, and examined using match footage. These six contests were chosen for their statistical analysis of decisive victories and defeats. Pearson Correlation was utilized for descriptive and inferential data analysis to evaluate the relationship between variables such as passing, shooting, goal, and goal allowed.

Results. As indicated by the high association between passing and shooting accuracy and goal-scoring against the opponent's goal, passing and shooting were dominating throughout street soccer matches, especially during big events such as the HWC.

Conclusions. This study may serve as a resource for all teams in the globe as they develop and implement training program plans to prepare street soccer teams in their various nations.

Keywords: Street soccer, Homeless World Cup, Shooting, Passing, Prominent abilities.

Introduction

Implementing the Homeless World Cup (HWC) that preserves societal ideals (Hendriks & Toepoel, 2020) for marginalized groups and gives opportunity for particular groups to represent their different countries must be memorable for all parties concerned. Not only do the athletes participating get new experiences, but so do the coaches. It even offers new views to the HWC's participating coaches. For street soccer coaches, training program references are required to help preparations for the championship match in a large tournament involving all nations. In the sport of street soccer, a training program that can explain the increase of players' skills has not yet been developed. In contrast to football, a systematic training program (Walker & Hawkins, 2018) emphasizes strength training (Silva et al., 2015), agility (Zouhal et al., 2019), power and speed (Sáez De Villarreal et al., 2015), and coordination (Popović et al., 2020).

There are currently just a few of nations that incorporate human rights protection teams with established programs. There was no regular street soccer competition in each country, such as the highest division of the soccer league or futsal. During the team preparation phase for the HWC tournament, only a handful of countries, including some in America, had adequately prepared their squads (Peachey et al., 2011) and Latin America, which have held distinctive street soccer events in their own nations in preparation for the HWC event.

The majority of prior study has focused on the social side, where a group of marginalized individuals have the option to engage in HWC activities (Jarvie & Ahrens, 2019; Magee, 2011; Magee & Jeanes, 2013), specifically addressing the link between poverty, playing chances, and individual alterations (Okada, 2021; Okada & Banda, 2018; Okada & Kashu, 2020), Moreover, a few of them pondered the idea of holding HWC (Attali et al., 2018). In addition to highlighting the importance of changing fate for the actors (players, referees, or coaches) after the HWC activity concluded, a review of the discussion of previous literature research reveals that

there was little discussion on technical issues directly related to large-scale street soccer matches. Furthermore, the predominance of technique and its influence on the eventual result of the match are noticeable.

Only one relevant study explored technical and particular impacts on activities during HWC matches, such as pulse and physiological control for homeless players, and even then, only for women (Randers et al., 2018). Unfortunately, no one has investigated the importance of the players' talents as a foundation for finishing training programs and evaluating which elements require improvement. It appears that nothing has been known about street soccer. Thus, the purpose of this study was to analyze the talent of the most dominating player, which might greatly impact the outcome of the world championship match. It was a beneficial aspect of expanding the understanding and application of technical abilities in order to assist coaches with answers and methods.

Consequently, the purpose of this study was to explore the primary technical elements identified during street soccer matches. The primary purpose of this study appears to be to assist coaches in preparing street soccer teams that may resume play after a pandemic-induced hiatus of more than two years. On the other hand, it was anticipated that this study would offer an overview of the investigation of statistical match data that was more explicit about the dominance of technical talents that may contribute to the ultimate outcome of street soccer matches.

Materials and methods

Study participants

The research subjects were picked using a technique of total sampling. Moreover, they included eight members of the Indonesian national squad. All players agreed that they were willing to participate in the study voluntarily, and their personal information was kept strictly anonymous for research purposes. Ethics committee approval number 00169/KT.7.4/VI/2021 obtained through the Commission on Health Research Ethics PKU Hospital Yogyakarta issued a procedural research review and approved this research. All of participants and subjects approved and signed the inform consent before conducting the research.

Table 1. Research Subjects

Variable	Mean±SD
Age	25.14±2.09
Height	170.42±2.09
Weight	66.71±5.99
BMI	22.90±1.5
Player's Category:	
Narcotics, %	37.50±3
Urban Poor, %	62.50±5

Study organization

The Indonesian squad faced Zimbabwe, Bulgaria, Denmark, Israel, Romania, Brazil, Netherlands, Mexico, Egypt, and Portugal in six of their ten HWC matches. Six primary matches that were eligible for data collection were chosen. Video match observations were utilized to retrieve data during the HWC tournament. Six of 10 matches were picked, with reasonably impressive victory percentages, along with a key encounter against one of the top-ranked nations in street soccer, Brazil. Thus, the development of the match would be measured quantitatively and compared to that of other nations. Passing (on- and off-target in each round and accumulation per match), shooting (on- and off-target in each round and accumulation per match), goals and goals allowed served as data gathering benchmarks.

Homeless World Cup: Brief Street Soccer Rules

The court is 22 meters long and 16 meters wide, with a board height of roughly 1.10 meters, so players may utilize the board to bounce the ball, with no chance of the ball leaving the court. As a result, each minute will be both physically and technically demanding, as well as strenuous. Maximum of 4 players per team on the court: 3 outfield players, 1 goalkeeper, plus 4 substitute players. Outfield players must not enter the penalty area. This rule applies to both attacking and defending players ("fishing for the ball" is not allowed). If a player from the defending team enters the penalty area, the other team receives a penalty. If a player from the attacking team enters the penalty area, the other team receives a free kick. At least one player must remain in the opposition half of play. A foul will be awarded against a team where the whole team is in its own half. As a result, the defense team will only have two players and one goalkeeper. On the other hand, with three outfield players, the offense team will be more viable, with passing and shooting as critical skills and abilities that may be contribute to the team's victory.

Statistical Analysis

The data analysis included descriptive statistical computations and Pearson Correlation to determine how the link between each component may impact the match's course and outcome.

Results

The statistical picture for six of the ten matches between Indonesia and Zimbabwe, Israel, Romania, Brazil, Egypt, and the Netherlands was shown in Tables 2 and 3. Passing and shooting were made more detailed by displaying on-target and off-target kicks in both the first and second halves, as well as the match's total accumulation and the passing accuracy from each game. The computation indicator for accuracy is based on on-target passing or shooting divided by the total passing or shooting attempts in a game.

After interpreting the passing and shooting descriptions, the calculation statistics for passing and shooting accuracy were acquired, as shown in Table 4 and Figure 1. It can be observed that the highest passing accuracy achieved during the seven-goal game versus Israel. Meanwhile, the most impressive shooting accuracy emerged during the encounter between Indonesia and the Netherlands, with a shooting accuracy rating of 48 percent (Table 3) and 10 goals scored (Table 4). In addition, Figure 2 illustrates the goals scored against the opponent's goal and goals conceded by the Indonesian squad, which faced six out of ten countries throughout the HWC.

Table 2. Passing

Indonesia vs	Passing							
	Round 1		Round 2		Total			Accuracy (%)
	On-target	Off-target	On-target	Off-target	On- target	Off-target	Full match	
Zimbabwe	25	5	30	7	55	12	67	82
Israel	52	7	33	6	85	13	98	87
Romania	14	7	17	5	31	12	43	72
Brazil	11	10	15	6	26	16	42	62
Egypt	29	9	12	4	41	13	54	76
Netherlands	33	4	28	10	61	14	75	81

Table 3. Shooting

Indonesia vs	Shooting							
	Round 1		Round 2		Total			Accuracy (%)
	On-target	Off-target	On-target	Off-target	On-target	Off-target	Full match	
Zimbabwe	4	8	7	7	11	15	26	35
Israel	8	1	10	3	18	4	22	32
Romania	5	2	7	3	12	5	17	29
Brazil	3	1	5	2	8	3	11	18
Egypt	5	9	5	2	10	11	21	24
Netherlands	7	4	6	4	13	8	21	48

Table 4. Accuracy of passing, shooting, goal, and goal conceded

Indonesia vs	Passing Accuracy	Shooting Accuracy	Enter (Goal)	Goal Conceded
Zimbabwe	82%	35%	9	2
Israel	87%	32%	7	2
Romania	72%	29%	5	3
Brazil	62%	18%	2	2
Egypt	76%	24%	5	4
Netherlands	81%	48%	10	1

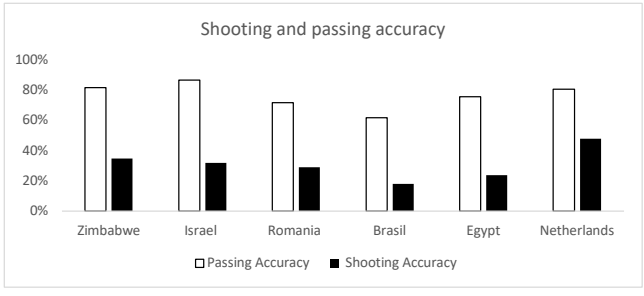


Fig. 1. Accuracy of shooting and passing by the Indonesian team in a street soccer match at the HWC

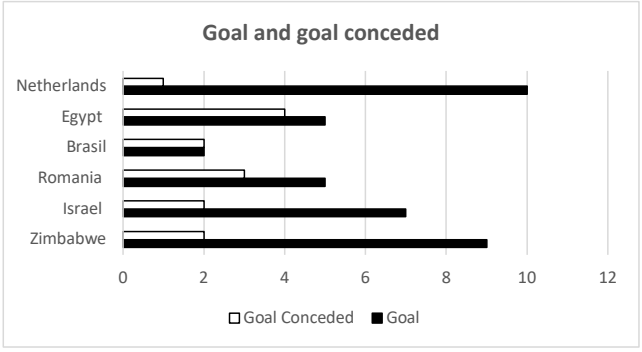


Fig. 2. Goal and goal-conceded by the Indonesian team in six street soccer matches at the HWC event

The association between passing on- and off-targets, shooting on- and off-targets, goals, and goals allowed was calculated. To determine how the connection between variables was determined from all recorded matches, the relationship between variables was measured using Pearson Correlation computations. Based on Sig. (2-tailed) and Pearson Correlation (r), the statistical calculations revealed significant correlation (p-value < 0.05; $r_{count} > r_{table}$) between passing and shooting was very significant (p: 0.019 < 0.05; r: 0.887 > 0.811) , so it passing accuracy (p: 0.042 < 0.05; r: 0.827 > 0.811) and shooting accuracy (p: 0.006 < 0.01; r: 0.939 > 0.811) were considerably associated with the incidence of goals against the opponent's goal. Meanwhile, it was able to calculate 16 opportunities. The correlation between the other factors was not statistically significant (p-value > 0.05; $r_{count} < r_{table}$).

Discussion

Diverse goals arose with the aim of bringing all peoples of the globe closer together, leaving no one behind. Since 2015, the United Nations has released the 2030 Agenda as a one-of-a-kind chance to inspire the emergence of global action for global development, which incorporates the Development

Table 5. Relationship between variables of the six recorded matches

Correlation between variables	Correlation		Correlation between variables	Correlation	
	r	Sig.		r	Sig.
Passing on target – Passing off target	-.284	.586	Shooting on target – Goal	.499	.314
Passing on target – Shooting on target	.887	.019*	Shooting on target – Goal conceded	-.284	.585
Passing on target – Shooting off target	.088	.868	Shooting off target – Goal	.552	.256
Passing on target – Goal	.679	.138	Shooting off target – Goal conceded	.153	.772
Passing on target – Goal conceded	-.422	.404	Goal – Goal conceded	-.504	.308
Passing off target – Shooting on target	-.390	.445	Passing accuracy – Goal	.827	.042*
Passing off target – Shooting off target	-.526	.284	Shooting accuracy – Goal	.939	.006**
Passing off target – Goal	-.481	.334	Passing accuracy – Goal conceded	-.226	.667
Passing off target – Goal conceded	-.343	.506	Shooting accuracy – Goal conceded	-.622	.187
Shooting on target – Shooting off target	-.215	.682			

* There was a significant correlation (p-value < 0.05); ** There was a very significant correlation (p-value < 0.01)

and Peace mission (Lemke, 2016). It provides a synopsis of the 17 essential SDGs (Sustainable Development Goals), which have been declared the priority for the next 15 years. Adjusted to the street soccer action held at the HWC event, the importance of this humanitarian activity is the eradication of poverty and the promotion of health and well-being (good health and well-being). HWC defends human values to a great degree, therefore empowering underprivileged groups to transform the stigma of being backward into the stigma of societal benefit (Hendriks & Toepoel, 2020). On the other South-East Asia members, such as Cambodia, which is in the southeastern part of the continent of Asia, Cambodia's robust economic expansion looks to be a driving force behind HWC's sustained success. Consequently, many soccer players have attained social engagement by learning, working, and enjoying the sport (Okada & Kashu, 2020). Sport may be an effective means of realizing social capital, with favorable effects on the mental health and substance abuse habits of individuals from marginalized and high-risk populations (Sherry & O'May, 2013).

Numerous studies have examined the economic, societal, and behavioral consequences toward HWC players (Jarvie & Ahrens, 2019; Okada & Banda, 2018; Okada & Kashu, 2020). One of the researchers, Randers (Randers et al., 2012, 2018, 2020), centered on discussing the physiological repercussions of a person's participation in recreational street soccer activities. This study examined how small-sided games have been demonstrated to boost the body's capacity, maximal oxygen consumption (VO_2max), body composition, blood pressure, and blood fat levels (Randers et al., 2012). Games can impact activity habits and health factors (Randers et al., 2020), especially range measurements, heart rate, blood samples, and tiredness assessment. The most extensive research indicates that high-intensity exercise during street soccer training may be an effective way for male players to enhance their physical fitness and cardiovascular health (Randers et al., 2012). According to another studies, street soccer involves a fast heart rate and intense repetition of motions (Randers et al., 2018) – coupled with the follow-up intervention, which led to the conclusion that high intensity was predicted to improve health status in both the short and long term as a result of routine participation, which involved movement patterns, physiological needs, high acceleration, player load, average pulse rate, blood plasma, and the level of perceived fatigue, despite the relatively low total cruising range, the number of running repetitions, and speed (Randers et al., 2020).

For the first time, there were still few references that matched or corresponded with earlier findings. Most of the prior study has been on the social implications of HWC (Jarvie & Ahrens, 2019; Magee & Jeanes, 2013; Sherry & O'May, 2013), particularly the relationship between poverty, playing opportunities, and individual changes (Okada, 2021; Okada & Banda, 2018; Okada & Kashu, 2020). Consequently, this study might be considered as the first technical discussion in the street soccer literature review. Only one significant research investigated the physiological effects on pulse and sign control for homeless players, and even then, only for women (Randers et al., 2018), not males. Hence, this study addresses the issue of acquiring more technical concerns tied directly to large-scale street soccer matches, especially in males, while also emphasizing the need of preparing technical and physical components for all future participants.

Due to a lack of data from the street soccer skills investigation throughout the game. Thus, data modified for the primary kind of foot motion pattern in kicking and lower extremity performance in general must be compared. Football and futsal, two related or comparable sports, were acquired. The distinction was in the field's size, shape, and alteration regulations. Using futsal-specific testing, it was determined that elite futsal athletes have higher shooting and passing skills compared to semi-elite athletes (Naser & Ali, 2016). According to football research, the world's best teams are more likely to make repeated long passes and more short passes than their vanquished opponents (Rampinini et al., 2009). Thus, it was proportional to the number of goals scored and the number of goals scored per possession by the winning side. In addition, (Olsen, 2013) attempting to quantify the passing ability of soccer players in international events, researchers discovered that 57 percent of goals were scored following a period of short passes.

One season of study comparing multiple elite futsal teams from Brazil, Spain, and Australia led to the conclusion

that the Brazilian team had the greatest possession of the ball compared to other teams and produced more passes on target per minute played than the Australian team. However, Australian players engaged in more intense exercises than their Spanish counterparts (Doğramacı et al., 2015). Less high-intensity activity expenditure, superior ball possession, and passing accuracy identified as crucial factors distinguishing between successful and poor match performances based on these data. According to this study, there was a correlation between the match with the greatest passing accuracy value and the number of shots on target. It was also consistent with a soccer study that identified the quantity of short passes as one of the game's deciding factors (Rampinini et al., 2009). Ironically, especially for street soccer players in the HWC tournament, the player's background was the most essential thing. It should be emphasized that several athletes were formerly addicted to drugs. Consequently, they could not be compared to elite futsal and soccer players in terms of fitness and technique. The remaining players on this national squad were classified as urban poor. In addition to providing data on player fitness, this study chose to highlight the skill component related to technical performance on the field. Passing on target was positively connected with the amount of shots on target in HWC championship-level street soccer. The greater the number of players that successfully pass the ball on target, the better the likelihood of reasonably huge shooting opportunities ($0.019 > 0.05$). Consequently, although this study found no significant correlation between passing on target and the number of goals ($0.138 > 0.05$), it can be assumed that it would provide more opportunities for players to score more goals based on the results of the statistical calculation of the correlation, which revealed a significant and very significant relationship between passing ($0.042 < 0.05$) and shooting ($0.006 < 0.01$) and the occurrence of goals against the opposition.

There was evidence of the advantages of engaging in frequent street soccer activities, which were extremely precise in their discussion of the health benefits of small-sided games. The research findings might serve as the basis for a further investigation into the peculiarities of street soccer as seen from a technical perspective. Only Randers' research examined the physiological characteristics of the global sport of street soccer (Randers et al., 2012, 2018, 2020). In addition to the research findings, various comparison studies on the features of futsal and football were also included. According to the research findings, it may aid coaches in analyzing, concocting, designing, and deciding systematic and planned training regimes for street soccer teams from any country prior to the end of the pandemic and the return of HWC competitions. Therefore, the research results may characterize the features of street soccer during the HWC performance.

Conclusions

Passing and shooting were the most prevalent strategies that determined the outcome of street soccer matches. The high correlation between passing and shooting accuracy in producing goals against the opponent's goal was particularly evident during the HWC competition. Both skills must be mastered to attain the highest levels of success in street soccer, both nationally and internationally. This information might be useful for coaches in identifying possible errors during the game and enhancing strategy formulation in both training and competition.

Acknowledgment

The researcher expresses gratitude to Rumah Cemara as the leading that cares about marginalized communities and provides substantial support from the beginning of competition preparations to its ending. Also, to the coaching staff of the Indonesian Homeless World Cup squad, who offer the researcher the opportunity to support the team as a coach assistant and data analyst throughout the preparation and competition phases, respectively. Moreover, this work has no conflicts of interest.

Conflict of interest

Authors declare no conflict of interest.

References

Hendriks, M., & Toepoel, V. (2020). *Social impact of street soccer leagues.* In Exploring the Social Impacts of Events (pp. 125–139). https://doi.org/10.4324/9780203108123-18

Walker, G. J., & Hawkins, R. (2018). Structuring a program in elite professional soccer. *Strength and Conditioning Journal, 40*(3). https://doi.org/10.1519/SSC.0000000000000345

Silva, J. R., Nassis, G. P., & Rebelo, A. (2015). Strength training in soccer with a specific focus on highly trained players. *In Sports Medicine - Open, 1*(1). https://doi.org/10.1186/s40798-015-0006-z

Zouhal, H., Abderrahman, A. B., Dupont, G., Truptin, P., Le Bris, R., Le Postec, E., Sghaeir, Z., Brughelli, M., Granacher, U., & Bideau, B. (2019). Effects of neuromuscular training on agility performance in elite soccer players. *Frontiers in Physiology, 10*(JUL). https://doi.org/10.3389/fphys.2019.00947

Sáez De Villarreal, E., Suarez-Arrones, L., Requena, B., Haff, G. G., & Ferrete, C. (2015). Effects of Plyometric and Sprint Training on Physical and Technical Skill Performance in Adolescent Soccer Players. *Journal of Strength and Conditioning Research, 29*(7). https://doi.org/10.1519/JSC.0000000000000838

Popović, B., Gušić, M., Radanović, D., Andrašić, S., Madić, D. M., Mačak, D., Stupar, D., Đukić, G., Grujičić, D., & Trajković, N. (2020). Evaluation of gross motor coordination and physical fitness in children: Comparison between soccer and multisport activities. *International Journal of Environmental Research and Public Health, 17*(16). https://doi.org/10.3390/ijerph17165902

Peachey, W., Texas, A., & Lyras, A. (2011). Street Soccer USA Cup : Preliminary Findings of a Sport-for-Homeless Intervention. *ICHPER-SD Journal of Research, 8*(1).

Jarvie, G., & Ahrens, S. (2019). Sport, Homelessness, and Capability: Voices from the Street. *Quest.* https://doi.org/10.1080/00336297.2018.1552160

Magee, J. (2011). Disengagement, de-motivation, vulnerable groups and sporting inclusion: A case study of the Homeless World Cup. *Soccer and Society.* https://doi.org/10.1080/14660970.2011.548353

Magee, J., & Jeanes, R. (2013). Football's coming home: A critical evaluation of the Homeless World Cup as an intervention to combat social exclusion. *International Review for the Sociology of Sport.* https://doi.org/10.1177/1012690211428391

Okada, C. (2021). Poverty Reduction through Sports: A Case Study of Five Countries Participating in the Homeless World Cup. *The International Journal of Sport and Society.* https://doi.org/10.18848/2152-7857/cgp/v12i01/91-106

Okada, C., & Banda, M. (2018). Sport as a Tool to Solve Community Issues in Poverty-stricken Areas in Zimbabwe: The Homeless World Cup. *The International Journal of Sport and Society.* https://doi.org/10.18848/2152-7857/cgp/v09i01/39-49

Okada, C., & Kashu, M. (2020). Sport for Poverty Reduction through a Cambodian Organization: The Homeless World Cup. *The International Journal of Sport and Society.* https://doi.org/10.18848/2152-7857/cgp/v11i02/11-22

Attali, M., Trejo, F. S. M., & Magee, J. (2018). The emergence and transformations of the world cup for the homeless: From the excitement of soccer to managerial decisions between 2003 and 2012. *International Journal of the History of Sport.* https://doi.org/10.1080/09523367.2019.1593148

Randers, M. B., Marschall, J., Nielsen, T.-T., Møller, A., Zebis, M. K., & Krustrup, P. (2018). Heart rate and movement pattern in street soccer for homeless women. *German Journal of Exercise and Sport Research, 48*(2), 211-217. https://doi.org/10.1007/s12662-018-0503-6

Lemke, W. (2016). The role of sport in achieving the sustainable development goals. *UN Chronicle, 53*(2). https://doi.org/10.18356/7260830a-en

Sherry, E., & O'May, F. (2013). Exploring the impact of sport participation in the Homeless World Cup on individuals with substance abuse or mental health disorders. *Journal of Sport for Development.*

Randers, M. B., Petersen, J., Andersen, L. J., Krustrup, B. R., Hornstrup, T., Nielsen, J. J., Nordentoft, M., & Krustrup, P. (2012). Short-term street soccer improves fitness and cardiovascular health status of homeless men. *European Journal of Applied Physiology, 112*(6). https://doi.org/10.1007/s00421-011-2171-1

Randers, M. B., Brix, J., Hagman, M., Nielsen, J. J., & Krustrup, P. (2020). Effect of Boards in Small-Sided Street Soccer Games on Movement Pattern and Physiological Response in Recreationally Active Young Men. *Journal of Strength and Conditioning Research, 34*(12). https://doi.org/10.1519/JSC.0000000000002401

Naser, N., & Ali, A. (2016). A descriptive-comparative study of performance characteristics in futsal players of different levels. *Journal of Sports Sciences, 34*(18). https://doi.org/10.1080/02640414.2015.1134806

Rampinini, E., Impellizzeri, F. M., Castagna, C., Coutts, A. J., & Wisløff, U. (2009). Technical performance during soccer matches of the Italian Serie A league: Effect of fatigue and competitive level. *Journal of Science and Medicine in Sport, 12*(1). https://doi.org/10.1016/j.jsams.2007.10.002

Olsen, E. (2013). *An analysis of goal scoring strategies in the World Championship in Mexico, 1986.* In Science and Football (Routledge Revivals) (pp. 395–398). Routledge. https://doi.org/10.4324/9780203720035-65

Doğramacı, S. N., Watsford, M. L., & Murphy, A. J. (2015). Activity Profile Differences Between Sub-elite Futsal Teams. *In International Journal of Exercise Science, 8*(2).

ФІКСАЦІЯ ПОКАЗНИКІВ ІГРИ У ВУЛИЧНИЙ ФУТБОЛ ТА РОБОЧОГО НАВАНТАЖЕННЯ ПІД ЧАС ЧЕМПІОНАТУ СВІТУ З ФУТБОЛУ ДЛЯ БЕЗХАТЬКІВ

Різкі Мульяван[1ABC], Сумарьянті[1ABC], Сігіт Нугрохо[1BCD]

[1]Джок'якартський державний університет

Авторський вклад: A – дизайн дослідження; B – збір даних; C – статаналіз; D – підготовка рукопису; E – збір коштів

Реферат. Стаття: 8 с., 5 табл., 2 рис., 23 джерела.

Мета дослідження. Метою цього дослідження було конвертувати опис стратегій, які використовують у вуличних футбольних матчах, у міжнародні змагання.

Матеріали та методи. Використовували описове кількісне дослідження, яке визначало учасників шляхом випадкової вибірки з усієї сукупності. В результаті було визначено вісім спортсменів національної збірної Індонезії для Чемпіонату світу для безхатьків (ЧСБ). Дані збирали з шести найважливіших матчів ЧСБ, які включали матчі проти Зімбабве, Ізраїлю, Румунії, Бразилії, Єгипту та Нідерландів, і вивчали з використанням записів матчів. Ці шість змагань були вибрані для статистичного аналізу вирішальних перемог і поразок. Для описового та інференційного аналізу даних використовували кореляцію Пірсона з метою оцінки зв'язку між такими змінними, як передача, удар, гол і пропущений гол.

Результати. Як показує високий зв'язок між точністю передачі та удару та забитим м'ячем у ворота суперника, передачі та удари домінували під час усіх вуличних футбольних матчів, особливо під час великих змагань, таких як ЧСБ.

Висновки. Це дослідження може слугувати ресурсом для всіх команд у світі, коли вони розробляють і впроваджують плани тренувальних програм для підготовки команд із вуличного футболу в своїх різних країнах.

Ключові слова: вуличний футбол, Чемпіонат світу для безхатьків, удар, передача, видатні здібності.

Information about the authors:

Mulyawan, Rizki: rizkimulyawan@uny.ac.id; https://orcid.org/0000-0002-0180-5025; Department of Sports Science, Faculty of Sport and Health Sciences, Universitas Negeri Yogyakarta, Jl. Colombo Yogyakarta No.1, Karang Malang, Caturtunggal, Kec. Depok, Kabupaten Sleman, Daerah Istimewa Yogyakarta 55281, Indonesia

Sumaryanti: sumaryanti@uny.ac.id; https://orcid.org/0000-0002-5989-5326; Department of Sports Science, Faculty of Sport and Health Sciences, Universitas Negeri Yogyakarta, Jl. Colombo Yogyakarta No.1, Karang Malang, Caturtunggal, Kec. Depok, Kabupaten Sleman, Daerah Istimewa Yogyakarta 55281, Indonesia

Nugroho, Sigit: sigit.nugroho@uny.ac.id; https://orcid.org/0000-0002-7681-3839; Department of Sports Science, Faculty of Sport and Health Sciences, Universitas Negeri Yogyakarta, Jl. Colombo Yogyakarta No.1, Karang Malang, Caturtunggal, Kec. Depok, Kabupaten Sleman, Daerah Istimewa Yogyakarta 55281, Indonesia

Cite this article as: Mulyawan, R., Sumaryanti, & Nugroho, S. (2023). Capturing Street Soccer Game Performances and Workload During Homeless World Cup. *Physical Education Theory and Methodology, 23*(2), 179-184. https://doi.org/10.17309/tmfv.2023.2.04

Received: 28.11.2022. Accepted: 27.01.2023. Published: 28.04.2023

Теорія та методика фізичного виховання
Physical Education Theory and Methodology
Teorìâ ta Metodika Fizičnogo Vihovannâ

ISSN 1993-7989 (print)
ISSN 1993-7997 (online)
ISSN-L 1993-7989

ORIGINAL SCIENTIFIC ARTICLE

INVESTIGATING THE CAUSATIVE FACTOR OF MUSCULOSKELETAL INJURY FOR INDONESIAN TRADITIONAL MARTIAL ARTS

Moh Nanang Himawan Kusuma[1ABCDE] and Novita[2ABCDE]

[1]University of Jenderal Soedirman
[2]State University of Medan

Authors' Contribution: A – Study design; B – Data collection; C – Statistical analysis; D – Manuscript Preparation; E – Funds Collection

Corresponding Author: Nanang Kusuma, E-mail: nanang.kusuma@unsoed.ac.id
Accepted for Publication: January 27, 2023
Published: April 28, 2023

DOI: 10.17309/tmfv.2023.2.05

Abstract

Background. The interest in Pencak Silat is growing significantly, however, followed by the elevation of injury cases with 7.7% for females and 17.8% for males.

Study purpose. The study explores the injuries profile of musculoskeletal, including type, form, location, mechanism, and risk factors, across genders.

Materials and methods. Two hundred and twenty-nine athletes including 148 males and 81 females in 4 different Sports Schools and Clubs (age 21.3±3.7 years old, BMI 21.12±1.56 kg/m^2, normal resting heart rate), who had ever attended the national competition, voluntarily participated. The personal data was collected by a research assistant, the training load was recorded by coaches, while the injuries profile was legitimated with the OSTRC-Questionnaire by medical rehabilitation specialists, and Postural Investigation was confirmed by certified clinical staff with FMS-Score-test.

Results. The Incidence Rate (IR) for males was higher with 48.5 (95% CI: 45.8–51.3) and was 35.2 injuries/1000 hours for females, males had 3.1 times higher severity level than females (2.3±1.2) and had longer injuries duration (4.8±2.6 weeks) than females. The contusion brought the most frequent incidence at 32.9/1000 hours (36.7%), hematoma at 19.9 injuries/1000 hours (95%CI:17.9-23.1), and muscle soreness (12.1/1000 hours). The lower limbs were the most damaged areas with 33/1000 hours and the upper limbs (26,5%) with 5-14 injuries/1000 hours. The previous injury has a risk effect with 3.0 times higher contributed to the on-set current injury, followed by Excessive training. A kick by the opponent (25%) and offensive kick (19%) were a frequent mechanism of injuries.

Conclusions. The Injury Rate (IR) was significantly different between the genders. The findings strengthen the study of injuries, which are specially characteristic of Pencak Silat, that may contribute to delivering injuries profile.

Keywords: Musculoskeletal, injuries, location, mechanism, Pencak Silat.

Introduction

Pencak Silat is one of the most Indonesia prominent traditional combat sports amidst another modern martial art, recognized by UNESCO as one of the cultural heritage of martial art surrounding the Southeast Asian Archipelago (Wilson, 2015). The increase of interest growing by 47% yearly in line with the policy of the ministry of education which requires Pencak Silat as a compulsory Extracurricular Program. Similarly, the number of school competitions, juvenile, youth, and adults has shown an elevation to date (Keilbart, 2019).

The study reported the Incidence Rate of injury (IR) was up to 67% in both genders yearly, including youth by 7.7%, and elite by 17.8% (Chan et al., 2020), and were known to vary from 24 %-77% (Del Vecchio et al., 2018). It was identified in Tae Kwon do that the lower extremity was the most prevalent injury of youths (29 cases), juniors (74 cases), and elites (41 cases) (Lystad et al., 2009). Another study has established the injuries' location in karate of upper limbs into specific locations such as craniofacial (31%), Head (11%), Neck (6%), Nose (9%), Jaw (4%), and Lips (3%) (Thomas & Ornstein, 2018). Meanwhile, the middle body is documented in hips (6%), forearm (4%), hand (3%), elbow (2%) and followed by lower limbs (Miguel-Andrés et al., 2020) such as the thigh (11%), Ankle (5%), shin splint (7%), and patellofemoral (19%) (Cierna et al., 2018). Furthermore, a cases study in karate and Kempo found that soft tissue injuries such as hematoma and contusion were the most prevalent injury, meanwhile, muscle soreness was the second most common injury, sprains and strains were the most prevalent in juveniles and teens (Cierna & Lystad, 2017).

The postural classification according to gender is frequently overlooked as a trigger factor of injuries by a

previous study (Meshkati et al., 2010). Despite other studies clarifying that postural classification has no significant effect on injury (Buist et al., 2010), however, different pieces of training management in individual cases (Anggraeni et al., 2019) often result in improper load (Kusuma et al., 2018) and contribute to a high risk of injury (Tabor et al., 2019). Other findings highlight differences impact of age and gender on injuries (Sterkowicz-Przybycien & Fukuda, 2016), which are related to physical fitness, motor coordination, and technical quality (Subekti et al., 2020), and as factors that may underlie biomechanical movement in Pencak Silat to prevent injuries incidences (Zheng et al., 2020; Kusuma, 2021b),

The limitation of the study is a lack of hypotheses related to the injuries profile that have not been identified in Indonesia to date. A subjective prognosis was confirmed based on the similarity of kicking technique between Pencak Silat and taekwondo, as well as the punching techniques with karate, therefore a similar injury could be hypothesized can also occur in Pencak Silat. The study aimed to investigate the causative factors of injury incidences starting from type, forms, number, risk factors, mechanism, and anatomical location for both males and females.

Materials and methods

Study participant

Two hundred and twenty-nine athletes including 148 males and 81 females in 4 different Sports Schools and Clubs (age 21.3±3.7 years old, BMI 21.12±1.56 kg/m^2, normal resting heart rate), had ever attended the national competition, voluntarily participated in this prospective cohort injury surveillance for 6-consecutive months. The study information has been delivered both orally and in written initially and completed with the confirmation of willingness by signing informed consent.

Study organization

The personal data, method of training, the number of sessions, competition, and training load from January to September were documented by the coaches and research assistants through an online questionnaire. Meanwhile, the health status, anthropometry, injury type, number, location, and injury mechanism were legitimated by rehabilitation staff using the Questionnaire of Oslo Sports Trauma Research Center (OSTRC) v=0.95, r=97 recorded in written informed consent. The study started with delivering an OSTRC (Madaleno et al., 2021) and was validated through on-site interviews and inspection of the craniofacial, trunk, hips, upper limb, and lower limb. The Postural Investigation including body stability, mobility, and range of motion was evaluated by FMS-certified staff using FMS-Protocol (v=0.89, r=0.88) (Wu et al., 2021). Injury exposure was reported as the number of injuries per 1000 hours of participation, while the magnitude of risk was expressed as a relative risk (RR) and its 95% confidence interval (CI).

The study was approved by the Institutional Review Board of Human Ethics Committee (Nr: KE/01211/13/2021) with the Declaration of the World Medical Association of Helsinki on the ethical conduct of research involving human subjects, while the clinical data were assembled in a secured institutional database according to General Data Protection Regulation (GDPR).

Statistical analysis

Statistical calculation was performed using the SPSS Software Version 26 for Windows. Descriptive statistics were employed to describe the characteristics and size of the samples and variables and were presented as mean standard deviations. The normality value was evaluated using the Shapiro-Wilk test, meanwhile, the chi-square test in SPSS software was used to make distinctions at a confidence interval of alpha ($p<0.05$).

Results

The respondent's profile (Table.1) shows the productive ages of males (20.3±3.7 years), and females (19.6±2.1 years), have a normal health status (BMI 22.5±2.6 kg/m^2) of males and 20.2±1.4 kg/m^2 of females, were not in fatigue state as reported by a basal pulse rate of 63.4±6.8 bpm. Samples have varied in weekly training hours (14.2±4.6 hours) for

Table 1. The Descriptive Profile of Samples

Variables	Number		Mean's ± SD	
	Males	Females	Males	Females
Age (years)	148	81	20.3±3.7	19.6±2.1
Height (cm)	148	81	178.3±.5.1	164.5±.4.4
Weight (Kg)	148	81	72.7±7.2	52.4±5.6
BMI (kg/m^2)	148	81	22.5±2.6	20.2±1.4
Resting Heartrate (pulse/minutes)	148	81	63.4±6.8	67.1±4.2
Weekly Training (hours/weeks)	148	81	40.6±4.6	38.7±2.3
Annual Competition (hours/year)	148	81	18.2±2.4	17.5±2.7
Chronis Injuries (express in number)	148	81	49.5±3.2	32.7±2.9
Acute Injuries (express in number)	148	81	17.4±5.1	13.2±4.6
Multiple Injuries (express in number)	148	81	12.8±2.5	9.3±3.1
Level of Injuries (Injury Score) *	148	81	3.1±1.7	2.3±1.2
Injury Duration (express in weeks)	148	81	4.8±2.6	2.6±1.4

*ISS: Injury severity score (rated with 1 being minor injury and 5 severe injuries)

Table 2. The Type of Musculoskeletal Injuries (In Average)

Type of Injuries	Number		Total (%)		IR* (95%CI)	
	Male	Female	Male	Female	Male	Female
Contusion (Bruise)	54	28	36.7	28.7	33 (30.2-35.8)	18 (14.8-20.2)
Hematoma	33	14	20.5	17.3	20 (17.9-23.1)	8.9 (5.9-11.1)
Muscle Soreness	20	18	13.3	20.6	12 (9.8-15.2)	11 (8.7-14.3)
Skin Scrapes	16	8	9.6	12.5	10 (7.3-11.7)	5.1 (3.2-7.8)
Nose Bleeding	10	7	7.2	1.7	6.1 (5.9-7.1)	4.5 (3.4-5.6)
Concussion	6	3	4.8	5.2	3.7 (2.4-4.6)	1.9 (0.3-2.7)
Torsion	5	2	4.2	2.6	3.7 (2.0-4.0)	1.3 (0.8-1.2)
Dislocation	3	1	2.4	1.4	2.9 (0.8-2.2)	1.6 (1.2-1.8)
Fracture	1	0	1.2	0	1.2 (0.9-1.1)	0
Total	148	81	100%	100%		

*IR: incidence rate per 1000 participation hours; CI: confidence interval

Table 3. The Anatomical Areas of Minor Injuries

Areas		Number and (Percentage)		IR* (95%CI)	
		Male	Female	Male	Female
Lower Limbs	Outer thigh	19 (14.4)	13 (12.7)	12 (9.2-13.8)	8.3 (6.8-10.2)
	Knee	16 (11.8)	7 (7.7)	10 (7.9-11.1)	4.5 (2.9-6.1)
	Inner thigh	7 (4.2)	9 (9.3)	4.3 (2.8-6.2)	5.7 (3.7-7.3)
	Shin-splint	6 (3.6)	4 (5.3)	3.7 (2.3-4.7)	2.6 (1.2-3.8)
	Calf	4 (2.4)	2 (3.6)	2.4 (1.4-3.6)	1.3 (0.3-2.7)
	Ankle	3 (1.8)	1 (2.8)	1.8 (0.8-2.2)	0.6 (0.1-1.6)
Upper Limb	Upper arm	16 (11.8)	10 (10.1)	9.7 (8.3-10.7)	6.4 (5.2-7.8)
	Forearm	12 (8.4)	4 (5.3)	7.3 (6.9-8.1)	2.6 (1.4-3.6)
	Shoulder	7 (4.2)	6 (6.9)	4.3 (3.4-5.6)	3.8 (2.3-4.7)
	Wrist	6 (3.6)	3 (4.5)	3.7 (2.2-4.8)	1.9 (0.8-1.8)
	Elbow	5 (3)	2 (3.6)	3.0 (2.8-4.8)	1.3 (0.2-1.9)
Trunk	Side Chest	14 (10.6)	9 (9.3)	8.5 (7.8-9.2)	5.7 (2.7-8.3)
	Hips	10 (6.4)	5 (6.1)	6.1 (5.3-7.7)	3.2 (1.2-5.8)
	Front Chest	4 (2.4)	2 (3.6)	2.4 (1.9-3.1)	1.3 (0.4-2.6)
	Back	4 (2.4)	1 (2.8)	2.4 (1.4-3.6)	0.6 (0.3-1.7)
Craniofacial	Head	5 (3)	1 (2.8)	3.0 (2.0-4.0)	0.6 (0.8-1.2)
	Neck	4 (2.4)	2 (3.6)	2.4 (1.8-4.2)	1.3 (0.2-1.8)
	Jaw	3 (1.8)	0 (0)	1.8 (0.8-2.2)	0 (0)
	Eyebrows	3 (1.8)	0 (0)	1.8 (0.3-2.7)	0 (0)
	Total	148	81		

*IR: incidence rate per 1000 participation hours; CI: confidence interval

males, and females (12.5±2.3 hours), meanwhile males spent more repetitive competition (14.2±2.4-hours), females (12.5±2.7-hours). The male participants spent 1642.2 hours; the female was 1565.5 hours. The IR of the male was 48.5/1000 hours (95% CI: 45.8–51.3), 35.2 (95% CI: 33.4–37.3) for the female. Chronic injuries were the most frequent mode of males (35.1%), and females (40.4%), contrarily females have more multiple injuries (11,9%) than males (8,8%). The male has high severity level (3.1±1.7) than female (2.3±1.2), and the male has longer injuries duration (4.8±2.6) weeks and 2.6±1.4 weeks than females.

The type, location, and the number of percentages which were experienced in the competition and training could be seen in the following table 2.

Contusion contributes 36% as the most injuries type with 32.9 incidences/1000 hours for males, while a female has 28.7% with 17.9 incidences/1000 hours. The hematoma has 19.9/1000 hours as the second most prevalent with 20,5% followed by muscle soreness (12.1/1000 hours) and impacted 13,3% of male injuries. The female shows were slightly different in muscle soreness (20.6%) as the second most frequent incidence (11.5 injuries per 1000 hours),

Table 4. Multivariate Test for Variable of Injuries Mechanism

Injuries Mechanism	Number and Percentage (%)		RR* (95%CI)	p
	Male	Female		
Defensive a kick	36 (26.6)	20 (20,3)	2.5 (0.7-7.6)	0.01
Offensive a kick	26 (19.2)	17 (25,7)	2.2 (0.5-7.4)	0.01
Defensive a hit	23 (13)	11 (13,4)	1.9 (0.7-7.6)	0.07
Offensive a hit	17 (12.6)	8 (9,7)	1.3 (0.3-5.4)	0.15
Techniques inadequacy	14 (8.2)	7 (8,5)	1.0 (0.6-7.1)	0.03
Slammed by opponents	11 (7.1)	5 (6,5)	1.0 (0.6-7.1)	0.02
Uncontrolled attack	8 (8.6)	4 (4,9)	1.7 (0.7-7.6)	0.27
Improper Fall	7 (4.2)	3 (3,8)	1.0 (0.6-7.1)	0.42
Unknown	6 (3)	6 (7,3)	1.0 (0.6-7.1)	0.52

* RRadj: adjusted relative risk. CI: confidence interval

hematoma (17.3%) recorded with 8.9 injuries in 1000 hours. The investigation of the injury location associated with major injuries was split into four sections for more comprehensive analysis as shown in Table 3.

The outer thigh was the highest injury location expressed with 8-12 injuries/hours in both genders. The knee (11,8%), and inner thigh (9,3%) brought 4-10 injuries/1000, shin-splint (3,6%), calf (2,4%), and ankle (1,8%) with 5 incidences/1000 hours', meanwhile inner thighs (12,7%) are the second most location, followed by outer thigh (9,3%), shin-splint (5,3%), calf 3,6) and ankle (2,8%) with less than 5 injuries/1000 hours for female. The upper arm was the most location found in males (11,8%), while the female (10.1%) with 6-10 injuries/1000 hours, followed by the forearm (8,4%) for males, and shoulder (6,9%) in females with less than 7 injuries/1000 hours. The wrist and Elbow were the lowest anatomical damage in both with 4 cases /1000 hours. Both genders have the side chest as the most injured locations with 8,5% and 5,7% cases, followed by male hips (6,1%), front chest (2,4%), back (2,4%), and female's hips (3,2%), front chest (1,3%) and back (0,6%). The highest injury exposure in the trunk was 8 injuries/1000 hours for the side chest and less than 6 injuries/1000 hours in the hips for both athletes. The craniofacial was also indicated as the highest injury location for both genders with 3 injuries/1000 hours, while the neck was the second most frequent with 2,4% for males and 3,6% for females with 2 cases in 1000 hours. The further injuries mechanism can be seen in Table 4.

The kick by the opponents was the most frequent injury mechanism in both males (26,6%), and females (20,3%) and have an injury risk factor of 2.5 times greater, followed by an offensive kick in males (19,2%) and females (25,7%) and have the risk for the injury of 2.5 times. The defensive hits have a rate of relative risk of 2.2 higher risks to bringing injuries for both males (13%) and females (13.4%), while offensive hits showed a contribution rate injury of 12,6% and 9,7% respectively and have a risk value of 1.3 times. Uncontrolled attack (6%), improper falling position (4,2%), and unknown risk factor (3%) were stated to have the least injuries mechanism for both genders with a relative risk of around 1.4 times more risk of being injured.

Discussion

The Incidence Rate (IR) of injuries in Pencak Silat was relatively higher with 32.9 incidences/1000 hours compared with Taekwondo and Karate with an IR rate of 29,7 injuries/1000 hours (Hammami et al., 2018). The previous study relies on the physician's complaint after competition and might overlook the causative factor of chronic injuries (Sari et al., 2019), therefore this prospective study seems to have a higher level of injury rate than the previous. The athlete's profile that suffered traumatic syndrome shows that contusion (36%) is the most frequent injury type, followed by hematoma (28%), and soreness (17%) with IR at 11-19 injuries/1000 hours. The high of IR certainly needs to be deliberated comprehensively due to has similarities of IR for Taekwondo and Kempo at the Olympics event (Drury et al., 2017), although Pencak Silat has not been classified as an Olympic Sport (Altarriba-Bartes et al., 2014). The lower limb injuries were the most frequent location (32.9 injuries/1000 hours), followed by the outer thigh as the highest location in both genders (11.7 injuries/1000 hours). Since FMS shows a reduction range of motion of the tensor fascia latae and rectus femoris due to a traumatic incident (Kusuma, 2021a), therefore, further investigation is still unestablished (Lystad et al., 2009). The high IR of the lower extremity was associated with the different art of leg attacks compared to other combat sports (Vitale et al., 2018; Listiandi et al., 2019), since Pencak Silat uses the unique style for leg attack, kicking, sweeping, cutting, slamming the opponent (Soo et al., 2018), and are elaborated to have a higher risk factor to lower extremity injury (Tulendiyeva et al., 2021).

Knee injuries of males (IR 9.8/1000 hours), shin-split, and ankle (IR 2.4-3.7/1000 hours) are assumed as an impact of being kicked by opponents repeatedly (excessive defensive kick) with a relative ratio (RR) of 2.5 times more risk, as reported in injury cases of muay Thai (Strotmeyer & Lystad, 2017). The inner thigh injuries in females (IR 5.7/1000 hours) are predicted due to overuse of groin muscle while kicking opponents (Gavagan & Sayers, 2017), which has an injury ratio of 2.2 times more risk. The data was accepted recently since almost all of the current findings reported significant results referring to the relationship between the lower extremity (Kusuma, 2021a), hamstring, and groin muscle with

a high rate of incidences in common martial-art (Čierna & Lystad, 2017). The differences of IR in the upper arm, forearm and, shoulder at 3.1/1000 hours, wrist (1.9/1000 hours), elbow (1.3/1000 hours), therefore further confirmation is necessary, considering both defensive and offensive hits have no significant effect on Pencak silat injury (95%CI, p>0.01), even though shown 1.2 times more risk to injury, and was justified in an injuries review (Noh et al., 2015) that hits have a twofold times effect on the injury incidences (Piejko, 2019) in the other combat sports competition (Del Vecchio et al., 2018)

Interestingly, the relatively higher incidence rate in the side chest, front, hips, and lower back comparing other combat sports, needs to be studied deeply even though wearing a similar body protector in competition (Garcia-Isidoro et al., 2021) (Hölbling et al., 2017). On the contrary, the head, and neck injuries were found comparatively lower (IR 2.1/1000 hours), the jaw, and brow (IR 1.3/1000 hours) compared to Muay Thai (Gavagan & Sayers, 2017), karate Kempo (Lockwood et al., 2018), where Pencak Silat is not equipped with head protector in competition (Ediyono & Widodo, 2019). The defensive and offensive kicks, technical inadequacy (10.5%), and being slammed by opponents (8%) have 1 time more risk. Although offensive hit (12.5%), uncontrolled attack (6.4%), and improper fall (5%) have no significant effect, however considering the varying number of injuries that occurred, therefore a comprehensive mechanism of exams is recommended (Thomas & Ornstein, 2018). The different techniques and styles used to justify the variation of the number, type, locations, mechanisms, and injury incidences in Pencak Silat (Dzakiya et al., 2021)

Over the years an investigation of the injuries profile in modern martial arts has been observed, however, not been implemented yet in Pencak Silat. It worth mentioning was the fact in this study that the longer and heavier training hours, contributing to more hours of slamming, and kicking consequently had a higher risk of injury. This aspect has not been addressed, and thus requires further study on a sizeable study group divided into weight categories in the future. Comprehensive data are required to investigate the effect of weight classes, experience on injuries, and the type of rehabilitation that has been conducted. RCTs are also required for interventions such as training and feedback on performance data to reduce injury rates.

Acknowledgment

The high appreciation expresses to the Ministry of Youth and Sport for providing allowance support and consent for the study.

Conflict of interest

All authors declare no conflict of interest.

References

Wilson, L. (2015). *Bodies of Knowledge: The Pedagogy of Pencak Silat.* In Martial Arts and the Body Politic in Indonesia (pp. 53-80). BRILL. https://doi.org/10.1163/9789004289352_004

Keilbart, P. (2019). *How to Be a Good Disciple (to a Martial Arts Master): Critical Reflections on Participation and Apprenticeship in Indonesian Pencak Silat Schools* (pp. 233-249). https://doi.org/10.1007/978-3-030-20831-8_21

Chan, L. L. Y., Wong, A. Y. L., & Wang, M. H. (2020). Associations between sport participation and knee symptoms: A cross-sectional study involving 3053 undergraduate students. *BMC Sports Science, Medicine and Rehabilitation, 12*(1). https://doi.org/10.1186/s13102-020-00169-w

Del Vecchio, F. B., Farias, C. B., de Leon, R. C., Rocha, A. C. C. A., Galliano, L. M., & Coswig, V. S. (2018). Injuries in martial arts and combat sports: Prevalence, characteristics and mechanisms. *Science and Sports, 33*(3). https://doi.org/10.1016/j.scispo.2018.02.003

Lystad, R. P., Pollard, H., & Graham, P. L. (2009). Epidemiology of injuries in competition taekwondo: A meta-analysis of observational studies. *Journal of Science and Medicine in Sport, 12*(6). https://doi.org/10.1016/j.jsams.2008.09.013

Thomas, R. E., & Ornstein, J. (2018). Injuries in karate: systematic review. *Physician and Sportsmedicine, 46*(3). https://doi.org/10.1080/00913847.2018.1472510

Miguel-Andrés, I., Rivera-Cisneros, A. E., Mayagoitia-Vázquez, J. J., Orozco-Villaseñor, S. L., & Rosas-Flores, A. (2020). Flatfoot index and areas with the highest prevalence of musculoskeletal disorders in young athletes. *Fisioterapia, 42*(1). https://doi.org/10.1016/j.ft.2019.08.002

Čierna, D., & Lystad, R. P. (2017). Epidemiology of competition injuries in youth karate athletes: A prospective cohort study. *British Journal of Sports Medicine, 51*(17). https://doi.org/10.1136/bjsports-2017-097603

Čiera, D., Barrientos, M., Agrasar, C., & Arriaza, R. (2018). Epidemiology of injuries in juniors participating in top-level karate competition: A prospective cohort study. *British Journal of Sports Medicine, 52*(11). https://doi.org/10.1136/bjsports-2017-097756

Meshkati, Z., Namazizadeh, M., Salavati, M., & Meshkati, L. (2010). The comparison of the role of vision on static postural stability in athletes and non-athletes. *Iranian Rehabilitation Journal, 8*(11), 50–53.

Buist, I., Bredeweg, S. W., Lemmink, K. A. P. M., van Mechelen, W., & Diercks, R. L. (2010). Predictors of Running-Related Injuries in Novice Runners Enrolled in a Systematic Training Program: A Prospective Cohort Study. *The American Journal of Sports Medicine, 38*(2), 273-280. https://doi.org/10.1177/0363546509347985

Anggraeni, D., Kusuma, N. N. H., Budi, D. R., Listiandi, A. D., Widanita, N., Suhartoyo, T., & Febriani, A. R. (2019). Developing a Narae Chagi kicking exercise model for beginner taekwondoins in special region of Yogyakarta. *Annals of Tropical Medicine and Public Health, 22*(11). https://doi.org/10.36295/ASRO.2019.221160

Kusuma, M. N. H., Rilastiyo, B. D., Topo, S., Muhamad, S., & Noor, H. F. (2018). Effect of Alkaline Fluids to Blood pH and Lactic Acid Changes on Sub Maximal Physical Exercise. I*OP Conference Series: Earth and Environmental Science, 197*(1). https://doi.org/10.1088/1755-1315/197/1/012049

Tabor, P., Mastalerz, A., Iwańska, D., & Grabowska, O. (2019). Asymmetry Indices in Female Runners as Predictors of Running Velocity. *Polish Journal of Sport and Tourism, 26*(3), 3-8. https://doi.org/10.2478/PJST-2019-0013

Sterkowicz-Przybycień, K., & Fukuda, D. H. (2016). Sex differences and the effects of modified combat regulations on endurance capacity in judo athletes: A meta-analytic approach. *Journal of Human Kinetics, 50*(2). https://doi.org/10.1515/hukin-2015-0175

Subekti, N., Sistiasih, V. S., Syaukani, A. A., & Fatoni, M. (2020). Kicking ability in pencak silat, reviewed from eye-foot coordination, speed, and ratio of limb length-body height. *Journal of Human Sport and Exercise, 15*(Proc2), 453-461. https://doi.org/10.14198/jhse.2020.15.Proc2.36

Zheng, R., Zhou, J., & Zhang, T. (2020). Biomechanical Risk Assessment of Non-Contact Anterior Cruciate Ligament Injury in Taekwondo Athletes. *Journal of Advances in Medicine Science, 3*(3). https://doi.org/10.30564/jams.v3i3.1908

Kusuma, M. N. H. (2021b). Mathematical simulation approach to diagnose performance limiting factor of shot put technique. *Journal of Physics: Conference Series, 1778*(1). https://doi.org/10.1088/1742-6596/1778/1/012038

Madaleno, F. O., Verhagen, E., Ferreira, T. V., Sampaio, R. F., Mancini, M. C., Fonseca, S. T., & Resende, R. A. (2021). Comparison of incidence, prevalence, severity and profile of health problems between male and female elite youth judokas: A 30-week prospective cohort study of 154 athletes. *Journal of Science and Medicine in Sport, 25*(1), 15-19. https://doi.org/10.1016/j.jsams.2021.07.004

Wu, H., Eungpinichpong, W., Ruan, H., Zhang, X., & Dong, X. (2021). Relationship between motor fitness, fundamental movement skills, and quality of movement patterns in primary school children. *PLoS ONE, 16*(5 May 2021). https://doi.org/10.1371/journal.pone.0237760

Hammami, N., Hattabi, S., Salhi, A., Rezgui, T., Oueslati, M., & Bouassida, A. (2018). Combat sport injuries profile: A review. *Science & Sports, 33*(2), 73–79. https://doi.org/10.1016/j.scispo.2017.04.014

Sari, S., Asmawi, M., Tangkudung, J., Hanif, A. S., & Dlis, F. (2019). Development of multimedia based sport injury pencak silat management model. *International Journal of Recent Technology and Engineering, 8*(2S9). https://doi.org/10.35940/ijrte.B1043.0982S919

Drury, B. T., Lehman, T. P., & Rayan, G. (2017). Hand and Wrist Injuries in Boxing and the Martial Arts. *Hand Clinics, 33*(1). https://doi.org/10.1016/j.hcl.2016.08.004

Altarriba-Bartes, A., Drobnic, F., Til, L., Malliaropoulos, N., Montoro, J. B., & Irurtia, A. (2014). Epidemiology of injuries in elite taekwondo athletes: Two Olympic periods cross-sectional retrospective study. *BMJ Open.* https://doi.org/10.1136/bmjopen-2013-004605

Kusuma, M. N. H. (2021a). Effect of cold water and contrast immersion on physiological and psychological responses of elite athletes after high-intensity exercises. *Journal of Physical Education and Sports, 21*(6), 3278-3287. https://doi.org/10.7752/jpes.2021.s6446

Lystad, R. P., Pollard, H., & Graham, P. L. (2009). Epidemiology of injuries in competition taekwondo: A meta-analysis of observational studies. *Journal of Science and Medicine in Sport, 12*(6), 614-621. https://doi.org/10.1016/j.jsams.2008.09.013

Vitale, J. A., Bassani, T., Galbusera, F., Bianchi, A., & Martinelli, N. (2018). Injury rates in martial arts athletes and predictive risk factors for lower limb injuries. *Journal of Sports Medicine and Physical Fitness, 58*(9). https://doi.org/10.23736/S0022-4707.17.07536-3

Listiandi, A. D., Kusuma, M. N., Syafei, M., Budi, D. R., Hidayat, R., Suhartoyo, T., Widanita, N., & Anggraeni, D. (2019). The dominant throwing technique (nagewaza) which produces ippon in female judo match at the 18th national sports week (PON XVIII) in Riau. *Annals of Tropical Medicine and Public Health, 22*(11). https://doi.org/10.36295/ASRO.2019.22118

Soo, J., Woods, C. T., Arjunan, S. P., Aziz, A. R., & Ihsan, M. (2018). Identifying the performance characteristics explanatory of fight outcome in elite Pencak Silat matches. *International Journal of Performance Analysis in Sport, 18*(6). https://doi.org/10.1080/24748668.2018.1539381

Tulendiyeva, A., Saliev, T., Andassova, Z., Issabayev, A., & Fakhradiyev, I. (2021). Historical overview of injury prevention in traditional martial arts. *Sport Sciences for Health, 17*(4), 837-848. https://doi.org/10.1007/s11332-021-00785-0

Strotmeyer, S., & Lystad, R. P. (2017). Perception of injury risk among amateur Muay Thai fighters. *Injury Epidemiology, 4*(1). https://doi.org/10.1186/s40621-016-0099-y

Gavagan, C. J., & Sayers, M. G. L. (2017). A biomechanical analysis of the roundhouse kicking technique of expert practitioners: A comparison between the martial arts disciplines of Muay Thai, Karate, and Taekwondo. *PLoS ONE, 12*(8). https://doi.org/10.1371/journal.pone.0182645

Noh, J. W., Park, B. S., Kim, M. Y., Lee, L. K., Yang, S. M., Lee, W. D., Shin, Y. S., Kim, J. H., Lee, J. U., Kwak, T. Y., Lee, T. H., Kim, J. Y., Park, J., & Kim, J. (2015). Analysis of combat sports players' injuries according to playing style for sports physiotherapy research. *Journal of Physical Therapy Science, 27*(8). https://doi.org/10.1589/jpts.27.2425

Piejko, L. (2019). Sport Injuries in Karate Kyokushin Athletes. *Biomedical Journal of Scientific & Technical Research, 15*(1). https://doi.org/10.26717/bjstr.2019.15.002653

Garcia-Isidoro, S., Miguel-Tobal, F., Martin-Escudero, P., Gutierrez-Ortega, C., & Castellanos-Sanchez, V. O. (2021). Martial arts injuries: A longitudinal study about judo, karate and wushu carried out in the Community of Madrid, Spain. *Journal of Sports Medicine and Physical Fitness, 61*(2), 244-251. https://doi.org/10.23736/S0022-4707.20.11216-7

Hölbling, D., Preuschl, E., Hassmann, M., & Baca, A. (2017). Kinematic analysis of the double side kick in pointfighting, kickboxing. *Journal of Sports Sciences, 35*(4). https://doi.org/10.1080/02640414.2016.1164333

Lockwood, J., Frape, L., Lin, S., & Ackery, A. (2018). Traumatic brain injuries in mixed martial arts: A systematic review. *Trauma, 20*(4), 245-254. https://doi.org/10.1177/1460408617740902

Ediyono, S., & Widodo, S. T. (2019). Memahami Makna Seni dalam Pencak Silat. *Panggung, 29*(3). https://doi.org/10.26742/panggung.v29i3.1014

Dzakiya, F. N. A., Tinduh, D., & Utomo, D. N. (2021). Risk Estimation of Anterior Cruciate Ligament (ACL) Injury in East Java Puslatda Pencak Silat Athletes. *Surabaya Physical Medicine and Rehabilitation Journal, 3*(1), 29. https://doi.org/10.20473/spmrj.v3i1.23190

ДОСЛІДЖЕННЯ ПРИЧИННОГО ФАКТОРА ТРАВМ ОПОРНО-РУХОВОГО АПАРАТУ В ІНДОНЕЗІЙСЬКИХ ТРАДИЦІЙНИХ БОЙОВИХ МИСТЕЦТВАХ

Мох Нанан Хімаван Кусума[1ABCDE], Новіта[2ABCDE]

[1]Університет імені генерала Судірмана
[2]Меданський державний університет

Авторський вклад: A – дизайн дослідження; B – збір даних; C – статаналіз; D – підготовка рукопису; E – збір коштів

Реферат. Стаття: 7 с., 4 табл., 39 джерел.

Історія питання. Інтерес до пенчак-силату значно зростає, проте супроводжується зростанням випадків травматизму на 7,7% для жінок і 17,8% для чоловіків.

Мета дослідження. У цьому дослідженні вивчають профіль травм опорно-рухового апарату, включаючи тип, форму, локалізацію, механізм і фактори ризику, для різних статей.

Матеріали та методи. У дослідженні добровільно взяли участь двісті двадцять дев'ять спортсменів, серед яких 148 чоловіків і 81 жінка, у 4 різних спортивних школах і клубах (вік 21,3±3,7 років, ІМТ 21,12±1,56 кг/м2, нормальна ЧСС у спокої), які коли-небудь брали участь у національних змаганнях. Особисті дані збирав асистент-дослідник, тренувальне навантаження реєстрували тренери, тоді як профіль травм підтверджували за допомогою опитувальника Центру досліджень спортивних травм Осло (OSTRC) фахівці з медичної реабілітації, а постуральне дослідження було підтверджене сертифікованим клінічним персоналом за допомогою тесту на перевірку функціональних рухів.

Результати. Частота випадків травматизму (ЧВТ) у чоловіків була вищою з показником 48,5 (95% ДІ: 45,8–51,3) і становила 35,2 травм/1000 годин для жінок, чоловіки мали в 3,1 разу вищий рівень тяжкості, ніж жінки (2,3±1,2) і мали більшу тривалість травм (4,8±2,6 тижнів), ніж у жінок. Контузія давала найвищу ЧВТ на рівні 32,9/1000 годин (36,7%), гематома – на рівні 19,9 травм/1000 годин (95% ДІ: 17,9-23,1), а біль у м'язах – 12,1/1000 годин. Найбільш ушкодженими ділянками були нижні кінцівки з показником 33/1000 годин і верхні кінцівки (26,5%) з показником 5–14 травм/1000 годин. Попередня травма має ефект ризику з у 3,0 рази вищим сприянням отриманню поточної травми, наступними йдуть надмірні тренування. Частим механізмом травм були удар ногою суперника (25%) та нападаючий удар (19%).

Висновки. Частота випадків травматизму (ЧВТ) значно різнилася між статями. Результати підкріплюють дослідження травм, особливо характерних для пенчак-силату, яке може сприяти створенню профілю травм.

Ключові слова: опорно-руховий, травми, локалізація, механізм, пенчак-силат.

Information about the authors:

Kusuma, Moh Nanang Himawan: nanang.kusuma@unsoed.ac.id; https://orcid.org/0000-0001-9352-824X; Faculty of Health Sciences, Universitas Jenderal Soedirman, Jl. Profesor DR. HR Boenyamin No.708, Purwokerto Utara, Kabupaten Banyumas, Jawa Tengah 53122, Indonesia.

Novita: noviade@unimed.ac.id; https://orcid.org/0000-0003-4472-9744; Faculty of Sport Science, Universitas Negeri Medan, Jl. Willian Iskandar Pasar V Medan Estate, Medan, North Sumatera, 20223, Indonesia.

Cite this article as: Kusuma, M.N.H., & Novita (2023). Investigating the Causative Factor of Musculoskeletal Injury for Indonesian Traditional Martial Arts. *Physical Education Theory and Methodology, 23*(2), 185-191. https://doi.org/10.17309/tmfv.2023.2.05

Received: 02.01.2023. Accepted: 27.01.2023. Published: 28.04.2023

Теорія та методика фізичного виховання
Physical Education Theory and Methodology
Teorìâ ta Metodika Fìzičnogo Vihovannâ

ISSN 1993-7989 (print)
ISSN 1993-7997 (online)
ISSN-L 1993-7989

ORIGINAL SCIENTIFIC ARTICLE

THE RELATIONSHIP BETWEEN LATENT MYOFASCIAL TRIGGER POINT AND RANGE OF MOTION OF KNEE FLEXOR AND EXTENSOR MUSCLES

Rajdeep Das[1ABCDE], Birendra Jhajharia[1ABCDE], Vasile Catalin Ciocan[2ADE], Indu Majumdar[3ADE] and Arnav Sharma[1ABC]

[1]Lakshmibai National Institute of Physical Education
[2] "Vasile Alecsandri" University of Bacău
[3]ITM University

Authors' Contribution: A – Study design; B – Data collection; C – Statistical analysis; D – Manuscript Preparation; E – Funds Collection

Corresponding Author: Rajdeep Das, E-mail: rjdpdas94@gmail.com
Accepted for Publication: February 25, 2023
Published: April 28, 2023

DOI: 10.17309/tmfv.2023.2.06

Abstract

The study purpose was to assess the relationship between Latent Myofascial Trigger Point and range of motion in the lower limb of athletes. A lower Pain pressure threshold (< 25 lbs/cm^2) in muscles indicates the presence of a latent myofascial trigger point.

Materials and methods. Initially, the study involved 46 male Athletes (aged 20-23 years) as participants. The pain pressure threshold was measured by the pressure algometer (FPX 25 Wagner Instruments, Greenwich, CT, USA) to detect latent myofascial trigger points on the hamstring and quadriceps muscles. Out of 46 participants, 23 tested positive with a latent myofascial trigger point, and rest of them tested negative with a latent myofascial trigger point. All the participants measured knee flexor and extensor range of motion with the Kinovea software (version 0.9.5). In descriptive statistics, mean and standard deviation were used, and Pearson correlation was used to determine the relationship between the variables. The level of significance was set at 0.05.

Results. A significant correlation was found between Latent Myofascial Trigger Points and lower limb range of motion ($p < 0.05$), and it was also observed that the magnitude of correlation coefficient was very large (0.7–0.9).

Conclusions. Latent Myofascial Trigger Points impair sports performance by decreasing the range of motion of knee flexors and extensors. In light of this, Latent Myofascial Trigger Point should be considered a serious musculoskeletal disorder, and appropriate preventative measures should be taken by health professionals.

Keywords: Latent Myofascial Trigger point, Range of Motion, Flexibility, Pain Pressure Threshold.

Introduction

Myofascial pain syndrome (MPS) is one of the most common musculoskeletal disorders (Das & Jhajharia, 2022b), it is defined as a regional pain syndrome and characterized by myofascial trigger points (MTrPs). According to current research studies, MTrP is a hyperirritable spot, usually, in muscle fascia or in a taut band of skeletal muscle, which feels uncomfortable when compressed and can cause referred pain. It has been reported that biochemical changes occur within these points such as increased concentration of bradykinin, substance P, and tumor necrosis factor alpha which may in turn increase of stiffness within the taut band or trigger point (TrP) (Öztürk et al., 2022). There is an assortment of hypothesized causes for MTrPs, including trauma and overuse, joint dysfunction, and psychological factors such as stress. Recent research suggests the pathophysiology of MPS and sequelae of MTrPs begins with excessive stress or injury to muscle fibers. This results in a diminished amount of nutrients and available oxygen, which in turn leads to protective and involuntary muscle shortening, and finally, an increase in tissue metabolic demands. Adaptive lengthening and eccentric muscle strain are also potential sources of myofascial pain (Charles et al., 2019). Clinically, MTrPs are classified as active and latent MTrPs (Das & Jhajharia, 2022a). Latent MTrPs (L-MTrPs) do not cause pain (Cygańska et al., 2022), various authors stated in their article that L-MTrPs possible to experience limitations in

range of motion (ROM) or deficiency in mobility (Charles et al., 2019; Öztürk et al., 2022; Walsh et al., 2019). In the field of sports and exercise, it is found that musculoskeletal injuries are the most common (Lee et al., 2020). Myofascial pain affects 37% of men and 65% of women, according to research (Xia et al., 2017), hence, MPS should be considered as a potential source of musculoskeletal pain (Wilke et al., 2018). From the research evidence, it is confirmed that athletes may develop MTrPs during their life (Kisilewicz et al., 2018). And also affect the potential performance of the athletes and may result in a damage to the muscle or muscle groups (Öztürk et al., 2022). Therefore, reduction of flexibility could be found in athletes. The American College of Sports Medicine has classified flexibility as a major component of physical fitness because it determines the maximum ROM of joints without causing injury (Nuzzo, 2020). Research evidence suggest that flexibility is a key factor in sports for performing, such as sprinting, jumping, agility and balance. It have been observed that physical and technical performance in sports (sprinting, jumping, agility, and balance) decreases when the technical movement is limited by muscle tightness or non-optimal ROM (Cejudo, 2021; Cejudo et al., 2020; Charles et al., 2019). During the swing phase of sprinting and the take-off phase of jumping, the knee joint extensor torque is a major determinant of rapid knee extension. Moreover, the knee extensor torque accelerates the body's centre of mass horizontally during sprinting and vertically during jumping and maintaining the height of the centre of mass during the stance phase while sprinting. On the other hand, knee joint flexors are important for joint stabilization. Therefore, knee joint extensors and flexors are one of the most important muscle groups for sprinting and vertical jumping performance (Diker et al., 2022). This knee flexion and extension movement are done by the help of hamstring and quadriceps muscles groups. Hamstrings muscle tightness is one of the major problems that can limit the movement of the knee and make it susceptible to injuries (Osailan et al., 2021) and quadriceps limited knee flexion ROM (Cejudo et al., 2020). Therefore, it is most important factor to identify whether L-MTrPs are the primary sources of reduction of ROM or not. Through the literature review it is found that there are no studies are available on athletes in hamstring and quadriceps muscles group. The relationship between MTrPs and ROM in the upper trapezius (Girasol et al., 2018) and gastrocnemius (Benito-de-Pedro et al., 2020) has been established. Most of the studies were done on sedentary population. Therefore, the purpose of this study to find out the relationship between L-MTrPs and ROM of knee flexor and extensor muscles.

Materials and methods

Study participant

This study included 46 national level players from Madhya Pradesh, India. G-power software was used to calculate sample size (Cordeiro et al., 2021) (Version 3.1.9.7), following were the criteria to consider for sample size determination: A 2-tailed hypothesis with 0.4 (Large effect), an error probability (1-β) of 0.80 and an α error probability of 0.05 provided an estimated sample size of 46 participants. For the equality of the sample size 23 L-MTrPs and 23 non-MTrPs subjects were selected on the basis of tested PPT of quadricep muscle group (Vastus lateralis, Rectus femoris, Vastus Medialis), and hamstring muscle group (Bicep femoris, semitendinosus, semimembranosus). Characteristics of the subjects were given in the table 1. Informed written consent was obtained by all athletes. Ethical approval was attained from the institutional ethics committee. The study was conducted at the Exercise Physiology laboratory of Lakshmibai National Institute of Physical Education, Gwalior, India.

L-MTrPs were diagnosed using the following criteria recommended by Simons et al: (I) muscles with a palpable taut band; (II) tenderness in an area that is hypersensitive; (III) In response to compression of the MTrP, referred pain is reproduced; (IV) jump sign (Zuil-Escobar et al., 2015). There was a difference in pressure pain threshold (PPT) of more than 4 lbs/cm^2 between the identical muscles on the opposite side, indicating MTrPs (Park et al., 2011). The L-MTrPs group was selected based on the following criteria: (I) Presence of L-MTrPs in the lower limbs (hamstring and quadriceps muscle groups). (II) Athletes were also required to be male (In sports requiring jumps, sprints, twists, turns, acceleration and deceleration, it is determined by these factors), those who participated in competitive sports (Participants in an official league or cup that participates in an organized training or match situation at least twice a week.). (III) Each of the subjects was a collegiate athlete who was in competition phase for their sport. (IV) PPT < 25 lbs/cm^2 (Cordeiro et al., 2021). Non-L-MTrPs were included based on the following criteria: (I) there are no palpable taut bands in the muscles. (II) PPT > 25 lbs/cm^2. Exclusion criteria: In addition to current injuries or illnesses, subjects who had sustained a lower limb or lower back injury within the previous three months were excluded from the study. Subjects with recent fibromyalgia diagnosis or treatment, vascular or neurological conditions, or MTrP (active or latent) treatment were excluded from the study. All subjects who met the criteria were informed about the study. In the first group, 23 subjects were purposively included who were tested positive for L-MTrPs.

Table 1 General characteristics of the subjects (N = 46)

Parameter	L-MTrPs (N=23)	Non-MTrPs (N=23)
Subject characteristics	Mean ± SD	Mean ± SD
Age (Years)	20.57±2.13	20.45±2.18
Height (Centimetre)	160.10±5.91	160.00±5.66
Weight (Kilogram)	52.40±5.16	59.80±5.81

Instruments

Pressure algometer (FPX 25 Wagner Instruments, Greenwich, CT, USA) was use for the evaluation of PPT, based on Cygańska et al., report, this device appears to be reliable et al. 0.90 (Cygańska et al., 2022) and Castien et al. also found that pressure algometer is reliable instrument for research (Castien et al., 2021). The software Kinovea® version 0.9.5 (downloadable free at https://www.kinovea.org/) used to measure the ROM, according to the group of researchers Kinovea is a valid and reliable tool that is able to measure accurately at distances up to 5 m from the object (Fernández-González et al., 2020; Puig-Diví et al., 2019).

Trigger Point Examination: Pressure algometer was used for the pain test by FPX 25 Algometer (Wagner Instruments, Greenwich, CT, USA). In this study, the pain threshold was defined in pounds/cm^2 and constant pressure was applied. A pressure threshold at which pressure sensations become painful is defined as the PPT (Ortega-Santiago et al., 2020). We determined the pain thresholds of selected muscle groups and the locations of the MTrPs, according to Cygańska AK et.al (Cygańska et al., 2022). A prone position was used to measure hamstrings and a supine position was used to measure quadriceps. The device should be applied at an angle of 90 degrees to the surface of the skin (Fig. 1), always starting from the right-side of the body. In response to experiencing the first distinct sensation of pain, subjects

Fig. 1. Evaluation of Latent Myofascial Trigger Point

were instructed to say "STOP". Before measuring the actual points, the subject underwent a trial measurement of his forearm muscles. During each measurement, the same researcher read the results. Two measurements were separated by a five-minute interval. The subjects who met the L-MTrPs criteria were placed into group 1 (L-MTrPs Group). Those subjects whose L-MTrPs profile did not match the criteria were assigned to group 2 (Non-MTrPs Group). Muscle tests were conducted in the following order for each subject; Right and left quadricep muscle group (Vastus lateralis, Rectus femoris, Vastus Medialis), followed by right and left hamstring (Bicep femoris, semitendinosus, semimembranosus). The measurements were conducted one by one under the supervision of an expert physical therapist (10 years of experience). Each measure was separated by a 30-second rest and the mean of three trials was calculated. It has been shown that this method of evaluating PPT exhibits high inter- and intra-examiner reliability (Chesterton et al., 2007; Das & Jhajharia, 2022b).

ROM Examination: Each participant's video was recorded using a GoPro 9 action camera. The footage was taken from the sagittal plane and the frontal axis profile of the knee joint. Passive and reflective markers were positioned in certain anatomical regions of the lower limbs, such as the greater trochanter, external femoral condyle, and lateral malleolus, to quantify the lateral view angular displacement of the knee joint (eSilva et al., 2018; Fernández-González et al., 2020). The tripod-mounted camera was positioned 80 cm high and 1.5 metres distant from the participants. The tripod was positioned on taped marks on the floor to keep the same distance between the camera and the participants. Each individual completed a prescribed warm-up exercise that lasted 5 minutes prior to the test. The knee of each subject was positioned near the edge of the table while they lay prone on a table (Fig. 2). The individual was instructed to bend their knee as much as possible before extending it to determine the angle of knee extension and flexion. All videos were imported into a laptop and analysed using Kinovea software. In kinovea, three markers were positioned in the greater trochanter, external femoral condyle, and lateral malleolus. Additionally, an angle was positioned in the external femoral condyle. Two lines were also placed: one through the humerus bone and ending at the greater trochanter (stationary arm); the other through the tibia bone and ending at the lateral malleolus (movable arm). The junction of the two lines' angle was expressed in degrees.

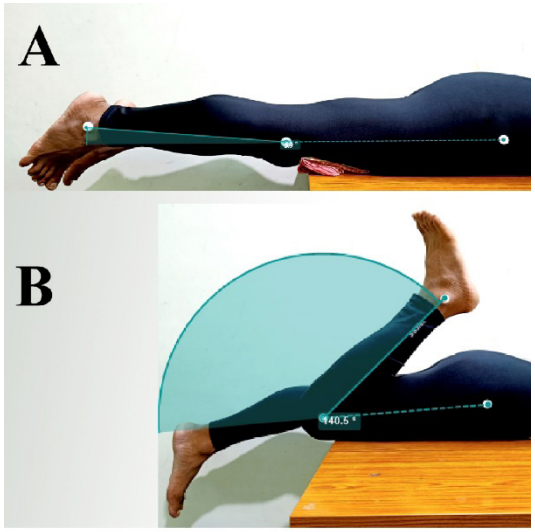


Fig. 2. Evaluation of Knee Range of Motion (A) Extension (B) Flexion

Statistical analysis

We conducted statistical analysis using IBM SPSS (version 26.0.0) data analysis software. Mean and standard deviation (SD) were used in descriptive statistics. Since the data did not deviate from the normality assumptions as shown by the Shapiro-Wilk test for the parametric test, therefore, we applied parametric test Pearson correlation to determine the relationship between L-MTrPs and ROM. The degree of the correlation between test measures was understood as trivial (≤0.1), small (0.1–0.3), moderate (0.3–0.5), large (0.5–0.7), very large (0.7–0.9), and almost perfect (0.9–1.0) (Martín-Fuentes & van den Tillaar, 2022). The level of significance was set at $p \leq 0.05$.

Results

To reach the goals of the study, descriptive statistics were performed, mean, SD and mean difference were used to represent the data and independent sample T-test was use to compare the significant difference between groups of PPT and ROM (table 2). From it was found the PPT and ROM of L-MTrPs and non-MTrPs groups were differ significantly at the level of 0.05.

Table 2. Descriptive statistics of PPT and ROM and Independent Samples T-Test of between L-MTrPs and Non-MTrPs Group.

			R.H	R.Q	L.H	L.Q
L-MTrPs	ROM	M±SD	134.11±0.87	2.72±1.28	134.49±1.12	3.56±1.07
N-MTrPs			139.05±0.88	0.96±0.52	138.23±1.18	0.90±0.48
	Mean Diff.		4.93	1.76	3.74	2.66
	Sig.		0.00	0.00	0.00	0.00
L-MTrPs	PPT	M±SD	17.71 ± 2.26	18.76 ± 1.81	19.05 ± 2.33	17.27 ± 2.74
N-MTrPs			27.16 ±1.16	27.09 ± 1.94	27.45 ± 1.57	27.23 ± 1.16
	Mean Diff.		9.45	8.32	8.40	9.95
	Sig.		0.00	0.00	0.00	0.00

H-Hamstring; Q-Quadricep; F-Flexion; E-Extension; R-Right; L-Left; M – Mean; SD – Standard Deviation; Mean Diff. – mean Difference

Table 3. Descriptive statistics and Pearson Correlation between PPT and ROM

	Descriptive Statistics		Correlation		
	Mean	SD			R. F (ROM)
R. H (PPT)	22.44	5.22	R.H (PPT)	Pearson Correlation	0.939**
				Sig. (2-tailed)	0.00
R.F (ROM)	136.58	2.70			
					R.E(ROM)
R. Q (PPT)	22.92	4.48	R.Q (PPT)	Pearson Correlation	-0.923**
				Sig. (2-tailed)	0.00
R. E(ROM)	2.23	1.58			
					L.F (ROM)
L.H (PPT)	23.25	4.71	L. H (PPT)	Pearson Correlation	0.866**
				Sig. (2-tailed)	0.00
L.F(ROM)	136.36	2.22			
					L. E(ROM)
L. Q (PPT)	22.25	5.48	L. Q (PPT)	Pearson Correlation	-0.580**
				Sig. (2-tailed)	0.00
L. E (ROM)	1.84	1.31			

**Correlation is significant at the 0.01 level (2-tailed)

In table 3 it was found that there was significant correlation between PPT and ROM at the level of 0.05. This result indicates that L-MTrPs in quadriceps muscles affect the extension ROM and L-MTrPs in hamstring muscles affect the flexion ROM significantly. And also observed that the magnitude of correlation coefficient was very large (0.7–0.9), because correlation coefficient between right hamstring PPT & right leg flexion ROM correlation coefficient was 0.939 (p-0.00), Right Quadriceps PPT & right extension ROM correlation coefficient was -0.923 (p=0.00), and left hamstring PPT & left flexion ROM correlation coefficient was 0.866 (p=0.00), and left Quadriceps PPT & left extension ROM correlation coefficient was -0.580 (p=0.00).

Discussion

The aim of this study to investigate the correlation between L-MTrPs and ROM in the lower limbs on athletes. In this study, it was confirmed that athletes also develop MTrPs, and that has been confirmed by previous studies as well (Benito-de-Pedro et al., 2019; Das et al., 2022; Kisilewicz et al., 2018). The independent samples T-test (table 2) shows that there was a significant difference between PPT in with L-MTrPs and non-MTrPs group, research evidence stated that lower PPT(<25 lbs), and more than 4 lbs/cm^2 as compared to the identical muscles in the opposite side indicate presence of L-MTrPs. After the evaluation of L-MTrPs, we investigate the ROM of knee flexor and extensor muscles, from the mean values it was observed that L-MTrPs group have lower flexion ROM than non-MTrPs group, that indicate the presence of L-MTrPs reduces the ROM of knee flexor muscles. Same findings observed in knee extensor muscle group, in this present study 0° angle consider as the best extension angle of knee, greater than 0° angle indicate lower in ROM. From mean value of knee extension, it was observed L-MTrPs group has higher angular value as compared

with non-MTrPs group. Therefore, it was confirmed that the presence of L-MTrPs reduce the ROM of particular joint, and also reduce the PPT. After the implementation independent samples T-test it was found that the values of PPT and ROM are significantly differ from the L-MTrPs and non-MTrPs groups as the p-value is less than 0.05 (<0.05), and the Pearson correlation was use to check the relationship between L-MTrPs and ROM. The result suggest that L-MTrPs are significantly correlated with the ROM. In the hamstring muscles group, L-MTrPs and flexion ROM were positively correlated, which indicates that lower PPT decreases knee flexion ROM while higher PPT increases ROM. L-MTrPs in quadricep muscles decreased knee extension as well. Similarly, we found that L-MTrPs and extension were significantly correlated with each other (table 3). These finding were also supported by the existing literature, as few studies have been conducted on MTrPs on upper trapezius, which were publicized to reduce cervical ROM (Agung et al., 2018; Park et al., 2018; Toghtamesh et al., 2021). According to research evidence lower PPT indicate low in muscles elasticity and high in muscles stiffness, reduction ROM and, the occurrence L-MTrPs (Grabowski et al., 2018). Literature shows that the stiffness in muscles had decreased strength, increased discomfort and muscular soreness, as a result enhance creatine kinase release. These events are related to changes in microscopic structure of muscles therefore, sarcomere mechanics get stiff and compliant muscles during eccentric movements. L-MTrP affects motor activation patterns and reciprocal inhibition mechanisms, resulting in joint movement limitations and overloading (Das et al., 2022). From the literature joint ROM has a strong influence on athlete performance. There is considerable evidence that increases in ROM enhance performance of general sports skills, such as jumping, sprinting, and changing directions (Pereira et al., 2021). Muscle injuries are more prone to happen in addition to having low ROM (Knapik et al., 2019). Therefore, Sports performance is negatively impacted by L-MTrPs, as determined by this investigation. As a result, L-MTrPs reduce an athlete's performance due to limited physical performance, sports scientist should focus on and conduct research on this aspect is absolutely necessary. Additionally, create a training programme to ensure appropriate L-MTrPs prevention.

Conclusion

In According to our analysis, there is a strong correlation between L-MTrPs and ROM of lower limb muscles. A pressure algometer was used to evaluate MTrPs, and lower PPT showed that L-MTrPs were present (25 lbs/cm^2). As a result of this article, it has been concluded that athletes also develop L-MTrPs, and that these L-MTrPs decrease ROM, which negatively affects sports performance. From this research article, sportspersons, physiotherapists, and sports therapists gain knowledge about L-MTrPs.

Acknowledgement

The researcher would like to thank all the athletes who participated in the study. The research facility at the institute is acknowledged for providing during data collection. More thanks to the Department of Exercise Physiology and for equipment assistance.

Conflict Of Interests

The authors declares that there is no conflict of interests.

References

Das, R., & Jhajharia, B. (2022b). Correlation between latent myofascial trigger point and peak torque production of lower limb muscles on sports person. *JPES 22*(9), 2224-2230. https://doi.org/10.7752/jpes.2022.09283

Öztürk, Ö., FeyziOğlu, Ö., Güven, F., & ÇeviK Saldiran, T. (2022). Myotonometric Evaluation of Latent Myofascial Trigger Points and Taut Band in Elite Athletes. *Journal of Basic and Clinical Health Sciences.* https://doi.org/10.30621/jbachs.959275

Charles, D., Hudgins, T., MacNaughton, J., Newman, E., Tan, J., & Wigger, M. (2019). A systematic review of manual therapy techniques, dry cupping and dry needling in the reduction of myofascial pain and myofascial trigger points. *Journal of Bodywork and Movement Therapies, 23*(3), 539-546. https://doi.org/10.1016/j.jbmt.2019.04.001

Das, R., & Jhajharia, B. (2022a). Fascia and Myofascial Pain Syndrome -An Overview. *Asian Pac. J. Health Sci., 9*(4s), 228-232. https://doi.org/10.21276/apjhs.2022.9.4S.44

Cygańska, A. K., Tomaszewski, P., & Cabak, A. (2022). Pain threshold in selected trigger points of superficial muscles of the back in young adults. *PeerJ,* 10, e12780. https://doi.org/10.7717/peerj.12780

Walsh, R., Kinsella, S., & McEvoy, J. (2019). The effects of dry needling and radial extracorporeal shockwave therapy on latent trigger point sensitivity in the quadriceps: A randomised control pilot study. *Journal of Bodywork and Movement Therapies, 23*(1), 82-88. https://doi.org/10.1016/j.jbmt.2018.02.010

Lee, J.-W., Lee, J.-H., & Kim, S.-Y. (2020). Use of Acupuncture for the Treatment of Sports-Related Injuries in Athletes: A Systematic Review of Case Reports. *International Journal of Environmental Research and Public Health, 17*(21), 8226. https://doi.org/10.3390/ijerph17218226

Xia, P., Wang, X., Lin, Q., Cheng, K., & Li, X. (2017). Effectiveness of ultrasound therapy for myofascial pain syndrome: A systematic review and meta-analysis. *Journal of Pain Research,* 10, 545-555. https://doi.org/10.2147/JPR.S131482

Wilke, J., Vogt, L., & Banzer, W. (2018). Immediate effects of self-myofascial release on latent trigger point sensitivity: A randomized, placebo-controlled trial. *Biology of Sport, 35*(4), 349-354. https://doi.org/10.5114/biolsport.2018.78055

Kisilewicz, A., Janusiak, M., Szafraniec, R., Smoter, M., Ciszek, B., Madeleine, P., Fernández-de-Las-Peñas, C., & Kawczyński, A. (2018). Changes in Muscle Stiffness of the Trapezius Muscle after Application of Ischemic Compression into Myofascial Trigger Points in Professional Basketball Players. *Journal of Human Kinetics, 64*(1), 35-45. https://doi.org/10.2478/hukin-2018-0043

Nuzzo, J. L. (2020). The Case for Retiring Flexibility as a Major Component of Physical Fitness. *Sports Medicine, 50*(5), 853-870. https://doi.org/10.1007/s40279-019-01248-w

Cejudo, A. (2021). Lower Extremity Flexibility Profile in Basketball Players: Gender Differences and Injury Risk Identification. *International Journal of Environmental Research and Public Health, 18*(22), 11956. https://doi.org/10.3390/ijerph182211956

Cejudo, A., Sainz de Baranda, P., Ayala, F., De Ste Croix, M., & Santonja-Medina, F. (2020). Assessment of the Range of Movement of the Lower Limb in Sport: Advantages of the ROM-SPORT I Battery. *International Journal of Environmental Research and Public Health, 17*(20), 7606. https://doi.org/10.3390/ijerph17207606

Diker, G., Struzik, A., Ön, S., & Zileli, R. (2022). The Relationship between the Hamstring-to-Quadriceps Ratio and Jumping and Sprinting Abilities of Young Male Soccer Players. *International Journal of Environmental Research and Public Health, 19*(12), 7471. https://doi.org/10.3390/ijerph19127471

Osailan, A., Jamaan, A., Talha, K., & Alhndi, M. (2021). Instrument assisted soft tissue mobilization (IASTM) versus stretching: A comparison in effectiveness on hip active range of motion, muscle torque and power in people with hamstring tightness. *Journal of Bodywork and Movement Therapies,* 27, 200-206. https://doi.org/10.1016/j.jbmt.2021.03.001

Girasol, C. E., Dibai-Filho, A. V., de Oliveira, A. K., & de Jesus Guirro, R. R. (2018). Correlation Between Skin Temperature Over Myofascial Trigger Points in the Upper Trapezius Muscle and Range of Motion, Electromyographic Activity, and Pain in Chronic Neck Pain Patients. *Journal of Manipulative and Physiological Therapeutics, 41*(4), 350-357. https://doi.org/10.1016/j.jmpt.2017.10.009

Benito-de-Pedro, M., Becerro-de-Bengoa-Vallejo, R., Elena Losa-Iglesias, M., Rodríguez-Sanz, D., López-López, D., Palomo-López, P., Mazoteras-Pardo, V., & Calvo-Lobo, and C. (2020). Effectiveness of Deep Dry Needling vs Ischemic Compression in the Latent Myofascial Trigger Points of the Shortened Triceps Surae from Triathletes on Ankle Dorsiflexion, Dynamic, and Static Plantar Pressure Distribution: A Clinical Trial. *Pain Medicine, 21*(2), e172–e181. https://doi.org/10.1093/pm/pnz222

Zuil-Escobar, J. C., Martínez-Cepa, C. B., Martín-Urrialde, J. A., & Gómez-Conesa, A. (2015). Prevalence of myofascial trigger points and diagnostic criteria of different muscles in function of the medial longitudinal arch. *Archives of Physical Medicine and Rehabilitation, 96*(6), 1123-1130. https://doi.org/10.1016/j.apmr.2015.02.017

Fernández-González, P., Koutsou, A., Cuesta-Gómez, A., Carratalá-Tejada, M., Miangolarra-Page, J. C., & Molina-Rueda, F. (2020). Reliability of Kinovea® Software and Agreement with a Three-Dimensional Motion System for Gait Analysis in Healthy Subjects. *Sensors, 20*(11), 3154. https://doi.org/10.3390/s20113154

Puig-Diví, A., Escalona-Marfil, C., Padullés-Riu, J. M., Busquets, A., Padullés-Chando, X., & Marcos-Ruiz, D. (2019). Validity and reliability of the Kinovea program in obtaining angles and distances using coordinates in 4 perspectives. *PLOS ONE, 14*(6), e0216448. https://doi.org/10.1371/journal.pone.0216448

Ortega-Santiago, R., González-Aguado, Á. J., Fernández-de-las-Peñas, C., Cleland, J. A., de-la-Llave-Rincón, A. I., Kobylarz, M. D., & Plaza-Manzano, G. (2020). Pressure pain hypersensitivity and referred pain from muscle trigger points in elite male wheelchair basketball players. *Brazilian Journal of Physical Therapy, 24*(4), 333-341. https://doi.org/10.1016/j.bjpt.2019.05.008

Chesterton, L. S., Sim, J., Wright, C. C., & Foster, N. E. (2007). Interrater Reliability of Algometry in Measuring Pressure Pain Thresholds in Healthy Humans, Using Multiple Raters. *The Clinical Journal of Pain, 23*(9), 760-766. https://doi.org/10.1097/AJP.0b013e318154b6ae

e Silva, D. C. C. M., de Andrade Alexandre, D. J., & Silva, J. G. (2018). Immediate effect of myofascial release on range of motion, pain and biceps and rectus femoris muscle activity after total knee replacement. *Journal of Bodywork and Movement Therapies, 22*(4), 930-936. https://doi.org/10.1016/j.jbmt.2017.12.003

Martín-Fuentes, I., & van den Tillaar, R. (2022). Relationship between Step-by-Step Foot Kinematics and Sprint Performance. *International Journal of Environmental Research and Public Health, 19*(11), 6786. https://doi.org/10.3390/ijerph19116786

Benito-de-Pedro, Becerro-de-Bengoa-Vallejo, Losa-Iglesias, Rodríguez-Sanz, López-López, Cosín-Matamoros, Martínez-Jiménez, & Calvo-Lobo. (2019). Effectiveness between Dry Needling and Ischemic Compression in the Triceps Surae Latent Myofascial Trigger Points of Triathletes on Pressure Pain Threshold and Thermography: A Single Blinded Randomized Clinical Trial. *Journal of Clinical Medicine, 8*(10), 1632. https://doi.org/10.3390/jcm8101632

Das, R., Jhajharia, B., Ciocan, V., Sharma, A., & Majumdar, I. (2022). Myofascial Trigger Points and its Influence on Athletic performance- A Review. *NeuroQuantology,* 20, 467-483. https://doi.org/10.48047/nq.2022.20.19.NQ99043

Agung, I., Murdana, N., Purba, H., & Fuady, A. (2018). Low-level laser therapy and dry needling for myofascial pain syndrome of the upper trapezius muscle: An interventional study. *Journal of Physics: Conference Series,* 1073, 062045. https://doi.org/10.1088/1742-6596/1073/6/062045

Park, K. D., Lee, W. Y., Park, M., Ahn, J. K., & Park, Y. (2018). High- versus low-energy extracorporeal shock-wave therapy for myofascial pain syndrome of upper trapezius: A prospective randomized single blinded pilot study. *Medicine, 97*(28), e11432. https://doi.org/10.1097/MD.0000000000011432

Toghtamesh, M., Bashardoust Tajali, S., & Jalaei, S. (2021). Comparing Between the Effects of Dry Needling and Shock Wave in the Treatment of Trapezius Myofascial Pain. *Journal of Modern Rehabilitation*. https://doi.org/10.18502/jmr.v14i4.7720

Pereira, A., Teixeira, C., Pereira, K., Ferreira, L., Marques, M., & Silva, A. G. (2021). Neural Mobilization Short-Term Dose Effect on the Lower-Limb Flexibility and Performance in Basketball Athletes: A Randomized, Parallel, and Single-Blinded Study. *Journal of Sport Rehabilitation, 30*(7), 1060-1066. https://doi.org/10.1123/jsr.2020-0389

Knapik, D. M., LaTulip, S., Salata, M. J., Voos, J. E., & Liu, R. W. (2019). Impact of Routine Gastrocnemius Stretching on Ankle Dorsiflexion Flexibility and Injury Rates in High School Basketball Athletes. *Orthopaedic Journal of Sports Medicine, 7*(4), 232596711983677. https://doi.org/10.1177/2325967119836774

ЗВ'ЯЗОК МІЖ ЛАТЕНТНОЮ МІОФАСЦІАЛЬНОЮ ТРИГЕРНОЮ ТОЧКОЮ ТА ДІАПАЗОНОМ РУХІВ М'ЯЗІВ-ЗГИНАЧІВ І РОЗГИНАЧІВ КОЛІННОГО СУГЛОБА

Дас Раджееп[1ABCDE], Джхаджхаріа Бірендра[1ABCDE], Васіле Каталін Чіокан[2ADE], Маджумдар Інду[3ADE], Арнав Шарма[1ABC]

[1]Національний інститут фізичного виховання імені Лакшмі Бай
[2]Університет імені Василе Александрі в Бакеу
[3]Університет ITM

Авторський вклад: A – дизайн дослідження; B – збір даних; C – статаналіз; D – підготовка рукопису; E – збір коштів

Реферат. Стаття: 7 с., 4 табл., 39 джерел.

Метою дослідження було оцінити взаємозв'язок між латентною міофасціальною тригерною точкою та діапазоном рухів у нижній кінцівці спортсменів. Нижчий поріг больового тиску (<25 фунтів/см^2) у м'язах вказує на наявність латентної міофасціальної тригерної точки.

Матеріали та методи. Спочатку в дослідженні брали участь 46 спортсменів чоловічої статі (віком 20-23 роки). Поріг больового тиску вимірювали алгометром тиску (модель FPX 25, виробник Вагнер Інструментс, Грінвіч, Конектикут, США) для виявлення латентних міофасціальних тригерних точок на підколінному сухожиллі та чотириголовому м'язі. Із 46 учасників 23 дали позитивний результат тесту з латентною міофасціальною тригерною точкою, а решта з них дали негативний результат із латентною міофасціальною тригерною точкою. Усі учасники вимірювали діапазон рухів згиначів і розгиначів колінного суглоба за допомогою програмного забезпечення Kinovea (версія 0.9.5). В описовій статистиці використовували середнє значення та стандартне відхилення, а для визначення зв'язку між змінними використовували кореляцію Пірсона. Рівень значущості був заданий показником 0,05.

Результати. Було виявлено статистично значущу кореляцію між латентними міофасціальними тригерними точками та діапазоном рухів нижніх кінцівок ($p < 0,05$), а також спостерігалося, що величина коефіцієнта кореляції була дуже високою (0,7–0,9).

Висновки. Латентні міофасціальні тригерні точки погіршують спортивні результати, зменшуючи діапазон рухів згиначів і розгиначів коліна. У світлі цього латентну міофасціальну тригерну точку слід вважати серйозним розладом опорно-рухового апарату, і медичні працівники повинні вживати відповідних профілактичних заходів.

Ключові слова: латентна міофасціальна тригерна точка, діапазон руху, гнучкість, поріг больового тиску.

Information about the authors:

Das, Rajdeep: rjdpdas94@gmail.com; https://orcid.org/0000-0001-7837-3702; Department of Exercise Physiology, Lakshmibai National Institute of Physical Education, Shakti Nagar, Mela Road, Gwalior, 474002, India.

Jhajharia, Birendra: birendrajhajharia@gmail.com; https://orcid.org/0000-0002-4980-6916; Department of Exercise Physiology, Lakshmibai National Institute of Physical Education, Shakti Nagar, Mela Road, Gwalior, 474002, India.

Ciocan, Vasile Catalin: ciocan.catalin@ub.ro; https://orcid.org/0000-0003-4357-0882; Department of Physical Education and Sports Performance Faculty of Movement, Sport and Health Sciences, Bacău, Romania, "Vasile Alecsandri" University of Bacău, Calea Mărășești 157, Bacău 600115, Romania.

Majumdar, Indu: indumazumdar.sopes@itmuniversity.ac.in; https://orcid.org/0000-0003-4180-6214; School of Physical Education, ITM University, Jhansi Rd, Turari, Gwalior, Madhya Pradesh 474001, India.

Sharma, Arnav: arnavsharma164@gmail.com; https://orcid.org/0000-0002-5268-8316; Department of Physical Education and Pedagogy, Lakshmibai National Institute of Physical Education, Shakti Nagar, Mela Road, Gwalior, 474002, India.

Cite this article as: Das, R., Jhajharia, B., Ciocan, V. C., Majumdar, I. & Sharma, A. (2023). The Relationship Between Latent Myofascial Trigger Point and Range of Motion of Knee Flexor and Extensor Muscles. *Physical Education Theory and Methodology, 23*(2), 192-198. https://doi.org/10.17309/tmfv.2023.2.06

Received: 19.11.2022. Accepted: 25.02.2023. Published: 28.04.2023

Теорія та методика фізичного виховання
Physical Education Theory and Methodology
Teorìâ ta Metodika Fizičnogo Vihovannâ

ISSN 1993-7989 (print)
ISSN 1993-7997 (online)
ISSN-L 1993-7989

ORIGINAL SCIENTIFIC ARTICLE

THE EFFECT OF PLYOMETRICS EXERCISE THROUGH AGILITY LADDER DRILL ON IMPROVING PHYSICAL ABILITIES OF 13–15-YEAR-OLD VOLLEYBALL PLAYERS

Harry Pramono[1ABCDE], Tandiyo Rahayu[1ABCDE] and Dewangga Yudhistira[1ABCDE]

[1]Universitas Negeri Semarang

Authors' Contribution: A – Study design; B – Data collection; C – Statistical analysis; D – Manuscript Preparation; E – Funds Collection

Corresponding Author: Harry Pramono, E-mail: hpr4mono@mail.unnes.ac.id
Accepted for Publication: January 21, 2023
Published: April 28, 2023

DOI: 10.17309/tmfv.2023.2.07

Abstract

Study purpose. The purpose of this study was to test the plyometrics training method through agility ladder drills to increase leg muscle power, agility, and aerobic endurance in 13-15-year-old volleyball players.

Materials and methods. The research method used was an experiment with a one-group pretest-posttest and pretest-posttest control group approach. The participants were 30 male volleyball players weighing 57-67 kilograms and 157-170 cm in height. Vertical jump, agility t-test, and multistage fitness test were used in this study. Data gathering methods included observation and tests, while data analysis methods included descriptive analysis, Wilcoxon, and Mann-Whitney nonparametric analysis.

Results. Descriptive data revealed a difference in the mean value of the pretest and posttest of the experimental group. Furthermore, it also showed a difference in the mean value of the experimental and control groups. In the Wilcoxon test, the value of Asymp. sig(2-tailed) was 0.006<0.05, agility was 0.001<0.05, and endurance was 0.001<0.05. In the Mann-Whitney test, the value of Asymp. sig(2-tailed) was 0.416>0.05, agility was 0.00<0.05, and endurance was 0.00<0.05.

Conclusions. In the experimental group, the posttest score is higher than the pretest score on power, agility, and endurance. In volleyball players aged 13-15 years, there is a significant effect, with the experimental group outperforming the control group in terms of power, agility, and endurance. As a result, one of the recommended exercises for young volleyball players is the plyometrics training method using an agility ladder drill.

Keywords: plyometrics, agility ladder drill, young volleyball players.

Introduction

Volleyball is a game sport that is carried out in teams (Zech et al., 2021). Nowadays, volleyball is very popular among parents, teenagers, and children (Duan, 2021; Rahmi & Bachtiar, 2020). People playing volleyball have different goals such as recreation, improving health, and achievement (Young, et al, 2011; Suh et al, 2022; Bloshchynsky et al, 2019). Achievements in volleyball certainly require more effort to get maximum results (Kolev, 2020).

Achievements in volleyball are carved from an early age, so it is necessary to implement long-term coaching development for athletes (Balyi, Way & Higgs, 2013). The study states that to achieve the top, a systematic and planned program is needed and is supported by adequate internal and external parties (Bompa & Buzzichelli, 2019).

In coaching achievement at a young age, especially in volleyball, of course, putting forward technical training with good technique would be able to maximize performance (Chevrier et al, 2016). But in essence, volleyball is related to physical conditions (Taware, Bhutkar & Surdi, 2013). Therefore, one of the maximum supporters of a technique is supported by excellent physical condition.

Volleyball players at a young age need training with a multilateral approach so that by applying this concept they can provide motion enrichment in carrying out techniques (Wicaksono & Hidayatullah, 2022). It is hoped that with the amount of physical literacy provided, young athletes can demonstrate more complex technical movements (Brendan et al., 2014). Studies suggest that exercise improves physical ability in young athletes need to emphasize varied movements

ТМФВ
ТОВ ОВС

that involve brain and muscle coordination (Faigenbaum et al., 2016)

Athletes require high physical literacy at a young age to avoid injury, whereas physical exercise is more than just running motions, physical training is based on cognitive and affective knowledge (Faigenbaum et al., 2016). As a result, when considering volleyball physical training, especially around the age of 13-15 years, it differs greatly from physical training for older athletes (Buśko et al, 2012). In-depth research, however, is required in the application of physical training for volleyball players aged 13 to 15.

A coach's responsibility is to establish an adequate training program for the chronological ages of young athletes (Wicaksono et al., 2022). To maximize accomplishment in old age, a scientific method is required (Alsaudi, 2020). Athletes are not obliged to become champions at a young age, but they can display the essential methods that have been acquired, such that the highest level of champions is in maturity (Sulistiyono et al, 2021). As a result, the purpose of a long-term training program is to build, maximize, and sustain peak performance.

Using the plyometrics training approach is one of the attempts made to increase a volleyball player's physical capacity (Jastrzbeski et al, 2014). Plyo means to increase, and metrics are a measurement (Radcliffe & Farentinos, 2015). This plyometrics workout is distinguished by quick leaping and jumping motions, which entail fast eccentric and concentric phases (Radcliffe & Farentinos, 2015). According to research, the plyometrics exercise approach offers several advantages for boosting power, agility, flexibility, and endurance (Pratama et al, 2018).

According to observational research employing an interview strategy, some trainers claimed that physical activity is highly required, but at a young age, it prioritizes basic techniques. This is correct, but it is not absolute that just technique is taught since when athletes walk together, they go forward, sideways, and backward methods, especially while jumping, which is extremely difficult when there is no element of physical condition (Yudhistira & Tomoliyus, 2020). This is consistent with other studies indicating that physical fitness is vital in performing technical motions when practicing and competing (Yudhistira et al., 2021; Yulianto & Yudhistira, 2021)

Furthermore, numerous instructors indicated that plyometrics training was not allowed to be offered to young athletes due to the risk of injury, then the coach stated that various conditions must be met before plyometrics training, such as the athlete being able to complete squats weighing 1.5 body weight (Jones & Ledford, 2012). This is right, but it is not suitable; in reality, plyometrics exercise, when done with the appropriate training dose, has a favorable influence on the development of young athletes' physical condition (Rubley et al, 2011).

Gjinovci et al. (2017) conducted an experimental study on young volleyball players for 12 weeks utilizing a skill-based plyometrics training approach, with the outcomes of plyometrics training having a substantial influence on 20-meter running, leaping ability, and effectively lowering body mass index. Then, according to Idrizovic (2018), physical activity utilizing the plyometrics training approach gives a considerable rise in ball medicine throwing and the capacity to leap vertically in junior volleyball competitors.

However, according to Fathi et al. (2019), plyometrics training had no significant effect on enhancing jump height, sprint time, and flexibility in teenage volleyball players. According to the findings of Maćkała et al (2021), plyometric training did not result in a substantial increase in vertical jump performance in volleyball players. Based on the studies discovered, there are contradictions in earlier research.

Studies on plyometrics training methods are still being debated (Ramirez-Campillo et al., 2020; Watkins et al, 2021). Furthermore, Gjinovci et al. (2017) claimed that there is still little study that investigates plyometric training approaches mixed with various motions to promote volleyball abilities. The goal of this study is to investigate the plyometrics training approach employing agility ladder drills to develop leg muscular strength, aerobic endurance, and agility in volleyball players aged 13-15 years.

Materials and methods

Study participants

The research method used was a field test experiment with a one-group pretest-posttest design approach and a pretest-posttest control group design approach. Participants were 30 male volleyball players aged 13-15 years with a height of 157-170 cm and a body weight of 57-67 kilograms. All participants were given a pretest in the first stage, with the instruments utilized being a vertical leap test, an agility t-test, and a multistage fitness test. Following the discovery of the findings, the data were sorted from highest to lowest. The A-B-B-A pattern was then used to carry out the ordinal pairing match mechanism. As a result of this method, the experimental group was divided into 15 players who used the plyometrics training method with agility ladder drills and 15 players who were in the control group and used different training methods.This research was assisted by two trainers to prepare and carry out the treatment using the plyometrics agility ladder drill method in each group of 15 volleyball players aged 13-15 years. Players were given treatment 2 times a week for 16 meetings. In one exercise session, approximately 90 minutes to 120 minutes of exercise time are given with adjusted exercise dose settings.

Study organization

Participants were given treatment in the form of a plyometrics training method using agility ladder drill facilities for 16 meetings where treatment was given 2 times a week. The minimum presence of participants is 80%. The vertical leap test was used to assess the leg muscle power instrument, the agility t-test was used to measure the agility test instrument, and the multistage fitness test was used to measure the aerobic endurance test instrument. The procedure for performing plyometrics agility ladder drill exercises is as follows: the first player is guided to jog for 3 to 5 minutes to increase the pulse. The athlete is then guided to do static and dynamic stretching for approximately 20 to 30 minutes. At last, the athlete executes the program that has been prepared. The following is a plyometrics training program based on an agility ladder drill (Table 1).

Statistical analysis

The SPSS version 23 program was used to process the data. The first analysis was a descriptive analysis in which the

Table 1. Plyometrics agility ladder drill training program

Week	Meeting	Exercise Items	Exercise Dosage
1-2	1-3	Item 1: Rabbit hops Item 2: Straddle hops squat Item 3: Hopscotch	Volume (rep × sets): 6 × 3 on one exercise item Rest between reps: 10-15 seconds Rest between sets: 60 seconds Intensity: moderate – maximal
	4-6	Item 1: Ladder taps (left leg) Item 2: Ladder taps (right leg) Item 3: Single leg hops (left leg) Item 4: Single leg hops (right leg)	Volume (rep × sets): 10 × 3 on one exercise item Rest between reps: 10-15 seconds Rest between sets: 60 seconds Intensity: moderate – maximal
3-4	7-9	Item 1: Shuffle Item 2: Snake Jump Item 3: Straddle hops Item 4: Skiers jump	Volume (rep × set): 10 × 4 on one exercise item Rest between reps: 10-15 seconds Rest between sets: 60 seconds Intensity: moderate – maximal
	10-12	Item 1: Two-foot hoops – zigzag pattern Item 2: Single foot hops zig-zag pattern (left right Item 3: Single foot hops zig-zag pattern (right leg)	Volume (rep × set): 15 × 2 on one exercise item Rest between reps: 10-15 seconds Rest between sets: 60 seconds Intensity: moderate – maximal
5-6	13-15	Item 1: Forward-backward hop Item 2: Cross legs Item 3: Fight shuffle Item 4: Two forward, one back	Volume (rep × set): 10 × 4 on one exercise item Rest between reps: 10-15 seconds Rest between sets: 60 seconds Intensity: moderate – maximal
	16-18	Item 5: Lateral in out Item 6: Carioca Item 7: Ski jumps	Volume (rep × set): 15 × 3 on one exercise item Rest between reps: 10-15 seconds Rest between sets: 60 seconds Intensity: moderate – maximal

Table 2. Descriptive analysis results of pretest and posttest power agility and endurance

Group	Variable	Pretest				Postest			
		Min	Max	Mean	SD	Min	Max	Mean	SD
Experiment	Power	41	56	49.73	4.803	43	56	50.53	4.596
	Agility	17.12	18.34	17.61	0.47211	16.45	18.00	17.12	0.32887
	Endurance	38.09	48.08	44.69	3.24535	48.08	51.9	50.32	1.02517
Control	Power	42	56	49.27	4.511	41	56	49.13	4.882
	Agility	17.09	18.23	17.65	0.40813	17.09	18.24	17.65	0.41500
	Endurance	38.10	48.08	43.91	2.76913	38.11	48.04	43.71	2.62126

lowest, maximum, standard deviation, and mean values were presented. The second stage was Wilcoxon data analysis to check if the pretest and posttest effects differed in the experimental group. The next step is to examine the Mann-Whitney data to determine if there is a difference between the experimental and control groups' post-test outcomes. Deciding if the significance value is <0.05 and there is a substantial difference. A descriptive study of physical abilities such as power, agility, and aerobic endurance is provided below (Table 2).

Results

The Wilcoxon analysis of the Asymp.sig (2-tailed) value on the leg muscle power variable yielded 0.006 < 0.05. This finding indicates that there was a considerable improvement in leg muscular power between the pretest and posttest findings. The Asymp. (sig2-tailed) value in the agility variable is 0.001<0.05. In other words, the data suggest that there is a considerable variation in agility outcomes between the pretest and posttest. The Asymp. (sig2-tailed) value in the endurance variable is 0.001<0.05. As a result, the result revealed a substantial difference between the pretest and posttest outcomes of aerobic endurance (Table 3).

Table 3. The results of the pretest-posttest comparison of the experimental group based on Wilcoxon analysis

Variable	Asymp. sig (2-tailed)
Pretest – power Postest – power	0.006
Pretest – Agility Postest – Agility	0.001
Pretest – Endurance Postest – Endurance	0.001

The Mann-Whitney analysis of the Asymp. sig (2-tailed) value for the power variable is 0.416 > 0.05 as shown in

the table, indicating that there is no significant difference between the post-test values of the experimental and control groups. The experimental group's mean value is 50.53, while the control group's mean value is 49.13. The agility variable has an Asymp.sig (2-tailed) value of 0.000<0.05, indicating a significant difference between the experimental and control groups' post-test values. The experimental group's mean value is 17.12, while the control group's mean value is 17.65. The Asymp.sig (2-tailed) value for the endurance variable is 0.00<0.05 which indicated a significant difference between the results of the post-test values of the experimental and control groups. The mean value in the experimental group is 50.32, while the mean value in the control group is 43.71 (Table 4).

Table 4. The results of the post-test comparison of the experimental and control groups based on Mann Whitney analysis

Group	Variable	Mean	Asymp. sig (2-tailed)
Experiment	Power	50.53	0.416
Control		49.13	
Experiment	Agility	17.12	0.000
Control		17.65	
Experiment	Endurance	50.32	0.000
Control		43.71	

Discussion

According to the Wilcoxon analysis of the pretest and posttest findings, the Asymp.sig (2-tailed) value for the power variable in the experimental group was 0.006<0.05. The Asymp.sig (2-tailed) value in the agility variable is 0.001<0.05. The value of Asymp.sig (2-tailed) in the endurance variable is 0.001<0.05. The results described in the power, agility, and endurance variables can be interpreted as meaning that there is a significant difference between the pretest and posttest results, such that the posttest score is higher than the pretest value, as evidenced by the average posttest score of 50.53 on the power variable, 17.12 on the agility variable, and 50.32 on the endurance variable.

Based on the Mann-Whitney analysis, which compared the results of the experimental and controls posttests, the value of Asymp.sig(2-tailed) on the power variable is 0.416 >0.05, the agility variable is 0.00<0.05, and the endurance variable is 0.00<0.05. The results show that the power variable has no significant effect between the experimental posttest and posttest control groups, however, the agility and endurance variables have a significant effect between the experimental posttest and control posttest groups.

Volleyball players frequently use complex movements such as passing to their teammates and fast jumping up before smashing, and they are ready to return to their starting position to defend and attack again, which is done repeatedly for an extended period (Boichuk et al., 2017; Budiman, 2016). Of course, physical fitness is crucial not just for older athletes, but also for young athletes (Faigenbaum et al., 2016). Furthermore, smart approaches, strategies, and tactics are, of course, supported by a strong body (Franchini et al, 2007). The author's plyometrics training program for volleyball players aged 13-15 years has a considerable effect on physical performance, including leg muscle power, agility, and endurance.

According to the authors' findings, although the plyometrics approach employing the agility ladder drill did not significantly affect leg muscle power, the mean value in the experimental group was 50.53, while the control group was 49.13. Previous studies have confirmed this, and while the increase is not statistically significant, it still has a positive effect on the physical performance of young players for a further stage, because young players are still in the development stage, and this performance may continue to improve with proper time workout program and maturity (Edoya et al., 2015; Markovic, 2007; Vassil & Bazanovk, 2012).

On the agility variable, the experimental group had an average score of 17.12, while the control group received an average score of 17.65. The endurance variable had a mean value of 50.32, while the control group had a mean value of 43.71. This is consistent with prior research showing that plyometric exercises improve cardiovascular and neuromuscular fitness (Wang & Zhang, 2016). Plyometric exercises improve maximum strength, running speed, endurance, and agility (Wang & Zhang, 2016). As a result, plyometrics training is an effective approach for young volleyball players to increase their athletic ability (Vassil & Bazanovk, 2012)

Plyometrics is a method that includes motions like bounding, jumping, and hopping (Ichailidis et al., 2013). Plyometric exercises have fast lengthening and shortening cycles (Booth & Orr, 2016; Meszler, 2019). Studies have shown that plyometrics exercises use stretching and shortening phases that develop during rapid eccentric and concentric muscle contractions (Markovic et al., 2007; Markovic & Mikulic, 2010).

Because the muscles store energy during the eccentric phase and swiftly release it during the concentric phase, this exercise improves muscle strength and power (Davies, 2015). As a result, plyometrics training is advised as one of the volleyball training recipes (Ziv & Lidor, 2010).

The common misconception that plyometric activities are only employed by adult athletes is untrue. According to studies, plyometrics exercises are not only taught to adult athletes but also to youngsters and teenagers (Meylan & Malatesta, 2009). Plyometrics training has a positive effect on the physical capacities of young athletes (Martínez-lópez et al., 2012). Furthermore, one of the program recommendations for injury prevention is the plyometrics exercise program (Weber, Lam & Mcleod, 2016). Understanding the proper notion of plyometrics will undoubtedly have a positive impact on the development of young athletes (Akaruk et al., 2011). However, it is very important to understand and clarify the specifics for compiling a plyometrics exercise program for volleyball players aged 13-15 years, since errors in compiling plyometrics exercise programs can lead to the overload of the musculoskeletal system and the occurrence of Osgood-scatter disease at the age of 10-19 years (Ozmen & Aydogmus, 2017; Patel, 2002)

According to the study, the prerequisite for plyometrics training is that athletes can complete squats weighing 1.5 times their body weight in one lift so that there is no injury in the provision of plyometrics training (Baechle & Earle, 2008). Another viewpoint holds that low and high-

impact plyometrics exercises performed once or twice a week in conjunction with strength training are unquestionably safe and useful in a variety of sporting activities (Diallo et al, 2001; Faigenbaum et al, 2009; Ingle et al, 2006; Potdevin et al, 2011; Rubley et al, 2011). Another study found that plyometrics training is done twice a week in young athletes, the rest time is 72 hours, the number of foot contacts each training session is 50-60 and climbs 80-120, the number of repetitions is 6-15, and as many as 3-4 exercises should be done. 2-4 sets were completed (Edoya et al., 2015)

Furthermore, plyometrics training for young volleyball players is extremely different from plyometrics training for senior volleyball players (Medeni et al., 2019). To build a plyometrics training program at a young age, one must examine the hormonal, neurological, and muscular systems, as this is related to puberty or growth acceleration that impacts teenagers when performing movements (Myer et al, 2013)

Plyometrics training employing agility ladder drill media is a type of exercise variation that helps young athletes avoid boredom (Alviana, Mintarto, & Hariyanto, 2020; Padrón et al, 2021). Trainers have commonly employed ladder drill exercises to promote coordination, agility, speed, balance, and other skills (Robin, & Raj, 2019; Ng, Cheung & Raymond, 2017). As a result, plyometrics training using an agility ladder drill is one way that is appropriate for young volleyball players.

Trainers can combine several actions to provide motion enrichment, as a foundation for advanced plyometrics training, and to build brain and muscle synchrony (Padrón et al, 2021; Milroy, 2010). Trainers must learn how to set training doses such that the plyometrics training supplied does not injure young athletes. The success of an exercise is an individual loading adjustment and regular exercise dosage; we compare the effect of physical exercises on the body with the effect of hormones of the endorphin group (hormones of happiness), and the dose must be regulated and adjusted effectively (Gronwald et al, 2020).

Conclusions

Based on the findings and discussions, the comparison of the pretest and posttest in the experimental group has a substantial effect on leg muscular power, agility, and endurance. Furthermore, a comparison of the posttest findings and mean values in the experimental and control groups revealed that the experimental group that received the plyometrics training approach through the agility ladder drill, had a substantial influence on leg muscular power, agility, and endurance. Thus, the plyometrics training approach with the agility ladder drill is one of the suggested exercises for young volleyball players and other sports that need complicated motion enrichment.

Acknowledgment

The author would like to thank the Semarang State University, Faculty of Sports Science, for their assistance in completing this research appropriately. Furthermore, the authors would like to thank the team for assisting in the collection of research data, which allowed this study to proceed successfully.

Conflict of interest

All authors declare there is no conflict of interest in this study

References

Zech, A., Hollander, K., Junge, A., Steib, S., Groll, A., Heiner, J., Nowak, F., Pfeiffer, D., & Rahlf, A. L. (2022). Sex differences in injury rates in team-sport athletes: A systematic review and meta-regression analysis. *Journal of Sport and Health Science, 11*(1), 104-114. https://doi.org/10.1016/j.jshs.2021.04.003

Duan, C. (2021). Design of online volleyball remote teaching system based on AR technology. *Alexandria Engineering Journal, 60*(5), 4299-4306. https://doi.org/10.1016/j.aej.2021.03.006

Rahmi, S., & Bachtiar, I. (2020). The Contribution the Physical Condition on Underhand Serve Ability in Volleyball of Elementary School Students in Makassar City. *In 3rd International Conference on Education, Science, and Technology (ICEST 2019)* (pp. 296-299). Atlantis Press. https://doi.org/10.2991/assehr.k.201027.062

Young, M. E. M., Goslin, A., Potgieter, N., Nthangeni, S., & Modise, J. (2011). Sport and recreation participation preferences in the Botswana Defence Force: sport and recreation participation. *African Journal for Physical Health Education, Recreation and Dance, 17*(s 1), 134-145. https://doi.org/10.4314/ajpherd.v17i3.68082

Suh, Y. I., Kim, J., Lee, S., Han, S., & Park, S. H. (2022). A qualitative investigation of leisure benefits for social and psychological health among international volleyball players living in South Korea. *International Journal of Qualitative Studies on Health and Well-being, 17*(1), 2131216. https://doi.org/10.1080/17482631.2022.2131216

Bloshchynsky, I., Kovalchuk, R., Balendr, A., Aloshyna, A., Bahas, O., Mozolev, O & Prontenko, V. (2019). *The conceptual basis of the organization of volleyball team training.*

Kolev, P. (2020). Research of adolesencent volleyball palayers intrinsic motivation for achievement of high sports results. *Research in Kinesiology, 48*(1-2), 35-37. https://doi.org/10.46705/rik201-20035k

Balyi, I., & Way, R. (2013). Long-term athlete development. *Choice Reviews Online, 51*(09). https://doi.org/10.5860/choice.51-5081

Bompa, T. O., & Buzzichelli, C. (2019). *Periodization: theory and methodology of training*. Human kinetics.

Chevrier, J., Roy, M., Turcotte, S., Culver, D. M., & Cybulski, S. (2016). Skills trained by coaches of Canadian male volleyball teams: A comparison with long-term athlete development guidelines. *International Journal of Sports Science & Coaching, 11*(3), 410-421. https://doi.org/10.1177/1747954116645013

Taware, G. B., Bhutkar, M. V., & Surdi, A. D. (2013). A profile of fitness parameters and performance of volleyball players. *Journal of Krishna Institute of Medical Sciences University, 2*(2), 48-59.

Wicaksono, D., Hidayatullah, F., Kristiyanto, A., & Purnama, S.K. (2022). The Effect of Training Based on Part And Whole Combinations on Smash Techniques Improvement in Volleyball Sports for 11-12 Year Old

Athletes. *Physical Education Theory and Methodology, 22*(1), 62-69. https://doi.org/10.17309/tmfv.2022.1.09

Brendan, J., Tompsett, C., Burkett, B., & Mckean, M. R. (2014). Development of physical literacy and movement competency: A literature review. *Journal of fitness research, 3*(2), 53-74.

Faigenbaum, A. D., Lloyd, R. S., MacDonald, J., & Myer, G. D. (2016). Citius, Altius, Fortius: beneficial effects of resistance training for young athletes: narrative review. *British journal of sports medicine, 50*(1), 3-7. https://doi.org/10.1136/bjsports-2015-094621

Buśko, K., Michalski, R., Mazur, J., & Gajewski, J. (2012). Jumping abilities in elite female volleyball players: Comparative analysis among age categories. *Biology of Sport, 29*(4), 317-319. https://doi.org/10.5604/20831862.1022654

Alsaudi, A. T. B. D. (2020). The Influence of Drill Exercise and Eye Coordination Foot Methods Toward the Smash Skill of Badminton. *In 1st South Borneo International Conference on Sport Science and Education (SBICSSE 2019)* (pp. 76-82). Atlantis Press. https://doi.org/10.2991/assehr.k.200219.021

Sulistiyono, S., Akhiruyanto, A., Primasoni, N., Arjuna, F., Santoso, N., & Yudhistira, D. (2021). The effect of 10 weeks game experience learning (gel) based training on teamwork, respect attitude, skill and physical ability in young football players. *Physical Education Theory and Methodology, 21*(2), 173-179. https://doi.org/10.17309/tmfv.2021.2.11

Jastrzbeski, Z., Wnorowski, K., Mikolajewski, R., Jaskulska, E., & Radziminski, L. (2014). The effect of a 6-week plyometric training on explosive power in volleyball players. *Baltic Journal of Health and Physical Activity, 6*(2), 1. https://doi.org/10.2478/bjha-2014-0008

Radcliffe, J., & Farentinos, R. (2015). *High-Powered plyometrics* (2nd ed.). Human Kinetics

Pratama, N. E., Mintarto, E., Kusnanik, N. W., & Pratama, N. (2018). The influence of ladder drills and jump rope exercise towards speed, agility, and power of limb muscle. *Journal of Sports and Physical Education, 5*(1), 22-29.

Yudhistira, D., & Tomoliyus. (2020). Content validity of agility test in karate kumite category. *International Journal of Human Movement and Sports Sciences, 8*(5), 211-216. https://doi.org/10.13189/saj.2020.080508

Yudhistira, D., Suherman, W. S., Wiratama, A., Wijaya, U. K., Paryadi, P., Faruk, M., Hadi, H., Siregar, S., Jufrianis, J., & Pratama, K. W. (2021). Content Validity of the HIIT Training Program in Special Preparations to Improve the Dominant Biomotor Components of Kumite Athletes. *International Journal of Human Movement and Sports Sciences, 9*(5), 1051-1057. https://doi.org/10.13189/saj.2021.090527

Yulianto, W. D., & Yudhistira, D. (2021). Content Validity of Circuit Training Program and Its Effects on The Aerobic Endurance of Wheelchair Tennis Athletes. *International Journal of Kinesiology and Sports Science, 9*(3), 60-65. https://doi.org/10.7575/aiac.ijkss.v.9n.3p60

Jones, N. B., & Ledford, E. (2012). Strength and conditioning for Brazilian jiu-jitsu. *Strength & Conditioning Journal, 34*(2), 60-69. https://doi.org/10.1519/ssc.0b013e3182405476

Rubley, M. D., Haase, A. C., Holcomb, W. R., Girouard, T. J., & Tandy, R. D. (2011). The effect of plyometric training on power and kicking distance in female adolescent soccer players. *The Journal of Strength & Conditioning Research, 25*(1), 129-134. https://doi.org/10.1519/jsc.0b013e3181b94a3d

Gjinovci, B., Idrizovic, K., Uljevic, O., & Sekulic, D. (2017). Plyometric training improves sprinting, jumping and throwing capacities of high level female volleyball players better than skill-based conditioning. *Journal of sports science & medicine, 16*(4), 527. https://doi.org/10.1123/pes.2017-0178

Idrizovic, K., Gjinovci, B., Sekulic, D., Uljevic, O., João, P. V., Spasic, M., & Sattler, T. (2018). The effects of 3-month skill-based and plyometric conditioning on fitness parameters in junior female volleyball players. *Pediatric exercise science, 30*(3), 353-363. https://doi.org/10.1123/pes.2017-0178

Fathi, A., Hammami, R., Moran, J., Borji, R., Sahli, S., & Rebai, H. (2019). Effect of a 16-week combined strength and plyometric training program followed by a detraining period on athletic performance in pubertal volleyball players. *The Journal of Strength & Conditioning Research, 33*(8), 2117-2127. https://doi.org/10.1519/jsc.0000000000002461

Maćkała, K., Synówka, A., Ćorluka, M., & Vodicar, J. (2021). Impact of Plyometric Training on the Power of Lower Limbs in Moderately Advanced Female Volleyball Players. *Acta Kinesiologica, 15*(1), 5-12. https://doi.org/10.51371/issn.1840-2976.2021.15.s1.1

Ramirez-Campillo, R., Sanchez-Sanchez, J., Romero-Moraleda, B., Yanci, J., García-Hermoso, A., & Manuel Clemente, F. (2020). Effects of plyometric jump training in female soccer player's vertical jump height: A systematic review with meta-analysis. *Journal of Sports Sciences, 38*(13), 1475-1487. https://doi.org/10.1080/02640414.2020.1745503

Watkins, C. M., Gill, N. D., Maunder, E., Downes, P., Young, J.D., McGuigan, M. R., & Storey, A. G. (2021). The Effect of Low-Volume Preseason Plyometric Training on Force-Velocity Profiles in Semiprofessional Rugby Union Players. *The Journal of Strength & Conditioning Research, 35*(3), 604-615. https://doi.org/10.1519/jsc.0000000000003917

Boichuk, R., Iermakov, S., & Nosko, M. (2017). Pedagogical conditions of motor training of junior volleyball players during the initial stage. *Journal of Physical Education and Sport, 17*(1), 327-334. https://doi.org/10.7752/jpes.2017.01048

Budiman, I. A. (2016). Development model of volleyball spike training. *International Journal of Sports Physical Education, Sport, and Health, 3*(3), 466-471.

Faigenbaum, A. D., Kraemer, W. J., Blimkie, C. J., Jeffreys, I., Micheli, L. J., Nitka, M., & Rowland, T. W. (2009). Youth resistance training: updated position statement paper from the national strength and conditioning association. *Journal of Strength & Conditioning Research, 23*(S5), S60-S79. https://doi.org/10.1519/jsc.0b013e31819df407

Franchini, E., Nunes, A. V., Moraes, J. M., & Del Vecchio, F. B. (2007). Physical fitness and anthropometrical profile of the Brazilian male judo team. *Journal of physiological anthropology, 26*(2), 59-67. https://doi.org/10.2114/jpa2.26.59

Edoya, A. A., Miltenberger, M. R., & Lopez, R. M. (2015). Plyometric training effects on athletic performance in youth soccer athletes: a systematic review. *Journal of Strength & Conditioning Research, 29*(8), 2351-2360. https://doi.org/10.1519/jsc.0000000000000877

Markovic, G. (2007). Does plyometric training improve vertical jump height? A meta-analytical review. *British journal of sports medicine, 41*(6), 349-355. https://doi.org/10.1136/bjsm.2007.035113

Vassil, K., & Bazanovk, B. (2012). The effect of plyometric training program on young volleyball players in their usual training period. *Journal of Human Sport and Exercise, 7*(1), S34-S40. https://doi.org/10.4100/jhse.2012.7.proc1.05

Wang, Y., & Zhang, N. A. (2016). Effects of plyometric training on soccer players. *Experimental and therapeutic medicine, 12*(2), 550-554. https://doi.org/10.3892/etm.2016.3419

Ichailidis, Y. I. M., Fatouros, I. G., Primpa, E., Michailidis, C., Avloniti, A., Chatzinikolaou, A., & Kambas, A. (2013). Plyometrics' trainability in preadolescent soccer athletes. *Journal of Strength & Conditioning Research, 27*(1), 38-49. https://doi.org/10.1519/jsc.0b013e3182541ec6

Booth, M. A., & Orr, R. (2016). Effects of Plyometric Training on Sports Performance. *Strength & Conditioning Journal, 38*(1), 30-37. https://doi.org/10.1519/ssc.0000000000000183

Meszler, B. (2019). European Journal of Integrative Medicine Combined strength and plyometric exercise training improves running economy and muscle elastic energy storage and re-use in young untrained women. *European Journal of Integrative Medicine, 28*(November 2018), 86-91. https://doi.org/10.1016/j.eujim.2019.05.004

Markovic, G., Arkovic, G. O. M., Ukic, I. G. O. R. J., & Ilanovic, D. R. M. (2007). Effects of sprint and plyometrics training on muscle function and athletic performance. *Journal of Strength and Conditioning Research, 21*(2), 543-549. https://doi.org/10.1519/R-19535.1

Markovic, G., & Mikulic, P. (2010). Neuro-musculoskeletal and performance adaptations to lower-extremity plyometric training. *Sports medicine, 40*(10), 859-895. https://doi.org/10.2165/11318370-000000000-00000

Davies, G. (2015). Current concepts of plyometrics exercise. *International Journal of Sports Physical Therapy, 10*(6), 760-786.

Ziv, G., & Lidor, R. (2010). Vertical jump in female and male volleyball players: a review of observational and experimental studies. *Scandinavian journal of medicine & science in sports, 20*(4), 556-567. https://doi.org/10.1111/j.1600-0838.2009.01083.x

Meylan, C., & Malatesta, & D. (2009). Effects of in-season plyometric training within soccer practice on explosive actions of young players. *Journal of Strength & Conditioning Research, 23*(9), 2605-2613. https://doi.org/10.1519/jsc.0b013e3181b1f330

Martínez-López, E. J., Benito-Martínez, E., Hita-Contreras, F., Lara-Sánchez, A., & Martínez-Amat, A. (2012). Effects of electrostimulation and plyometric training program combination on jump height in teenage athletes. *Journal of sports science & medicine, 11*(4), 727–735.

Weber, M. L., Lam, K. C., & McLeod, T. C. V. (2016). The effectiveness of injury prevention programs for youth and adolescent athletes. *International Journal of Athletic Therapy and Training, 21*(2), 25-31. https://doi.org/10.1123/ijatt.2015-0034

Akaruk, H. U. M., Inchester, J. A. B. W., Adowski, J. E. S., & Zaplicki, A. D. A. M. C. (2011). Effects of unilateral and bilateral plyometric training on power and jumping ability in women. *Journal of Strength & Conditioning Research, 25*(12), 3311-3318. https://doi.org/10.1519/jsc.0b013e318215fa33

Ozmen, T., & Aydogmus, M. (2017). Effect of plyometric training on jumping performance and agility in adolescent badminton players. *Turkish Journal of Sport and Exercise, 19*(2), 222-227.

Patel, S. H. (2002). *A descriptive analysis of physical therapists' knowledge of pediatric sports injury diagnosis and management.* D'Youville College.

Baechle, T. R., & Earle, R. W. (Eds.). (2008). *Essentials of strength training and conditioning.* Human kinetics.

Diallo, O., Dore, E., Duche, P., & Van Praagh, E. (2001). Effects of plyometric training followed by a reduced training program on physical performance in prepubescent soccer players. *Journal of sports medicine and physical fitness, 41*(3), 342.

Ingle, L., Sleap, M., & Tolfrey, K. (2006). The effect of a complex training and detraining programme on selected strength and power variables in early pubertal boys. *Journal of sports sciences, 24*(9), 987-997. https://doi.org/10.1080/02640410500457117

Potdevin, F. J., Alberty, M. E., Chevutschi, A., Pelayo, P., & Sidney, M. C. (2011). Effects of a 6-week plyometric training program on performances in pubescent swimmers. *Journal of Strength & Conditioning Research, 25*(1), 80-86. https://doi.org/10.1519/jsc.0b013e3181fef720

Medeni, Ö. Ç., Turgut, E., Çolakoğlu, F. F., & Baltacı, G. (2019). Plyometric training combined with jump rope training in female adolescent volleyball players. *Türkiye Klinikleri Sağlık Bilimleri Dergisi, 4*(3), 261-268. https://doi.org/10.5336/healthsci.2018-63472

Myer, G. D., Lloyd, R. S., Brent, J. L., & Faigenbaum, A. D. (2013). How young is "too young" to start training? *ACSM's health & fitness journal, 17*(5), 14. https://doi.org/10.1249/fit.0b013e3182a06c59

Alviana, S. I., Mintarto, E., & Hariyanto, A. (2020). The Effect of Exercise with Ladder Drill Slaloms and Carioca on Speed and Agility. *International Journal for Educational and Vocational Studies, 2*(1), 103-108. https://doi.org/10.29103/ijevs.v2i1.2039

Padrón-Cabo, A., Lorenzo-Martínez, M., Pérez-Ferreirós, A., Costa, P. B., & Rey, E. (2021). Effects of plyometric training with agility ladder on physical fitness in youth soccer players. *International Journal of Sports Medicine, 42*(10), 896-904. https://doi.org/10.1055/a-1308-3316

Robin, K. V., & Raj, Y. L. (2019). Impact of ladder training on the agility performance of footballers. *International Journal of Yogic, Human Movement and Sports Sciences, 4*(1), 1.

Ng, R. S., Cheung, C. W., & Raymond, K. S. (2017). Effects of 6-week agility ladder drills during recess intervention on dynamic balance performance. *Journal of Physical Education and Sport, 17*(1), 306.

Milroy, T. (2010). *Correlation between an Athletes' Consideration of Future Consequences and Their Improvement in Strength, Speed, and Agility with a Six Week Training Program*. Unpublished Master's Thesis). Bozeman, Montana: Montana State University.

Gronwald, T., Törpel, A., Herold, F., & Budde, H. (2020). Perspective of dose and response for individualized physical exercise and training prescription. *Journal of Functional Morphology and Kinesiology, 5*(3), 48. https://doi.org/10.3390/jfmk5030048

ВПЛИВ ПЛІОМЕТРИЧНИХ ВПРАВ НА СПРИТНІСТЬ НА КООРДИНАЦІЙНІЙ ДРАБИНІ НА ПОКРАЩЕННЯ ФІЗИЧНИХ ЗДІБНОСТЕЙ ВОЛЕЙБОЛІСТІВ ВІКОМ 13–15 РОКІВ

Гаррі Прамоно[1ABCDE], Тандійо Рахаю[1ABCDE], Деванга Юдхістіра[1ABCDE]

[1]Семарангський державний університет

Авторський вклад: A – дизайн дослідження; B – збір даних; C – статаналіз; D – підготовка рукопису; E – збір коштів

Реферат. Стаття: 7 с., 4 табл., 39 джерел.

Мета дослідження. Метою цього дослідження було перевірити метод пліометричних тренувань шляхом виконання вправ на спритність на координаційній драбині для підвищення сили м'язів ніг, спритності та аеробної витривалості у волейболістів віком 13-15 років.

Матеріали та методи. Як метод дослідження використовували експеримент із попереднім і підсумковим тестуванням на одній групі та попереднім і підсумковим тестуванням на контрольній групі. Учасниками були 30 волейболістів чоловічої статі вагою 57-67 кілограмів і зростом 157-170 см. У цьому дослідженні використовували вертикальний стрибок, Т-тест на спритність і багатоетапний фітнес-тест. Методи збору даних включали спостереження та тести, а методи аналізу даних включали описовий аналіз, критерій Вілкоксона та непараметричний аналіз Манна-Уітні.

Результати. Описові дані виявили різницю в середньому значенні попереднього та підсумкового тестування експериментальної групи. Крім того, вони також показали різницю в середньому значенні експериментальної та контрольної груп. У критерії Вілкоксона величина двосторонньої асимптотичної значущості (Asymp. sig (2-tailed)) становила 0,006<0,05, спритність – 0,001<0,05, витривалість – 0,001<0,05. У критерії Манна-Уітні величина двосторонньої асимптотичної значущості (Asymp. sig (2-tailed)) становила 0,416>0,05, спритність – 0,00<0,05, витривалість – 0,00<0,05.

Висновки. В експериментальній групі бал підсумкового тестування вищий за бал попереднього тестування за силою, спритністю та витривалістю. У волейболістів віком 13–15 років спостерігається достовірний ефект, при цьому експериментальна група перевершує контрольну за показниками сили, спритності та витривалості. У зв'язку із цим однією з рекомендованих вправ для юних волейболістів є метод пліометричних тренувань з використанням вправ на спритність на координаційній драбині.

Ключові слова: пліометрика, вправи на спритність на координаційній драбині, юні волейболісти.

Information about the authors:

Pramono, Harry: hpr4mono@mail.unnes.ac.id; https://orcid.org/0000-0002-9673-5823; Departement of Physical Education, Faculty of Sport Science, Universitas Negeri Semarang, Sekaran, Kec. Gn. Pati, Kota Semarang, Jawa Tengah 50229, Indonesia

Rahayu, Tandiyo: tandiyorahayu@mail.unnes.ac.id; https://orcid.org/0000-0002-8690-6377; Departement of Physical Education, Faculty of Sport Science, Universitas Negeri Semarang, Sekaran, Kec. Gn. Pati, Kota Semarang, Jawa Tengah 50229, Indonesia

Yudhistira, Dewangga: dewanggayudhistira@mail.unnes.ac.id; https://orcid.org/0000-0002-4194-1283; Department of Sport Coaching Education, Faculty of Sport Science, Universitas Negeri Semarang, Sekaran, Kec. Gn. Pati, Kota Semarang, Jawa Tengah 50229, Indonesia

Cite this article as: Pramono, H., Rahayu, T., & Yudhistira, D. (2023). The Effect of Plyometrics Exercise through Agility Ladder Drill on Improving Physical Abilities of 13–15-Year-Old Volleyball Players. *Physical Education Theory and Methodology, 23*(2), 199-206. https://doi.org/10.17309/tmfv.2023.2.07

Received: 17.11.2022. Accepted: 21.01.2023. Published: 28.04.2023

Теорія та методика фізичного виховання
Physical Education Theory and Methodology
Teorìâ ta Metodika Fizičnogo Vihovannâ

ISSN 1993-7989 (print)
ISSN 1993-7997 (online)
ISSN-L 1993-7989

ORIGINAL SCIENTIFIC ARTICLE

THE RELATIONS BETWEEN BLOOD PRESSURE AND HANDGRIP STRENGTH IN CHILDREN

Gentiana Beqa Ahmeti[1ABCDE], Besnik Morina[1ABCDE], Georgi Georgiev[2ABCDE] and Seryozha Gontarev[2ABCDE]

[1]University of Pristina "Hasan Pristina"
[2]Ss. Cyril and Methodius University

Authors' Contribution: A – Study design; B – Data collection; C – Statistical analysis; D – Manuscript Preparation; E – Funds Collection

Corresponding Author: Besnik Morina, E-mail: besnik.morina@uni-pr.edu
Accepted for Publication: February 18, 2023
Published: April 28, 2023; Retracted: August 30, 2023

DOI: 10.17309/tmfv.2023.2.08

Abstract

Background. Studies, previously completed, announce that the handgrip strength as a measurement for assessing muscle fitness is associated with cardiovascular risk factors. Yet, the relation of handgrip strength to the blood pressure in children is inconsistent. Therefore, we conducted the present research aiming to establish the relation of the handgrip strength to the blood pressure in Macedonian children from the Skopje region.

Materials and methods. The research was conducted on a sample of 1076 children (534 boys and 542 girls),whereby the following characteristics were measured: blood pressure, handgrip strength, weight, height, body fat percentage, waist circumference and the body mass index (BMI) was calculated. General linear models were used to examine the association between handgrip strength and the outcome variables.

Results. After the adjustment of age, gender, BMI, body fat percentage and waist circumference, the handgrip strength was statistically significantly positively associated to both systolic ($p<0.0001$) and diastolic ($p=0.02$) blood pressure. There was a growing trend of the systolic blood pressure as the handgrip strength increased from the lower quartile to the upper quartile with 3,7 mm Hg difference between the upper and lower quartile (p for trend = 0.03). In this research, it was not established a statistically significant trend of the diastolic blood pressure as the hand grip strength increases from the lower quartile to the upper quartile (p for trend=0.09).

Conclusions. The muscle fitness has a positive correlation with the blood pressure in the respondents. The implications and the basic mechanisms of these results require further research studies.

Keywords: hypertension, children, muscle strength, body mass index.

Introduction

Hypertension is an important challenge public health problem due to the high prevalence and high mortality that is occurring (Mozaffarian et al., 2015). Hypertension in adults originates from childhood (Bao et al., 1995; Chen & Wang, 2008; Juhola et al., 2011; Kagura et al., 2015). Therefore, it is important to identify those factors that provoke the blood pressure variations (BP) in childhood and adolescent period, the aim of which is to design appropriate strategies and state policy for early prevention and intervention. The physical fitness is increasingly recognized as an important predictor of morbidity and mortality (Kodama et al., 2009). The relation between fitness and cardiovascular health is that well recorded in children and adolescents, too (Froberg & Andersen, 2005; Ruiz et al., 2007; Ortega et al., 2008). The muscle fitness, assessed through the handgrip strength, has become an important cardiometabolic marker in children (Ortega et al., 2008; Peterson et al., 2014; Smith et al., 2014). In spite of the fact that muscle fitness is generally related to the cardiometabolic health in children, some people put under question the relation between the muscle strength and cardiometabolic risk (Diez-Fernandez et al., 2015). Regarding the blood pressure, recent studies presented that the high muscle strength correlates with low blood pressure (Ortega et al., 2011; Cohen et al., 2014; Cohen et al., 2017), however there are research studies that have contradictory results (Dong et al., 2016; Demmer et al., 2016; Zhang et al., 2018) in children and adolescents.

The establishment of association between the blood pressure and muscle fitness in children and adolescents can be of help in better understanding the mechanisms for blood pressure regulation and in implementing of early prevention. For that particular intention we conducted the present research, aiming to establish the association between the hand-grip strength and blood pressure in Macedonian children living in the Skopje region.

Materials and methods

Participants

The research was conducted on a sample of 1076 respondents divided into two subsamples of 534 boys and 542 girls aged 6-10. The respondents were chosen at random from a number of schools in the region of the city of Skopje in the Republic of North Macedonia. All the sample consisted of schoolchildren whose parents agreed for their children to be involved in the project. All the children were physically and mentally healthy during the measurements, and no parent reported for their child to have some chronic disease or high blood pressure. The children were treated according to the Principles of the Declaration of Helsinki (Edinburgh revision 2000 year). The project received the Ethics committee approval from Ss. Cyril and Methodius University in Skopje. The measurements were completed in 2019 year.

Anthropometric measures and body composition

The anthropometric measurements were performed regarding the methodology of the International biology program (IBP) and regarding the recommendations of the World Health Organization (WHO) and Weiner and Lurie (1981). The weight was taken by a digital scale of 0,1 kg accuracy, and the height was measured with a stadiometer scale with accuracy of 0,1 cm. The waist circumference was measured with a non-elastic scaled tape placed horizontally midway between the bottom of the chest and hipbones. The body mass index was calculated as body weight in kilograms divided by the square of height in meters.

The body composition was established through the method of bioelectrical impedance. The measurements were performed with a monitor of body composition, model "OMRON – BF11". In order to obtain better results' validity, at the beginning of every measuring it was insisted to follow the recommendations of American College of Sports Medicine (2005) and Heyward (2006) was fulfilled.

Blood Pressure Assessment

The blood pressure measuring was taken through an oscillometric method via the calibrated digital device Omron (Kyoto, Japan) model HEM 742, with cuffs of suitable size for the arm circumference of a child. This device has been validated for use with children (Christofaro et al. 2009).

The hypertension was defined as BP ≥ 95th percentage, the prehypertension was defined as BP between ≥ 90th and <95th percentage, the normal blood pressure was defined as BP < 90th percentage. For classifying the respondents, the Update on the Task Force Report on High Blood Pressure in Children and Adolescent was used.

HGS measurement

For assessing the hand-grip strength, the Takei TKK 5101 digital dynamometer was used (range, 1-100 kg). The same was used in measuring the hand-grip strength of both hands. The dynamometer's handle used to be adapted to the hand size of every respondent. The children were instructed to squeezethe dynamometer three consecutive times with each handas tight as possible, and the highest value (maximal value in kilograms) was used for the analyses (Haidar et al., 2004).

Statistical analysis

The sample's characteristics were presented as arithmetic mean and standard deviation of the continuous variables and frequencies and percentages of nominal variables. For establishing the gender differences in continuous variables, the applied analysis was that of covariance with age partialization and chi-square test for nominal variables. For establishing the correlation between the hand-grip strength and blood pressure, the Pearson partial correlation was applied together with its age and gender adjustment. For establishing the relation between the hand-grip strength and measures of the blood pressure, the linear regressive analysis was used together with its adjustment for age, gender, BMI, body fat percentage and waist circumference. All of the analyses were performed using the Statistical Package for Social Sciences software (SPSS, v. 22.0), and the values from $p<0.05$ were considered statistically insignificant.

Table 1. Characteristics of the study sample

Independent variable	Boys		Girls		F	P
	Mean	SD	Mean	SD		
Age (years)	8.62	1.30	8.54	1.33	0.99	0.320
BMI (kg/m^2)	18.84	3.70	18.40	3.33	4.13	0.042
Body fat percentage (%)	24.43	7.78	23.72	8.04	2.02	0.155
Waist circumference (cm)	62.36	9.75	60.19	8.45	15.04	0.000
Handgrip strength (kg)	13.40	3.64	12.14	3.58	32.28	0.000
Systolic blood pressure (mg Hg)	103.92	17.87	101.70	18.75	3.95	0.047
Diastolic blood pressure (mg Hg)	65.99	14.17	65.32	14.84	0.55	0.457

Abbreviations: BMI – body mass index

Table 2. Partial Pearson's correlation to systolic BP and diastolic BP and body mass index, body fat percentage, waist circumference and handgrip strength

Independent variable	Systolic blood pressure (mg Hg)		Diastolic blood pressure (mg Hg)	
	r	P	r	P
BMI (kg/m^2)	0.265	0.000	0.256	0.000
Body fat percentage (%)	0.268	0.000	0.247	0.000
Waist circumference (cm)	0.307	0.000	0.298	0.000
Handgrip strength (kg)	0.186	0.000	0.161	0.000

P values were adjusted for age and sex.

Table 3. Regression coefficients of handgrip strength and other covariates for blood pressure

Independent variable	Systolic blood pressure (mm Hg)			Diastolic blood pressure (mm Hg)		
	β	± SE	P	β	± SE	P
Female sex	0.08	1.16	0.94	0.99	0.92	0.28
Age (per year)	-1.58	0.61	0.01	-1.07	0.48	0.03
BMI (per kg/m^2)	-0.79	0.47	0.09	-0.26	0.37	0.48
Body fat percentage (%)	0.42	0.18	0.02	0.15	0.14	0.30
Waist circumference (cm)	0.56	0.13	0.00	0.46	0.10	0.00
Handgrip strength (kg)	0.74	0.23	0.00	0.42	0.18	0.02

Abbreviations: BMI – body mass index

Results

The examined respondents' characteristics, according to their gender, are presented in Table 1. The Table review shows that the male respondents have greater values of the body mass index (BMI), waist circumference; they demonstrate higher results in the handgrip-strength test and have higher values of the symbolic blood pressure ($p \leq 0.05$). Statistically significant differences between the male and female respondents were not established in the years/age, the percentage of fat tissue and the values of the diastolic blood pressure. Among the participants, the average age was 8.6 ±1.3 years. The prevalence of prehypertension was 8.8% in boys and 5.9% in girls, while the prevalence of hypertension was 20.8% in boys and 18.8% in girls. No statistically significant differences were found between the estimates of prehypertension and hypertension prevalence by sex groups ($p = 0.577$)

Handgrip strength is in a statistically significant positive correlation with the systolic blood pressure ($r = 0.19$, $p < 0.0001$) and with the diastolic blood pressure ($r = 0.16$, $p < 0.0001$) after partializing the age and gender. In addition, the body mass index, the body fat percentage and the waist circumference are in a statistically significant positive correlation with the systolic and diastolic blood pressure ($p < 0.0001$) (Table 2). Handgrip strength was significantly and positively associated with both systolic and diastolic BP, independent of age, sex, BMI, body fat percentage and waist circumference; increase of each kilogram in handgrip strength was associated with 0.74 mm Hg increase in systolic BP ($p < 0.0001$) and 0.42 mm Hg increase in diastolic BP ($p = 0.02$) (Table 3). It was established that there is a statistically significant trend of increasing the systolic blood pressure as the handgrip strength increases from the lower quartile to the upper quartile with 3,7 mm Hg difference between the upper and lower quartile (p for trend = 0.03, Figure 1). It was not established a statistically significant trend of the diastolic blood pressure as the handgrip strength increases from the lower to the upper quartile (p for trend = 0.09, Figure 1).

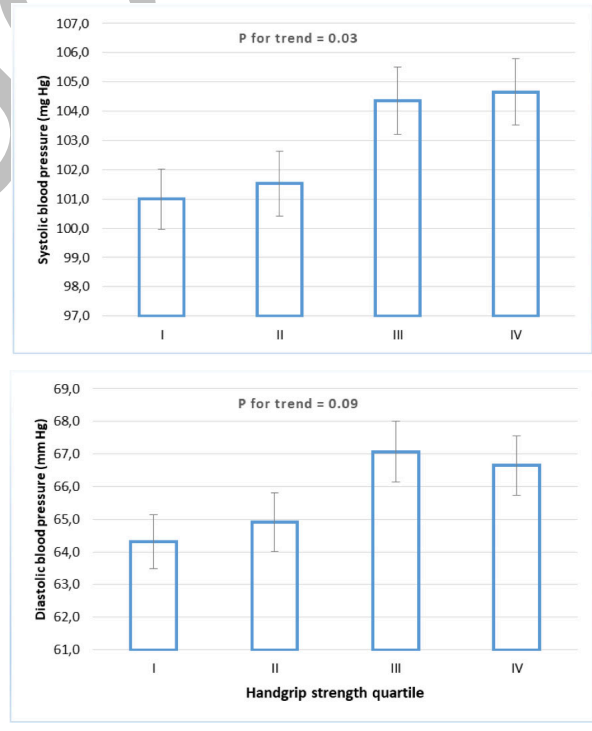


Fig. 1. Least square means of systolic blood pressure (top panel) and diastolic blood pressure (bottom panel) by age- and sex-specific handgrip strength quartile. P values were adjusted for age, sex and body mass index

Discussion

The research results suggest that the hand-grip strength is in a positive correlation with BP in children aged 6-10. This relation was considerably strong, since it was independent of percentages of body fat, waist circumference and BMI. The findings were contrary to the beneficial effects of increased muscular fitness on other cardiometabolic risk factors in both children and adults (Artero et al., 2012; Lin et al., 2015; Kawamoto et al., 2016; Ortega et al., 2003).

The correlation between the handgrip strength and blood pressure is inconsistent, and in some studies an inverse correlation is established (Ortega et al., 2011; Cohen et al., 2014; Cohen et al., 2017), whereas in other research studies a positive correlation is established (Dong et al., 2016; Demmer et al., 2016; Zhang et al., 2018. Dong et al. (2016) have established in their research that the handgrip strength is positively related to the blood pressure after adjusting or stratifying of BMI in 88.865 Chinese adolescents at the age of 13-17. Demmer et al. (2016) have established similar results in both boys and girls at the age of 10, 14 and 17 years.

All these findings, along with ours, are in contrast to the findings of an inverse association (Ortega et al., 2011; Cohen et al., 2014; Cohen et al., 2017) and by Diez-Fernandez et al. (2015) showing that the inverse associations are mediated by BMI. The positive relationship that we have established between the handgrip strength and blood pressure is in contrast to what would be expected, having in mind the results of previous studies which indicate the associations of muscular fitness with other cardiometabolic risk factors, especially in the adult population (Artero et al., 2012; Lin et al., 2015; Kawamoto et al., 2016). It is well known that the blood pressure in childhood predicts future risks of hypertension and cardiovascular diseases (Bao et al., 1995; Lurbe, 2003; Lawlor & Smith, 2005), and the muscle fitness is inversely correlated to the cardiometabolic risk (Artero et al., 2012; Mainous et al., 2015).

We have many opinions that aerobic exercises have a positive impact on reducing blood pressure in children (García-Hermoso et al., 2013). Also, the 2015 Canadian Hypertension Education Program Recommendations for Blood Pressure Measurement, Diagnosis, Assessment of Risk, Prevention and Treatment of Hypertension just makes mention of the fact that the applied resistance training does not have a negative influence on the blood pressure with a weak strength of evidence (Grade D) (Daskalopoulou et al., 2015), and the instruction developed by European Society of Hypertension gives no specific recommendations related to the resistance training (Lurbe et al., 2009).

Finally, some advantages as well as certain limitations of the present study should be pointed. The study was conducted on a relatively big sample of 1076 respondents. Measurements were performed by professionally trained persons using a proper methodology and procedures, which provided quality and control. One of the study's limitations is the fact that its nature was transversal and monitoring. Therefore, it is not possible to establish the causality of the observed associations. It is necessary to conduct longitudinal research works and clinical examinations in order to elucidate the relation between the muscle strength and blood pressure. Several studies despite the fact that the grip strength is readily employed and has been shown to be highly correlated with total muscle strength in adolescents, (Wind, et al., 2010), it is not necessarily effective for assessing the strength change with resistance training interventions. In addition, we had no information about how often children do exercises for muscle strengthening, and it is advisable for that type of data to be included in future research studies.

In addition, there were no data about the cardiorespiratory fitness and physical activity that would be significant determinants of the blood pressure in children (Kim et al., 2016). Finally, our research did not cover all of the eight regions into which the Republic of North Macedonia is divided. Nevertheless, our goal was to establish the relationships in the available sample, and not to assess the population parameters of the whole Macedonian population in total.

Conclusion

So far, a given number of studies have had their focus on the relation between the muscle strength and specific health outcomes in children and adolescents, obscuring relevant interventions and treatments. The research results show that the greater hand-grip strength is associated with a greater blood pressure in children. This correlation is independent of the body mass index, waist circumference and body fat percentage.

Taking into consideration the multiple benefits of the muscle fitness, it is necessary to be very precautious in interpreting the findings of this study. Additional clinical trials and cohort studies are needed on a bigger sample of respondents in order to confirm the results and explain the possible mechanisms of this correlation. The present study can be of significant importance in hypertension intervention.

References

Mozaffarian, D., Benjamin, E. J., Go, A. S., Arnett, D. K., Blaha, M. J., Cushman, M., ... & Turner, M. B. (2015). Heart disease and stroke statistics—2015 update: a report from the American Heart Association. *Circulation, 131*(4), e29-e322. https://doi.org/10.1161/cir.0000000000000152

Bao, W., Threefoot, S. A., Srinivasan, S. R., & Berenson, G. S. (1995). Essential hypertension predicted by tracking of elevated blood pressure from childhood to adulthood: The Bogalusa Heart Study. *American journal of hypertension, 8*(7), 657-665. https://doi.org/10.1016/0895-7061(95)00116-7

Chen, X., & Wang, Y. (2008). Tracking of blood pressure from childhood to adulthood: a systematic review and meta–regression analysis. *Circulation, 117*(25), 3171-3180. https://doi.org/10.1161/circulationaha.107.730366

Juhola, J., Magnussen, C. G., Viikari, J. S., Kähönen, M., Hutri-Kähönen, N., Jula, A., ... & Juonala, M. (2011). Tracking of serum lipid levels, blood pressure, and body mass index from childhood to adulthood: The Cardiovascular Risk in Young Finns Study. *Journal of pediatrics, 159*(4), 584-590. https://doi.org/10.1016/j.jpeds.2011.03.021

Kagura, J., Adair, L. S., Musa, M. G., Pettifor, J. M., & Norris, S. A. (2015). Blood pressure tracking in urban black South African children: birth to twenty cohort. *BMC pediatrics, 15*(1), 1-7. https://doi.org/10.1186/s12887-015-0402-z

Kodama, S., Saito, K., Tanaka, S., Maki, M., Yachi, Y., Asumi, M., ... & Sone, H. (2009). Cardiorespiratory fitness as a quantitative predictor of all-cause mortality and cardiovascular events in healthy men and women: a meta-analysis. *Jama, 301*(19), 2024-2035. https://doi.org/10.1001/jama.2009.681

Froberg, K., & Andersen, L. B. (2005). Mini review: physical activity and fitness and its relations to cardiovascular disease risk factors in children. *International journal of obesity, 29*(2),S34-S39. https://doi.org/10.1038/sj.ijo.0803096

Ruiz, J. R., Ortega, F. B., Rizzo, N. S., Villa, I., Hurtig-Wennlöf, A., Oja, L., & Sjöström, M. (2007). High cardiovascular fitness is associated with low metabolic risk score in children: the European Youth Heart Study. *Pediatric research, 61*(3), 350-355. https://doi.org/10.1203/pdr.0b013e318030d1bd

Ortega, F. B., Ruiz, J. R., Castillo, M. J., & Sjöström, M. (2008). Physical fitness in childhood and adolescence: a powerful marker of health. *International journal of obesity, 32*(1), 1-11. https://doi.org/10.1038/sj.ijo.0803774

Peterson, M. D., Saltarelli, W. A., Visich, P. S., & Gordon, P. M. (2014). Strength capacity and cardiometabolic risk clustering in adolescents. *Pediatrics, 133*(4), e896-e903. https://doi.org/10.1542/peds.2013-3169

Smith, J. J., Eather, N., Morgan, P. J., Plotnikoff, R. C., Faigenbaum, A. D., & Lubans, D. R. (2014). The health benefits of muscular fitness for children and adolescents: a systematic review and meta-analysis. *Sports medicine, 44*(9), 1209-1223. https://doi.org/10.1007/s40279-014-0196-4

Diez-Fernandez, A., Sanchez-Lopez, M., Gulias-Gonzalez, R., Notario-Pacheco, B., Canete Garcia-Prieto, J., Arias-Palencia, N., & Martinez-Vizcaino, V. (2015). BMI as a mediator of the relationship between muscular fitness and cardiometabolic risk in children: a mediation analysis. *PLoS One, 10*(1), e0116506. https://doi.org/10.1371/journal.pone.0116506

Ortega, F. B., Artero, E. G., Ruiz, J. R., España-Romero, V., Jiménez-Pavón, D., Vicente-Rodríguez, G., ... & Castillo, M. J. (2011). Physical fitness levels among European adolescents: the HELENA study. *British journal of sports medicine, 45*(1), 20-29. https://doi.org/10.1136/bjsm.2009.062679

Cohen, D. D., Gómez-Arbeláez, D., Camacho, P. A., Pinzon, S., Hormiga, C., Trejos-Suarez, J., ... & Lopez-Jaramillo, P. (2014). Low muscle strength is associated with metabolic risk factors in Colombian children: the ACFIES study. *PloS one, 9*(4), e93150. https://doi.org/10.1371/journal.pone.0093150

Cohen, D. D., Lopez-Jaramillo, P., Fernández-Santos, J. R., Castro-Piñero, J., & Sandercock, G. R. (2017). Muscle strength is associated with lower diastolic blood pressure in schoolchildren. *Preventive medicine,* 95, 1-6. https://doi.org/10.1016/j.ypmed.2016.11.006

Dong, B., Wang, Z., Arnold, L., Song, Y., Wang, H. J., & Ma, J. (2016). The association between blood pressure and grip strength in adolescents: does body mass index matter? *Hypertension Research, 39*(12), 919-925. https://doi.org/10.1038/hr.2016.84

Demmer, D. L., Beilin, L. J., Hands, B., Burrows, S., Cox, K. L., Straker, L. M., & Mori, T. A. (2016). Effects of muscle strength and endurance on blood pressure and related cardiometabolic risk factors from childhood to adolescence. *Journal of hypertension, 34*(12), 2365-2375. https://doi.org/10.1097/hjh.0000000000001116

Zhang, R., Li, C., Liu, T., Zheng, L., & Li, S. (2018). Handgrip strength and blood pressure in children and adolescents: evidence from NHANES 2011 to 2014. *American Journal of Hypertension, 31*(7), 792-796. https://doi.org/10.1093/ajh/hpy032

American College of Sports Medicine. (2005). *Health-related physical ftnessassessment manual.* Baltimore: Lippincott Williams and Wilkins. https://www.acsm.org/education-resources/books/ACSMs-Fitness-Assessment-Manual

Heyward, V. H. (2006). *Advanced fitness assessment and exercise prescription.* 5th ed. Champaign: Human Kinetics Publishers. https://doi.org/10.1097/00008483-199211000-00020

Christofaro, D. G. D., Fernandes, R. A., Gerage, A. M., Alves, M. J., Polito, M. D., & Oliveira, A. R. D. (2009). Validation of the Omron HEM 742 blood pressure monitoring device in adolescents. *Arquivos brasileiros de cardiologia,* 92, 10-15. https://doi.org/10.1590/s0066-782x2009000100003

Haidar, S. G., Kumar, D., Bassi, R. S., & Deshmukh, S. C. (2004). Average versus maximum grip strength: which is more consistent. *Journal of Hand Surgery, 29*(1), 82-84. https://doi.org/10.1016/j.jhsb.2003.09.012

Artero, E. G., Lee, D. C., Lavie, C. J., España-Romero, V., Sui, X., Church, T. S., & Blair, S. N. (2012). Effects of muscular strength on cardiovascular risk factors and prognosis. *Journal of cardiopulmonary rehabilitation and prevention, 32*(6), 351. https://doi.org/10.1097/hcr.0b013e3182642688

Lin, X., Zhang, X., Guo, J., Roberts, C. K., McKenzie, S., Wu, W. C., ... & Song, Y. (2015). Effects of exercise training on cardiorespiratory fitness and biomarkers of cardiometabolic health: a systematic review and meta-analysis of randomized controlled trials. *Journal of the American heart association, 4*(7), e002014. https://doi.org/10.1161/jaha.115.002014

Kawamoto, R., Ninomiya, D., Kasai, Y., Kusunoki, T., Ohtsuka, N., Kumagi, T., & Abe, M. (2016). Handgrip strength is associated with metabolic syndrome among middle-aged and elderly community-dwelling persons. *Clinical and Experimental Hypertension, 38*(2), 245-251. https://doi.org/10.3109/10641963.2015.1081232

Ortega, F. B., Leskošek, B., Blagus, R., Gil-Cosano, J. J., Mäestu, J., Tomkinson, G., Ruiz, J. R., Mäestu, E., Starc, G., Milanovic, I., Tammelin, T. H., Sorić, M., Scheuer, C., Carraro, A., Kaj, M., Csányi, T., Sardinha, L. B., Lenoir, M., Emeljanovas, A., … HELENA and IDEFICS consortia. (2022). European Fitness Landscape in Children and Adolescents: Updated reference values, fitness maps, and country rankings based on nearly 8 million data points from 34 countries gathered by the FitBack network [Preprint]. *Sports Medicine.* https://doi.org/10.1101/2022.06.09.22275139

Lurbe, E. (2003). Childhood blood pressure: a window to adult hypertension. *Journal of hypertension, 21*(11), 2001-2003. https://doi.org/10.1097/00004872-200311000-00004

Lawlor, D. A., & Smith, G. D. (2005). Early life determinants of adult blood pressure. *Current opinion in nephrology and hypertension, 14*(3), 259-264. https://doi.org/10.1097/01.mnh.0000165893.13620.2b

Lurbe, E., Cifkova, R., Cruickshank, J. K., Dillon, M. J., Ferreira, I., Invitti, C., ... & Zanchetti, A. (2009). Management of high blood pressure in children and adolescents: recommendations of the European Society of Hypertension. *Journal of hypertension, 27*(9), 1719-1742. https://doi.org/10.1097/hjh.0b013e32832f4f6b

Mainous III, A. G., Tanner, R. J., Anton, S. D., & Jo, A. (2015). Grip strength as a marker of hypertension and diabetes in healthy weight adults. *American journal of preventive medicine, 49*(6), 850-858. https://doi.org/10.1016/j.amepre.2015.05.025

García-Hermoso, A., Saavedra, J. M., & Escalante, Y. (2013). Effects of exercise on resting blood pressure in obese children: a meta-analysis of randomized controlled trials. *Obesity reviews, 14*(11), 919-928. https://doi.org/10.1111/obr.12054

National High Blood Pressure Education Program Working Group on High Blood Pressure in Children and Adolescents. (2004). The fourth report on the diagnosis, evaluation, and treatment of high blood pressure in children and adolescents. *Pediatrics, 114*(S 2), 555-576. https://doi.org/10.1542/peds.114.s2.555

Daskalopoulou, S. S., Rabi, D. M., Zarnke, K. B., Dasgupta, K., Nerenberg, K., Cloutier, L., ... & Canadian Hypertension Education Program. (2015). The 2015 Canadian Hypertension Education Program recommendations for blood pressure measurement, diagnosis, assessment of risk, prevention, and treatment of hypertension. *Canadian Journal of Cardiology, 31*(5), 549-568. https://doi.org/10.1016/j.cjca.2016.02.075

Wind, A. E., Takken, T., Helders, P. J., & Engelbert, R. H. (2010). Is grip strength a predictor for total muscle strength in healthy children, adolescents, and young adults. *European journal of pediatrics, 169*(3), 281-287. https://doi.org/10.1007/s00431-009-1010-4

Kim, H. J., Lee, K. J., Jeon, Y. J., Ahn, M. B., Jung, I. A., Kim, S. H., ... & Suh, B. K. (2016). Relationships of physical fitness and obesity with metabolic risk factors in children and adolescents: Chungju city cohort study. *Annals of pediatric endocrinology & metabolism, 21*(1), 31. https://doi.org/10.6065/apem.2016.21.1.31

ЗВ'ЯЗОК МІЖ АРТЕРІАЛЬНИМ ТИСКОМ І ДИНАМІЧНОЮ СИЛОЮ КИСТІ В ДІТЕЙ

Гентіана Бека Ахметі[1ABCDE], Беснік Моріна[1ABCDE], Георгі Георгієв[2ABCDE], Серьожа Гонтарев[2ABCDE]

Приштинський університет
Кирило-Мефодіївський університет в Скоп'є

Авторський вклад: A – дизайн дослідження; B – збір даних; C – статаналіз; D – підготовка рукопису; E – збір коштів

Реферат. Стаття: 7 с., 3 табл., 1 рис., 35 джерел.

Історія питання. У дослідженнях, які були завершені раніше, було заявлено, що динамічна сила кисті як вимірювання для оцінки підготовленості м'язів пов'язана з факторами ризику серцево-судинних захворювань. Проте зв'язок динамічної сили кисті з артеріальним тиском у дітей суперечливий. Тому ми провели це дослідження з метою встановити зв'язок динамічної сили кисті з артеріальним тиском у македонських дітей із регіону Скоп'є.

Матеріали та методи. Дослідження проводили на вибірці з 1076 дітей (534 хлопчики та 542 дівчинки), за допомогою яких вимірювали такі характеристики: артеріальний тиск, динамічна сила кисті, вага, зріст, відсоток жиру в організмі, окружність талії та розраховували індекс маси тіла (ІМТ). Для вивчення зв'язку між динамічною силою кисті та вихідними змінними використовували загальні лінійні моделі.

Результати. Після узгодження віку, статі, ІМТ, відсотка жиру в організмі та окружності талії динамічна сила кисті була статистично значущо позитивно пов'язана як із систолічним ($p<0,0001$), так і з діастолічним ($p=0,02$) артеріальним тиском. Спостерігався тренд до зростання систолічного артеріального тиску, оскільки динамічна сила кисті збільшувалася від нижнього квартиля до верхнього квартиля з різницею 3,7 мм рт.ст. між верхнім і нижнім квартилем (p для тренда = 0,03). У цьому дослідженні не було встановлено статистично значущого тренда діастолічного артеріального тиску, оскільки динамічна сила кисті зростає від нижнього квартиля до верхнього квартиля (p для тренда = 0,09).

Висновки. Підготовленість м'язів позитивно корелює з артеріальним тиском в учасників. Наслідки та основні механізми цих результатів потребують подальших досліджень.

Ключові слова: гіпертонія, діти, сила м'язів, індекс маси тіла.

Information about the authors:

Ahmeti, Gentiana Beqa: gentiana.beqa@uni-pr.edu; https://orcid.org/0000-0001-7727-1827; Faculty of Physical Education and Sport, University of Pristina, Industrial Zone, Pristina, 10000, Kosovo

Morina, Besnik: besnik.morina@uni-pr.edu; https://orcid.org/0000-0001-7554-799X; Faculty of Physical Education and Sport, University of Pristina, Industrial Zone, Pristina, 10000, Kosovo

Georgiev, Georgi: georgigeorgiev63@yahoo.com; https://orcid.org/0000-0002-1748-9477; Faculty of Physical Education, Sport and Health, Ss. Cyril and Methodius University in Skopje, Dimce Mircev, 3, Skopje, 1000, Republic of North Macedonia

Gontarev, Seryozha: gontarevserjoza@gmail.com; https://orcid.org/0000-0001-5873-2974; Faculty of Physical Education, Sport and Health, Ss. Cyril and Methodius University in Skopje, Dimce Mircev, 3, Skopje, 1000, Republic of North Macedonia

Cite this article as: Ahmeti, G.B., Morina, B., Georgiev, G., & Gontarev, S. (2023). The Relations Between Blood Pressure and Handgrip Strength in Children. *Physical Education Theory and Methodology, 23*(2), 207-213. https://doi.org/10.17309/tmfv.2023.2.08

Received: 09.12.2022. Accepted: 18.02.2023. Published: 28.04.2023; Retracted: August 30, 2023

Retraction Note

The Editors have retracted the following article:

Ahmeti, G. B., Morina, B., Georgiev, G., & Gontarev, S. (2023). The Relations Between Blood Pressure and Handgrip Strength in Children. Physical Education Theory and Methodology, 23(2), 207–213. https://doi.org/10.17309/tmfv.2023.2.08

Following the publication of the article, the Organizata për Rritjen e Tälätsë në Arsim – ORCA contacted the journal. Upon editorial follow-up, similarities were noted between this article and a previous publication by another group ("Handgrip Strength and Blood Pressure in Children and Adolescents: Evidence From NHANES 2011 to 2014", published in the American Journal of Hypertension in 2018, by Zhang, R., Li, C., Liu, T., Zheng, L., & Li, S.). Considering these issues, the Editors retract this article. The authors don't agree with the retraction.

We have been informed in our decision-making by our policy on publishing ethics and COPE guidelines.

The retracted article will remain online to maintain the scholarly record, but it will be digitally watermarked on each page as "Retracted".

Теорія та методика фізичного виховання
Physical Education Theory and Methodology
Teorìâ ta Metodika Fìzičnogo Vihovannâ

ISSN 1993-7989 (print)
ISSN 1993-7997 (online)
ISSN-L 1993-7989

ORIGINAL SCIENTIFIC ARTICLE

ISOLATED AND COMBINED EFFECT OF STRENGTH TRAINING AND SPECIFIC STRENGTH TRAINING ON PERFORMANCE LEVELS AMONG ARCHERS

Arun Kumar Chatla[1ABCD], K Venkata Narasimha Rao[2ABC], Deepak Pandey[1ABC], Laishram Shila Devi[1AB] and Vaddepalley Satyanarayana[3ABC]

[1]Lovely Professional University
[2]Central University of Odisha
[3]Osmania University

Authors' Contribution: A – Study design; B – Data collection; C – Statistical analysis; D – Manuscript Preparation; E – Funds Collection

Corresponding Author: Arun Kumar Chatla, Email: arunkumarchatla@gmail.com
Accepted for Publication: March 18, 2023
Published: April 28, 2023

DOI: 10.17309/tmfv.2023.2.09

Abstract

Study purpose. The purpose of the study was to find out the impact of isolated and combined effect of Specific Strength Training, Strength Training, and Combined Strength Training on the performance levels among archers.

Materials and methods. Quantitative research study and non-random sampling method used for the study, a total of sixty (N=60) archers from various archery academies across India aged between 20.5±3.8 years were divided into four groups – Control Group (CG), Specific Strength Training Group (SSTG), Strength Training Group (STG) and Combined Strength Training Group (CTG) received 12 weeks of training schedule. SSTG & STG received alternate days/week where as CTG received alternate days of strength and specific training schedule.

Results. The results of the data were analysed using Analysis of Covariance (ANCOVA) followed by Bonferroni post hoc test and showed that the implementation of training methods significantly impacted the scoring performance index among the archer groups (SST<0.05, ST<0.05 and CT<0.05). The combined training group achieved highest performance index following strength training and specific strength training. However, no significant improvement in scoring performance index was found in the control group.

Conclusions. This research is an evidence that combination of training with shooting is necessary for improving the performance index among archers.

Keywords: isolated, combined, specific strength training, strength training, combined training.

Introduction

Archery is an individual recreational and competitive sport involves Power, Strength, Strength Endurance and Stability among the competing archers. In Archery mostly the upper body muscles were involved which are generally muscles recruiting Shoulder girdle (Mann & Littke, 1989) and arm muscles such as rhomboids, Trapezius, Deltoid, biceps, triceps etc. During shooting process, the archer has to hold the bow with his one arm extended towards the target which is then statically held by maintaining the force where in the string is pulled towards the reference point dynamically loading the strength through the back muscles and maintaining the force until the arrow is released dynamically executed by the draw arm/other arm (Leroyer, Van Hoecke, & Helal, 1993).

The archery shot cycle classified into eleven basic steps which indulges extreme muscular contraction and exhaustion due to repeated shot cycle execution during shooting. During this rigorous shooting archer generally experiences high static tremors as the number of arrows shot in a session increases due to the increased muscular force utilization with the decreased muscular strength and endurance of the specified group of muscles (Laishram, Kumar, & Sandhu, 2008; Satti, Mohan, & Chatla, 2022). The important pre requisite for an archer to develop is the strength, strength endurance, power and stability among the upper arm muscles.

Strength is one of the component which plays vital role in the performance of an archer (Sharma, Singh, & Singh, 2015). The strength of the arm muscles helps in preventing the tremors during the aiming process and also helps in de-

laying & overcoming the fatigue developed the repetitive shot process (Laishram, Kumar, & Sandhu, 2008; Lin, et al., 2010). Strength also plays vital role in the control of bow during the draw, hold & aiming phases of the shot cycle. The successful application of the forces and its distribution among the arms results in the success of an archer's performance (Lin et al., 2010). Resistance training in recent years had become one of the pre requisite for the development of general fitness, specific fitness and athletic conditional ability (Fleck & Kraemer, 1997). The sport specific resistance training should be an integral component for sport preparation which targets through the direct enhancement of specific muscular strength also facilitates improvement in sporting performance of specified sport (Syahputra & Pelana, 2021; Devi, Chatla, Pandey, Kaur, & Devi, 2022). The second important component of which performance of an archer determines is the Strength endurance (Ertan, Kentel, & Tümer, 2003; Landers et al., 1994; Lin et al., 2010). Strength endurance is the ability of an archer to perform shooting under the conditions of fatigue. Repetitive and greater volume of shooting of arrows increases the endurance of an archer there by delaying the onset of fatigue. Strength endurance also plays vital role in increasing the fatigue resistance of recruiting muscles which helps in the performance (Lin et al., 2010; Prasetyo & Siswantoyo, 2018).

Plyometric exercises which helps in the development of power ability among the recruiting muscles, this type of exercises employs quick action involving powerful movement of the muscle with stretch followed by concentric shortening muscular cycle (Ahmad et al., 2013; Dhawale et al., 2018). The major muscles which are used in archery for the initial outburst of power ability are the triceps, biceps, trapezius and posterior deltoid muscles (Ertan, Kentel, & Tümer, 2003). The plyometric exercises are adapted into the archer in order to prevent acute or chronic injuries development as archery is generally considered as the closed kinetic chain movement for repetitive use of the same muscles for the activity (Chelly et al., 2014; Lin, et al., 2010).

Stability is one of the key pre requisite variable for the consistency and reliability of the scores in archery. The stability involves the postural, core and upper body stability which can be observed for the consistency in shooting. The postural & core stability plays vital role in shot cycle execution with accuracy & elite performance. During the shot cycle in archery, one arm exerts dynamic pulling of the bowstring towards the reference point by flexing the elbow, the other arm pushes the bow with extended elbow position to the target, along with being statically held the position in the direction of target until release of arrow from the bow window. When archers draw the bow and aim at the target, they try to maintain stability at the highest level possible by minimizing tremors while maintaining a still posture of the trunk and arms.

Considering the simultaneous prospective of strength, endurance, stability and power coupling with the shooting consistency and rhythmical ability, the study focussed on the isolated and combined effect of strength training and specific strength training on the shooting ability.

Materials and methods

Participants

A total of sixty (N=60) archers including both male and female, aged between 20.5±3.8 years were recruited from various parts of India (Telangana, Andhra Pradesh, Karnataka, Tamil Nadu) for the study. The archers were reported for not having any acute and chronic pathological conditions for 6 months prior to the conduct of the study. Archers observed to be in the specific discipline (Recurve or Compound event) of their training for at least 3 years before shortlisting. Archers were both from recurve and compound divisions with medallists or participation at national level tournaments were recruited.

Study design

All the procedures performed under the study was in accordance with the Ethical Standards laid down by the Institutional Human Ethical committee. The research protocol was approved by the Institutional Ethics Committee for Biomedical Research (Institute of Genetics and Hospital for Genetic Diseases, Osmania University, O.No: 28/IEC/IOG/OU/18 dated: 05-02-2018). Archers training at different archery academies across India along with their coaches were approached and written consent form was taken from them explaining the aims and objectives of the research study. Archers who are willing to participate were segregated into four groups i.e., Control Group {CG} (n=15), Strength Training Group {STG} (n=15), Specific Strength Training Group {SSTG} (n=15) and Combined Training Group {CTG} (n=15). The Archers underwent 12 weeks of training schedule with Strength Training and Specific Strength Training Groups received alternate days of training viz., in Table 1, 2. The Combined Training group received alternate days of strength and specific strength training wherein the control group underwent their routine training schedule under Fig. 1. The data was obtained using data collection sheet at the beginning and the end of sessions their performance was assessed and reported.

Study setting

The study setting of different groups were conducted at four private academies run by NIS qualified Coaches. Initially one-week work shop was made mandatory for incorporation and inoculation of the training methodology for the respective coaches and strength training experts supervising the archers. The coaches & strength training experts were randomly assigned with the training schedule and were periodically supervised by the research investigator for appropriate information transfer and training modification. Initially before adaptation of training schedule the scoring of 72 arrows at 70-meter distance for recurve on standard 122 centimetres target face and compound division 50-meter distance on standard 80 centimetres target face with minimum score of 5 points was recorded accordance with the world archery rule. The scores of 72 arrows were recorded periodically before training and end of training programme i.e., after 12 weeks. The scores were collected at their regular practice venue and were evaluated. The technical and tactical training of the coaches remained unchanged.

Statistical analysis

The statistical analysis of the results was analysed based on SPSS software (version 21.0: SPSS Inc, Chicago, Illinois,

Table 1. 12-weeks Strength Training Schedule for archers

Type	Strength Training Group (Monday, Wednesday and Friday)		
	Week 1-4	**Week 5-8**	**Week 9-12**
Warmup (15 min)	Cardio endurance (8 min) Dynamic Stretching (7 min)	Cardio endurance (8 min) Dynamic Stretching (7 min)	Cardio endurance (8 min) Dynamic Stretching (7 min)
Strength Training (45 min) Initially 1 RM of each archer is determined - resistance for both Lower & Upper body 50-70% of 1 RM			
Lower Body: (15 min) {8-10 Reps X 3 sets} 1. Quadriceps 2. Glute Muscles 3. Calf Muscle 4. Hamstring Muscles	1. Goblet Squats with Fixed or Varied Resist. 2. Hip Hinge with Varied Resist. 3. Calf Raise with fixed Resist.	1. Smith varied Resistance Squats. 2. Dead Lifts with varied resist. 3. Calf Raise with varied Resist	1. Smith varied Resistance Squats. 2. Dead Lifts with varied resist. 3. Calf Raise with varied Resist.
Upper Body: (20 Min) {10-12 Reps X 3 Sets} 1. Posterior Deltoid, Latissimus Dorsi, Triceps 2. Anterior Deltoid, Trapezius, Pectoralis Major, Biceps 3. Lateral Deltoid and Supraspinatus	1. Rowing machine with Fixed or Varied Resistance 2. Push ups with Varied Elbow Position 3. Lateral Rises with varied Resistance	1. Bent over Rowing with Fixed or Varied Resist. dumbbells Rare Deltoid Flies 2. Resistance Push ups with Varied Elbow Position. Front Raises with Resistance 3. lateral Raises with varied resistance	1. Bent over Rowing with Fixed or Varied Resist. Barbell Inclined French press Rare Deltoid Flies 2. Chest press machine with varied resistance. Front Raises with Resistance Bicep curls 3. lateral Raises with varied resistance
Lower Back & Core Group: (10 Min) {8-10 Reps X 3 Sets} 1. Rectus abdominis 2. External oblique, Internal oblique, transverse abdominis 3. Longissimus and Quadratus Lumborum	1. Plank hold 2. Abdominal Crunches 3. Leg Raises 4. Side Planks 5. Flying Pose on abdomen	1. Abdominal V Hold 2. Abdominal Crunches 3. Flying Pose on abdomen 4. Side Plank with one complete arm extended and other folded at elbow.	1. Abdominal V Hold 2. Abdominal Crunches 3. Flying Pose on abdomen 4. Side Plank with one complete arm extended and other folded at elbow
Cool-down	Static Stretches from toe to head is followed by holding the pose for 5 seconds		

Table 2. 12-weeks of Specific Strength Training Schedule for archers

Type	Specific Strength Training (Tuesday, Thursday and Saturday)		
	1-4 Weeks	**5-8 weeks**	**8-12 Weeks**
With Bow (30 min)	1. Thera band Exercises: Both the hands Half Draw hold – (8-10 Reps × 3 Sets) Full Draw Hold – (8-10 Reps × 3 Sets) Over Draw Hold – (8-10 Reps × 3 Sets) Backwards Draw hold – (8-10 Reps × 3 Sets)	1. One Hand Bow Holding – different positions {target, overhead} – (8-10 Reps × 2 Sets) 2. Half Draw hold for 45 seconds – (6 Reps × Sets) 3. Full Draw hold for 60 seconds – (6 Reps × 2 sets) shift the balance from one leg to other front, back, sideways 4. Over draw and hold for 45 seconds – (6 Reps × 2 sets) 5. Pulling Backwards – (6 Reps × 2 Sets)	1. One Hand Bow Holding – different positions {target, overhead} – (8-10 Reps × 3 Sets) 2. Half Draw hold for 45 seconds – (8 Reps × 3 Sets) 3. Full Draw hold for 60 seconds – (8 Reps × 3 sets) shift the balance from one leg to other front, back, sideways 4. Over draw and hold for 45 seconds – (8 Reps × 3 sets) 5. Pulling Backwards – (8 Reps × 3 Sets)
Without Bow (20 min)	1. Static Strap – the strap length maintained at 80% of draw length of specified archer – hold for 15 seconds (4 Reps × 2 Sets) 2. Single arm hold – Side Plank with one complete arm extended and other folded at elbow – Started with Bow Arm for 2 min hold and other arm with 1 min hold	1. Static Strap – the strap length maintained at 80% of draw length of specified archer – hold for 30 seconds (6 Reps × 2 Sets) 2. Single arm hold – Side Plank with one complete arm extended and other folded at elbow – Started with Bow Arm for 3 min hold and other arm with 1.5 min hold	1. Static Strap – the strap length maintained at 80% of draw length of specified archer – hold for 30 seconds (8 Reps × 3 Sets) 2. Single arm hold – Side Plank with one complete arm extended and other folded at elbow – Started with Bow Arm for 4 min hold and other arm with 2 min hold
Cooling Down (15 min)	Static Stretches from toe to head is followed by holding the pose for 5 seconds followed by Partner stretching for complete relaxation		

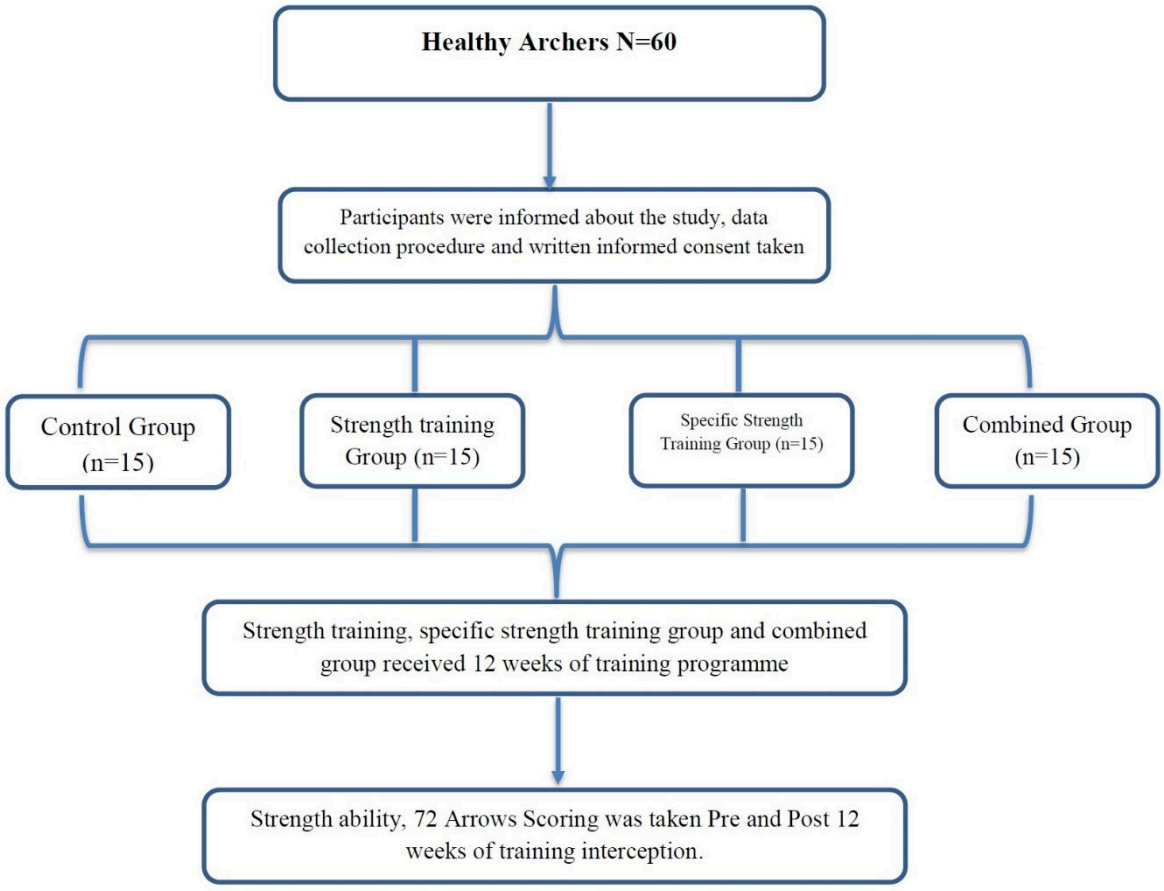


Fig 1. Schematic Representation of Research Protocol

USA). The data was presented on Mean ± Standard Deviation. The results were statistically analysed through paired t test to determine the effect of the training schedule on the performance ability and ANOVA followed by Bonferroni Post hoc test was adapted to differentiate among the groups with the level of significance was fixed at 0.05 level.

Results

The data of pre-test and post-test were arranged and tabulated for further treatment. For the research investigation, the researcher divided the players into four groups. For testing the significance effect of strength training, specific strength training and combined training on the scoring ability of archers (t) test was employed to determine the difference between in the performance between pre-test and post-test means of each group which was presented in the following Table 3. Significant at 0.05 level of confidence.

From table 3 is clearly stated that, the obtained t test values 12.243, 12.866 and 16.725 of Specific Strength Training Group, Strength training group and combined training group respectively, were greater than the table value 2.45 at 0.05, whereas the control group t test value 1.24 is less than the table value. Thus SSTG, STG and Combined training group had significantly effects the shooting/scoring ability among archers.

Assessing the major impact of the training methods on the scoring/shooting performance index Analysis of Co-variance was employed with Bonferroni post hoc test.

Table 4 indicated that the F ratio value was 111.512 greater than table value 2.758 with df. 3 and 55 at 0.05 level. Thus result of the study indicated that there was significant difference exist among the adjusted post-test means of Control group, Specific Strength Training Group, Strength Training Group and Combined training group on the scoring/shooting ability among archers.

Table 3. Mean, standard deviation and dependent 't' test for the pre and post test on shooting ability among control group, Specific Strength Training Group, Strength training group and combined training group

Test	Control Group	SSTG	STG	CTG
Pre Test (mean ± SD)	531.20 ± 14.958	535.33 ± 12.965	533.44 ± 7.04	536.13 ± 8.68
Post Test (mean ± SD)	537.27 ± 9.896	557.93 ± 10.068	568.35 ± 8.62	591.60 ± 10.49
Paired t-test	1.24	12.243	12.866	16.725

Table t-value = 2.45

Table 4. Analysis of Covariance on shooting/scoring ability among Control Group, Specific Strength Training Group, Strength Training Group and Combined Training Group

Group	Pre Test	Post Test	Adj. Post	Source	Sum SS	Df	Mean SS	F	P Value
CG	531.20 ± 14.958	537.27 ± 9.896	532.635	Between	25772.971	3	8590.990	111.512	0.0001
SSTG	535.33 ± 12.965	557.93 ± 10.068	557.385						
STG	533.44 ± 7.04	568.35 ± 8.62	569.10	With in	4237.244	55	77.041		
CG	536.13 ± 8.68	591.60 ± 10.49	590.68						

Significant at 0.05 level of confidence

Table 5. p-value of Adjusted Post Mean difference and p-values among Control Group, Specific Strength Training Group, Strength Training Group and Combined Training Group with Bonferroni Correction α value at 0.00833

Adjusted Post Test Mean				Mean Difference	P Value	Bonferroni correction α-Value
CG	SSTG	STG	CTG			
532.635	557.385	–	–	24.75	0.00015	0.00833
532.635	–	569.10	–	36.465	0.0001	
532.635	–	–	590.68	58.045	0.00001	
–	557.385	569.10	–	11.715	0.0034	
–	557.385	–	590.68	33.295	0.0001	
–	–	569.10	590.68	21.58	0.00012	

Significant at 0.05 level of confidence

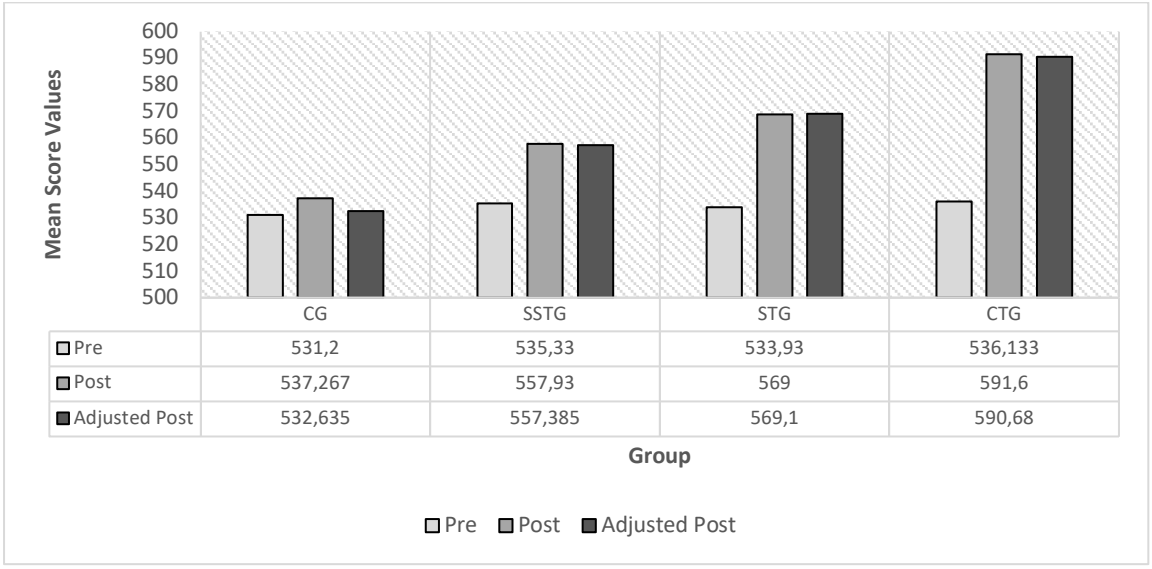


Fig 2. Pre, Post and Adjusted post mean Score values of Control Group, Specific Strength Training Group, Strength Training Group and Combined Training Group

The p-values of adjusted post-test mean difference among the Control Group, Specific Strength Training Group, Strength Training Group and Combined Training Group were significantly less than Bonferroni corrected α-value at 0.00833 indicated that there is a significant difference exists through the training methods on the scoring ability among archers under table 5.

Discussions

The present study aimed at to find out the effect of isolated and combined effect of Strength Training and Specific Strength Training on the performance levels among archers. The main research findings of the study suggested that there was significant change in scoring ability among all the subjects of various experimental groups such as Specific Strength Training Group, Strength training group and Combined Training Group under research protocol which was carried out for period of 12 weeks of innervation and its impact on the performance levels of archers with that of control group. This suggests that there is a significant impact of training methods among the three groups SSTF, STG and CTG.

The results conform with the findings of (Sharma, Singh, & Singh, 2015) have studied on the effect of 6 weeks training

on the development of static strength among archery players. Dhawale, Yeole and Jedhe (2018) also found out the effect of upper extremities plyometric training on strength and accuracy among performance levels of archery players. Whereas (Humaid, 2014) had investigated that the impact of Arm muscle strength, Draw length and technique on the Achievement levels among archers. The above research studies indicated that there is significant impact on the performance index through strength training.

Lin et al. (2010) signified the importance of muscles used in the archery are of the shoulders and upper back such as rhomboids, levator scapulae, trapezius, deltoid (Anterior, posterior and lateral), latissimus dorsi and the most important stabilizer rotator cuff muscles (supraspinatus, infraspinatus, teres minor and subscapularis). As there is a need of maintaining a proper stability during archery shooting, muscles belonging to the upper extremities are the utmost responsible and should be activated contrary with the lower extremities (Ertan, 2009). These upper muscles help to push, pull and hold the bow until the arrow is released from the bow window till it hits the specified target where in muscles remain in the activated form. Laishram, Kumar, and Sandhu (2008) and his associates studied the effect of strength training among the upper extremities targets the building of strength among major muscles such as Trapezius, Pectoralis major, biceps, triceps, deltoid and stabilizers such as rotator cuff muscles ensures the prevention of tremors and stability during shooting and consistency of scores among archers.

Conclusion

The principle conclusion based on the current research study shows the implementation of strength and specific strength training can progressively improve the performance index of archers. It was also signified that Combined Strength Training had greater impact on the performance index among archers. The findings of this study could potentially be applied for future studies extrapolating with the yogic practices.

Acknowledgement

We express our gratitude to those who have provided support for this research activity.

Conflict of Interest

No conflict of interest.

References

Mann, D. L., & Littke, N. (1989). Shoulder injuries in archery. *Canadian journal of sport sciences, Journal canadien des sciences du sport, 14*(2), 85-92.

Leroyer, P., Van Hoecke, J., & Helal, J. N. (1993). Biomechanical study of the final push-pull in archery. *Journal of Sports Sciences, 11*(1), 63-69. https://doi.org/10.1080/02640419308729965

Laishram, D., Kumar, R., & Sandhu, J. S. (2008). Effects of Strength Training and Jatamansi on reducing Hand Tremor amongst archers. *Archivos Venezolanos de Farmacología y Terapéutica, 27*(2), 105-109.

Satti, A., Mohan, N. V., & Chatla, A. K. (2022). Assessment of yoga techniques on physical and psychological status of middle-aged people. *Journal of Pharmaceutical Negative Results,* 401-407.

Sharma, H. S., Singh, N. S., & Singh, T. B. (2015). Effectiveness of six weeks training on static strength of archery players. *International Journal of Physical Education, Sports and Health,* 12, 2-13809.

Lin, J. J., Hung, C. J., Yang, C. C., Chen, H. Y., Chou, F. C., & Lu, T. W. (2010). Activation and tremor of the shoulder muscles to the demands of an archery task. *Journal of sports sciences, 28*(4), 415-421. https://doi.org/10.1080/02640410903536434

Fleck, S. J., & Kraemer, W. J. (1997). *Designing resistance-training programs.* Champaign, Illinois: Human kinetics.

Syahputra, D. S., & Pelana, R. (2021). Development of resistance-based archery training models for athletes aged 13-15 years. *Gladi: Jurnal Ilmu Keolahragaan, 12*(05), 412-425. https://doi.org/10.21009/gjik.125.08

Devi, L. S., Chatla, A. K., Pandey, D., Kaur, G., & Devi, S. S. (2022). Effect of yoga and self-myofascial release on flexibility and leg muscle explosive power among men football players. *Journal of Pharmaceutical Negative Results,* 426-430.

Ertan, H., Kentel, B., & Tümer, S. (2003). Activation patterns in forearm muscles during archery shooting. *Human movement science, 22*(1), 37-45. https://doi.org/10.1016/s0167-9457(02)00176-8

Landers, D. M., Han, M., Salazar, W., & Petruzzello, S. J. (1994). Effects of learning on electroencephalographic and electrocardiographic patterns in novice archers. *International Journal of Sport Psychology*.

Prasetyo, M., & Siswantoyo, M. (2018). Holding Bow Digital Test for Strength and Endurance Arm Muscles of Archery. *In 2nd Yogyakarta International Seminar on Health, Physical Education, and Sport Science and 1st Conference on Int*. https://doi.org/10.2991/yishpess-cois-18.2018.103

Ahmad, Z., Taha, Z., Johari, N., & Kadirgama (2013). Biomechanics measurements in archery. *International Conference on Mechanical Engineering Research, 1*(3).

Dhawale, T., Yeole, U., & Jedhe, V. (2018). Effect of Upper Extremity Plyometric Training on Strength and Accuracy in Archery Players. *Journal of Medical Science and Clinical Research, 6*(12), 143-147. https://doi.org/10.18535/jmscr/v6i12.22

Chelly, M., Hermassi, S., Aouadi, R., & Shephard, R. (2014). Effects of 8-week in-season plyometric training on upper and lower limb performance of elite adolescent handball players. *Journal of Strength & Conditioning Research, 28*(5), 1401-1410. https://doi.org/10.1519/jsc.0000000000000279

Humaid, H. (2014). Influence of arm muscle strength, draw length and archery technique on archery achievement. *Asian Social Science, 10*(5), 28. https://doi.org/10.5539/ass.v10n5p28

Ertan, H. (2009). Muscular activation patterns of the bow arm in recurve archery. *Journal of Science and Medicine in Sport, 12*(3), 357-360. https://doi.org/10.1016/j.jsams.2008.01.003

ОКРЕМИЙ І КОМБІНОВАНИЙ ВПЛИВ СИЛОВИХ ТРЕНУВАНЬ І СПЕЦІАЛЬНИХ СИЛОВИХ ТРЕНУВАНЬ НА РІВНІ ПОКАЗНИКІВ ЛУЧНИКІВ

Арун Кумар Чатла[1ABCD], К. Венката Нарасімха Рао[2ABC], Панді Діпак[1ABC], Лайшрам Шила Деві[1ABC], Ваддепалле Сатьянараяна[3ABC]

[1]Прекрасний професійний університет
[2]Центральний університет Одіша
[3]Османський університет

Авторський вклад: A – дизайн дослідження; B – збір даних; C – статаналіз; D – підготовка рукопису; E – збір коштів

Реферат. Стаття: 7 с., 5 табл., 2 рис., 17 джерел.

Мета дослідження. Метою дослідження було з'ясувати вплив окремого та комбінованого ефекту спеціальних силових тренувань, силових тренувань і комбінованих силових тренувань на рівні показників лучників.

Матеріали та методи. У дослідженні використовували кількісне дослідження та метод невипадкової вибірки, загалом шістдесят (N=60) лучників із різних академій стрільби з лука з усіх регіонів Індії віком 20,5±3,8 років розподілили на чотири групи: контрольна група (КГ), група спеціальних силових тренувань (ГССТ), група силових тренувань (ГСТ) і група комбінованих силових тренувань (ГКТ), і вони отримали 12-тижневий розклад тренувань. ГССТ та ГСТ отримували почергові дні/тиждень, тоді як ГКСТ отримала почергові дні графіка силових тренувань і спеціальних тренувань.

Результати. Результати даних були проаналізовані за допомогою коваріаційного аналізу (ANCOVA) з наступним апостеріорним критерієм Бонферроні та показали, що впровадження методів тренування статистично значущо вплинуло на індекс результативності в групах лучників (ССТ<0,05, СТ<0,05 та КТ<0,05). Група комбінованих тренувань досягла найвищого індексу результативності після силових тренувань і спеціальних силових тренувань. Проте в контрольній групі статистично значущого покращення індексу результативності не виявлено.

Висновки. Це дослідження є доказом того, що поєднання тренувань зі стрільбою є необхідним для покращення індексу результативності лучників.

Ключові слова: окремий, комбінований, спеціальні силові тренування, силові тренування, комбіновані тренування.

Information about the authors:

Chatla, Arun Kumar: arun.28151@lpu.co.in; https://orcid.org/0000-0002-3808-3206; Faculty of Physical and Sports Science, Lovely Professional University, Jalandhar - Delhi, Grand Trunk Rd, Phagwara, Punjab 144001, India.

Narasimha Rao, K Venkata: kvnrao009@gmail.com; https://orcid.org/0000-0001-6699-0471; Department of Education, Central University of Odisha, NAD Post Office, Sunabeda, Odisha 763004, India.

Pandey, Deepak: deepak.28157@lpu.co.in; https://orcid.org/0000-0002-4518-4013; Faculty of Physical and Sports Science, Lovely Professional University, Jalandhar - Delhi, Grand Trunk Rd, Phagwara, Punjab 144001, India.

Devi, Laishram Shila: shila.28238@lpu.co.in; https://orcid.org/0000-0003-4081-2890; Faculty of Physical and Sports Science, Lovely Professional University, Jalandhar - Delhi, Grand Trunk Rd, Phagwara, Punjab 144001, India.

Satyanarayana, Vaddepalley: drvsndrvsn@gmail.com; https://orcid.org/0000-0002-9685-9076; Department of Physical Education, Osmania University, Amberpet, Hyderabad, Telangana 500007, India.

Cite this article as: Chatla, A. K., Narasimha Rao, K V., Pandey, D., Devi, L. S., & Satyanarayana, V. (2023). Isolated and Combined Effect of Strength Training and Specific Strength Training on Performance Levels Among Archers. *Physical Education Theory and Methodology, 23*(2), 214-220. https://doi.org/10.17309/tmfv.2023.2.09

Received: 11.01.2023. Accepted: 18.03.2023. Published: 28.04.2023

Теорія та методика фізичного виховання
Physical Education Theory and Methodology
Teorìâ ta Metodika Fizičnogo Vihovannâ

ISSN 1993-7989 (print)
ISSN 1993-7997 (online)
ISSN-L 1993-7989

ORIGINAL SCIENTIFIC ARTICLE

AEROBICS APPROACH IN TEACHING SOCIAL DANCE

T. Hadji Kasan Yashier[1ABCDE] and D. Sugador Bandraz[1BCE]

[1]Mindanao State University

Authors' Contribution: A – Study design; B – Data collection; C – Statistical analysis; D – Manuscript Preparation; E – Funds Collection

Corresponding Author: Yashier, T. Hadji Kasan, E-mail: yhkasan@msumaguindainao.edu.ph
Accepted for Publication: March 18, 2023
Published: April 28, 2023

DOI: 10.17309/tmfv.2023.2.10

Abstract

Study purpose. The aim of this study was to find out the performance, acceptability and effectiveness of teaching social dance using an aerobics approach among students.

Materials and methods. In this study, quantitative research with a descriptive-evaluative and experimental research design (ERD) was used to determine the level of dance of cha-cha and samba social dances by two groups of participants (control and experimental groups). The researcher used a total enumeration of fourth-year and third-year students taking the Bachelor in Secondary Education major in MAPEH, using traditional and aerobics approaches. The aerobics approach was used to teach the experimental group, which included nonstop disco music in cha-cha-cha and samba as well as warm-up and cool-down exercises. The same social dance was taught to the control group, which used the traditional method of counting 8 sets of beats: 1, 2, 3, 4, 5, 6, 7, 8, 6, 5, 4, 3, 2, 1. Both the traditional and aerobic approaches were taught for 40 minutes each.

Results. The findings reveal significant differences in dance performance, acceptability, and effectiveness between the control group using a traditional approach and the experimental group using an aerobics approach.

Conclusions. Aerobics is recommended in teaching social dance to facilitate better learning because it allows students to learn at their own pace and according to their own interests and needs.

Keywords: aerobics, approach, social dance, teaching, traditional.

Introduction

Despite a series of changes over time, social dancing has become a part of people's lifestyle, culture, and socialization. The appreciation for social dancing has been passed down from generation to generation. It has become a classic dance that has achieved a specific genre all its own. Despite changes in its style, it remains the most appreciated and acceptable dance ever. It has surpassed the test of time and changed the tastes and preferences of different generations (Georgios, 2018; Gilbert, 2015).

Ballroom dancing is a live activity that is affected by events and perceptive to what is happening all around it, not a world-cut off pastime. The dancing scene has been affected by changes in fashion, war, increasing interest in a certain foreign nation, pop music, more travel options, social upheavals, and the acceptance of film or television music (Malamov, 2020).

The best way to understand how dance and dance styles evolved and are still evolving across time and between cultures is to read scholarly books on the subject. The core of dance sport still consists of five Latin and five Standard dances. Couples perform each of these dances according to the required music and tempo, using proper technique as well as poise, power, floor craft, and other qualities that speak to the caliber of their dancing. The samba, cha-cha, rumba, paso doble, and jive are the five Latin dances (DanceSports Club, 2016).

According to Bubnis (2019), aerobics is currently widely popular on a global scale. Numerous fitness, exercise, and social aficionados attempt to incorporate these activities into their daily life. The interest and excitement of the dancers are maintained by uninterrupted disco music. The academic community is working toward a policy on dance exercise as part of their flag ceremony and other activities that aim to develop the healthy lifestyles and holistic well-being of students, faculty, and staff. This policy will apply to academic institutions at the elementary, secondary, and tertiary levels. Dance is also covered in the curriculum for subjects like physical education and Music Art Physical Education and Health (MAPEH), as well as during intermissions and school event competitions (Kohl & Cook, 2013).

Moreover, Patel et al. (2017) stated that aerobics is a form of physical exercise that combines rhythmic aerobic

exercise with stretching and strength training routines with the goal of improving all elements of fitness (flexibility, muscular strength, and cardio-vascular fitness). It is usually performed to music and may be practiced in a group setting led by an instructor (a fitness professional). A well-balanced aerobics class will have five components: warm-up (5-10 minutes), cardio-vascular conditioning (25-30 minutes), muscular strength and conditioning (10–15 minutes), cool-down (5-8 minutes), and stretching and flexibility (5-8 minutes).

According to the same source, aerobic gymnastics, also known as sport aerobics and competitive gymnastics, may combine complicated choreography, rhythmic gymnastics, and acrobatic gymnastics with parts of aerobics.

Teachers are essential in improving learning because they give students the chance to study in a number of ways (Mainwaring & Krasnow, 2010). The instructor creates the environment or motivational climate while presenting the content and influencing how the students comprehend and apply it. Teixeira et al. (2012) explained that in a setting that is both demanding and engaging, students learn more successfully. Students may lose interest and motivation if the lesson speed is too slow or the goals are too simple. If the goals are too challenging or the pace is too fast, students may grow worried and frustrated. The teacher's job is to strike a balance and foster a fun and stimulating environment.

Some people learn better through association, while others learn better through experimentation; some people respond well to visual simulation, while others respond well to auditory stimuli. This is why teachers should use new ways of teaching that fit the learning styles, skills, and abilities of their students in order to get their attention and get them involved (Fadare et al., 2021; Abdulrahaman et al., 2020).

Teachers can encourage the use of a variety of strategies to learn material and increase the speed and accuracy of these strategies. Finally, looking to the psychological realm, a dance class can incorporate methods to enhance self-esteem and self-efficacy. Verbal communication, body language, and tone all convey the teacher's attitude.

According to Soot and Viskus (2014), dance is an intellectual, physical, and sensorial response to world experiences, as suggested by Bannon (2010). She argues that the integration of our physical, intellectual, and emotional selves that can occur in learning dance has been advocated by many theorists and practitioners as essential to understanding the holistic benefits of education in and through dance. The pedagogical practice of dance education has, during the past few decades, changed considerably (Sööt & Leijen, 2012).

The ability to investigate, analyze, and synthesize is a must for anybody involved in dance, and knowledge of dance art as a science in general supports the development of modern dance teachers. However, a dance instructor is also a researcher in that he is concerned with the whole individual. Sims and Erwin (2012) note that all of the higher education dance instructors who took part in their study indicated that they had adopted the instructional strategies and practices of their prior instructors. To ensure that these traditions are passed down from generation to generation, it is crucial for the dance community to ensure that all dance instructors use management and teaching techniques that are both successful and efficient.

According to Salo (2019), many people who engage in dance as participants, artists, observers, and critical thinkers in contexts that are relevant to their own life gain confidence as students and as useful group members. and Risner & Stinson (2010) also identify other distinctions, along socio-cultural ones, in addition to intercultural ones.

Dance students, especially younger ones, frequently bring problems from their daily lives to class, and it is up to the instructor to either ignore them or find answers. Therefore, dance as a practice serves as rehabilitation for both the person and the community. Dance may be therapeutic, but social work's main objective cannot be seen as required. Art can be therapeutic on its own, without the help of therapy, and unintentionally solve many social issues (Risner, 2009).

The purpose of this study is to evaluate the performance, acceptability, and efficacy of teaching social dancing to fourth and third-year MAPEH students majoring in secondary education.

Materials and methods

Study participants

The researcher used a total enumeration of 60 participants of third and fourth year students taking up bachelor of secondary education major in MAPEH in Mindanao State University, Maguindanao. The participants were randomly divided into experimental and controlled group. The written permission of the participants of all to participate in this research was obtained, as well as the consent.The purpose of the research was explained and clarity were made top all participants. Subject characteristics are presented in Table 1.

Table 1. Distribution of the participants according to Group

Group	Frequency
Controlled Group	30
Experimental Group	30
Total	60

Statistical analysis

Instruments

To answer the problems formulated in the study, the data gathered was subjected to and analyzed through descriptive statistics, particularly means to determine the level of dance performance, level of acceptability, and level of effectiveness of teaching social dance through traditional and aerobics approaches. Trochim (2006) states that descriptive statistics are used to describe the basic features of the data in a study. They provide simple summaries about the sample and the measures.

In analyzing the level of dance performance, acceptability level, and level of effectiveness in teaching cha-cha-cha and samba, mean scores were used, respectively.

In analyzing the significant difference in dance performance between the controlled and experimental groups, a t-test was used.

The t-test was also used to determine whether there was a significant difference in the acceptability level of approaches.

According to Saltikov (2014), the t-test for independent means is a commonly used inferential test of the significance

of the difference between two means based on two independent, unrelated groups. These are two different groups, such as males and females, or those who received a treatment and those who did not. According, the t-test is used to determine a p-value that indicates how likely we could have gotten the result by chance if, in fact, the null hypothesis were true (i.e., no difference in the population). By convention, if there is less than a 5% chance of getting the observed differences by chance, we reject the null hypothesis and say we found a statistically significant difference between the two groups.

All statistical tools that were used in testing the hypotheses were set at a 0.05 level of significance

Data Gathering Instruments

Two different sets of research tools were used by the researcher. These were the standardized social dance evaluation criteria that had been marginally altered to suit the study.

The panel of experts utilized the modified Standardized Rubric for Evaluating Social Dance as a reference while assessing and rating the participants' performances. The rubric was created using sets of rubrics from Hanson (2008) "Learning Through the Arts". The experts were given the survey questionnaire sets, and their opinions and suggestions were taken into consideration. To find out how well aerobics can be used to teach social dance, a group of professionals who are skilled at dancing and instructing cha-cha and samba dance filled out and assessed the first set of survey questions.

Two (2) components made up the second set of survey forms that the students completed. The acceptability of teaching social dance, notably the cha-cha-cha and samba, using an aerobics approach in the experimental group is covered in part one (1). The degree of effectiveness of the aforementioned strategy is the subject of part two (2). Bias was avoided by having participants and five (5) experts judge the success of teaching social dancing. The questions were answered on a five-point Likert-style scale by the researcher. Both textual and tabular presentations of the data were made.

Results

The interpretations of the research findings are presented in this chapter. The information was gathered from the findings of an experimental study that taught social dancing to third- and fourth-year physical education students. The experimental and control groups were created by randomly dividing the groups utilizing traditional and aerobic methods.

Table 2 presents the performance level of the control group and experimental group using traditional and aerobics approaches to teaching.

Data shows that the level of dance performance in the control group with a traditional approach got a grand mean of 2.85, which is interpreted as "satisfactory". It means that the controlled group in the traditional approach

Table 2. Level of Dance Performance of Students using Traditional and Aerobics Approaches

Indicators	Mean (TA) (n1=30)	Inter pretation	Mean (AA) (n2=30)	Inter- pretation
1. Executes proper alignment and posture throughout each exercise	3.08	Satisfactory	3.77	Very satisfactory
2. Performs all exercises with proper weight distribution, performs each of the exercises with proper execution/ form/placement of the body (head, arms, torso, legs, feet),	2.93	Satisfactory	3.65	Very satisfactory
3. Performs all sequences maintaining appropriate rhythm and tempo with the music	2.99	Satisfactory	3.81	Very satisfactory
4. Maintains a high performance quality by dancing full out to the best of their abilities	2.96	Satisfactory	3.81	Very satisfactory
5. Performs all movement with a high level of technique	2.88	Satisfactory	3.80	Very satisfactory
6. Performs the combination with no memory errors, performs complete dance with lots of confidence and enthusiasm, making few errors.	2.67	Satisfactory	3.64	Very satisfactory
7. Obtain a high level of technical mastery and work with group all the time.	2.77	Satisfactory	3.71	Very satisfactory
8. The dancer demonstrates a clear sense of alignment, center control, flexibility and strength. He/she has a strong sense of musicality and the ability to assimilate	2.73	Satisfactory	3.74	Very satisfactory
9. The dancer demonstrates a high level of concentration, energy and confidence when executing movement	2.73	Satisfactory	3.61	Very satisfactory
10. Performs a dance sequence that is creative, complete and displays lots of effort and practice.	2.77	Satisfactory	3.76	Very satisfactory
Grand Mean	2.85	Satisfactory	3.73	Very satisfactory

Legend * TA – Traditional Approach AA – Aerobics Approach

satisfactorily performs in terms of execution of proper alignment and posture, weight distribution and placement of body, sequencing and maintaining appropriate tempo and rhythm with music, level of technique, quality of dancing, performing with confidence, technical mastery, sense of alignment, center control, and strength, sense of musicality, and ability to assimilate, level of concentration, energy, and confidence, and performing dance sequences creatively.

On the other hand, the level of dance performance of the experimental group employing an aerobics approach got a grand mean of 3.73, which is interpreted as "very satisfactory", including all the same indicators as mentioned above.

Acceptability of Traditional and Aerobics Approach in Teaching Social Dance

Tables 3 and 4 present the acceptability of two approaches in teaching social dance.

Table 3 above presents the acceptability level of the control group using the traditional approach to teaching social dance, which obtained an overall section mean of 3.53 and was interpreted as "highly acceptable," with all the other indicators also being highly acceptable. It signifies that the traditional approach is still highly acceptable among learners of social dance, as it meets 88–99% of expectations.

Table 4 above shows the acceptability level of aerobics approach in teaching social dance. It can be gleaned that

Table 3. Level of Acceptability of traditional approach in teaching social dance

Indicator	Mean	Interpretation
1. Using traditional counting 1,2,3,4,5,6,7,8, and counter counting 8,7,6,5,4,3,2,1 for teaching cha cha cha and samba social dance	3.67	Highly Acceptable
2. Incorporating counting in teaching social dance enhance self empowerment	3.53	Highly Acceptable
3. Age and time appropriate for the instructional Approach	3.30	Moderate Acceptable
4. Develop articulated class lesson using counting help support student differences	3.47	Highly Acceptable
5. Serving as a simple strategy to facilitate easy learning of social dance step.	3.53	Highly Acceptable
6. Serving as an approach in teaching social dance that can boost, stimulate, and sustain student's interest all throughout the class session.	3.53	Highly Acceptable
7. Feeling in control of the body and feel healthy and accept and feel curious.	3.60	Highly Acceptable
8. Serving as a strategy that eliminates student's boredom and optimizes participation in the task.	3.47	Highly Acceptable
9. Finding traditional approach control over both physical body and mind and as rewarding.	3.60	Highly Acceptable
10. Physically challenging but appealing, enjoys strong movement using arms, legs and knee in dancing. and develop dance mastery	3.60	Highly Acceptable
Section Mean	3.53	Highly Acceptable

Table 4. Acceptability of aerobics approach in teaching social dance

Indicator	Mean	Interpretation
1. Using current modern music for teaching cha cha and samba social dance	4.83	Very Highly Acceptable
2. Incorporating of dance aerobics elements in teaching social dance enhance self empowerment	4.67	Very Highly Acceptable
3. Suitable for all age and time appropriate for the instructional approach	4.57	Very Highly Acceptable
4. Develop articulated class lesson using innovation that support student differences	4.57	Very Highly Acceptable
5. Serving as an innovative strategy to facilitate easy learning of social dance step especially the warm-up, exercise and step proper ending with cool down exercise.	4.83	Very Highly Acceptable
6. Serving as an approach in teaching social dance that can boost, stimulate, and sustain student's interest all throughout the class session.	4.70	Very Highly Acceptable
7. Feeling in control of the body and feel healthy and accept and feel curious.	4.67	Very Highly Acceptable
8. Serving as a strategy that eliminates student's boredom and optimizes participation in the task.	4.57	Very Highly Acceptable
9. Finding aerobics approach control over both physical body and mind and as rewarding	4.60	Very Highly Acceptable
10. Physically challenging but appealing, enjoys strong movement using arms, legs and knee in dancing.	4.73	Very Highly Acceptable
Section Mean	4.67	Very Highly Acceptable

a section mean of 4.67 was obtained which is described as "very highly acceptable".

This means aerobics approach in teaching social dance is "very highly acceptable" to the experimental group.

Level of Effectiveness of Teaching Social Dance

The succeeding tables (5-6) present the level of effectiveness of teaching social dance with two approaches.

Table 5 shows the experts' and students' ratings on the effectiveness of teaching social dance employing a traditional approach with a mean of 3.60 and is interpreted as "highly effective." It means that the teacher using the traditional approach is highly effective in teaching students through acquiring skills, mastery, and retention; facilitating easy learning through counting; establishing joy in an engaging learning environment; developing correct timing; ensuring student participation; improving focus and attention of students; developing proper projection; eradicating students' boredom; providing enjoyment; and teaching students the essence, elements, and purpose of learning social dance. Therefore, using the traditional approach meets 88-89% of expectations.

Table 5. Mean and Interpretation of Effectiveness of Traditional Approach in Teaching Social Dance

Indicator	Mean	Interpretation
1. Teacher uses his knowledge of dance to aid student in acquiring skills and Facilitates mastery and retention of the social dances (cha cha & samba) steps among students by using counting approach in a sets of 8.	3.94	Highly effective
2. Creates, performs, critically analyzes and interprets and evaluates works of dancer. Facilitates easy learning of the social dance through counting approach in a set of 8.	3.60	Highly effective
3. Teacher establish joy in engaging learning environment that meet the opportunity to learn, boosts, stimulates, and sustains the interest and enthusiasm of the students in learning the dance all throughout the class session..	3.66	Highly effective
4. Develops correct timing and able the students to perform the dance n-sync with the beat and rhythm of the music with the aid of counting in mind through a set of 8 beats.	3.57	Highly effective
5. Ensures student participation, support student learning and growth.	3.57	Highly effective
6. Improves focus and attention of students on the task, utilize variety of resources and employ diverse strategies that enable student maximized learning through counting.1,2,3,4,5,6,7,8,and counter counting 8,7,6,5,4,3,2,1.	3.37	Moderately effective
7. Develops proper projection, grace, poise, and body alignment	3.51	Highly effective
8. Eradicates student's boredom on learning the social dance and allows session a means for research to improve the teaching and learning processes with the aid of counting in a set of 8.	3.49	Highly effective
9. Provides enjoyment and satisfaction in learning the Dance	3.66	Highly effective
10. Allows the teacher to fully teach to the students the essence, elements, and purpose of learning social dances.	3.60	Highly effective
Section Mean	3.60	Highly effective

Table 6. Effectiveness of Aerobics Approach in Teaching Social Dance

Indicator	Mean	Interpretation
1. Teacher uses his knowledge of dance to aid student in acquiring skills and Facilitates mastery and retention of the social dances (cha cha & samba) steps among students through modern music.	4.71	Very highly effective
2. Creates, performs, critically analyzes and interprets and evaluates works of dancer. Facilitates easy learning of the social dance.	4.63	Very highly effective
3. Teacher establish joy in engaging learning environment that meet the opportunity to learn, boosts, stimulates, and sustains the interest and enthusiasm of the students in learning the dance all throughout the class session.	4.63	Very highly effective
4. Develops correct timing and able the students to perform the dance n-sync with the beat and rhythm of the music.	4.60	Very highly effective
5. Ensures student participation, support student learning and growth.	4.69	Very highly effective
6. Improves focus and attention of students on the task, utilize variety of resources and employ diverse strategies that enable student maximized learning.	4.60	Very highly effective
7. Develops proper projection, grace, poise, and body alignment.	4.31	Very highly effective
8. Eradicates student's boredom on learning the social dance and allows session a means for research to improve the teaching and learning processes	4.60	Very highly effective
9. Provides enjoyment and satisfaction in learning the dance through non-stop modern music	4.77	Very highly effective
10. Allows the teacher to fully teach to the students the essence, elements, and purpose of learning social dances.	4.60	Very highly effective
Section Mean	4.61	Very highly effective

As indicated in Table 6, the mean and interpretation of the level of effectiveness using the aerobics approach in teaching social dance are reflected in the section mean of all items, which is 4.61 with "very highly effective" as the shown interpretation. Therefore, using an aerobics approach meets 90% or above expectations.

Difference in the acceptability of Traditional and Aerobics Approaches in Teaching Social Dance

Table 7 presents the significant difference between acceptability of two approaches in teaching social dance.

Table 7. t-analysis Between Acceptability of Traditional and Aerobics Approaches as Perceived by Experts and Students

Groups	Means	Sd	df	t-comp	t-tabular	Interpretation
Aerobics	4.67	0.48	58	6.30	2.002	Significant
Traditional	3.53	0.87				

α = 0.05

As shown by the data above, the aerobics approach had a 4.67 as its computed mean of 4.67 and the traditional approach had a mean of 3.53. At alpha.05., the t-computed value of 6.30 is greater than the t tabular value of 2.002. This implies that there is a significant difference between the acceptability levels of the traditional and aerobics approaches as perceived by the participants themselves and the teacher experts.

Difference in the Effectiveness of Traditional and Aerobics Approaches in Teaching Social Dance

The t-test analysis between the effectiveness of Traditional and Aerobics Approaches in Teaching Social Dance.

Table 8. t-analysis between Effectiveness of Traditional and Aerobics Approaches as Perceived by the Experts and Students

Groups	Means	Sd	df	t-comp	t-tabular	Interpretation
Aerobics	4.61	0.30	58	6.76	1.995	Significant
Traditional	3.60	0.84				

α = 0.05

Data indicates that the t computed value of 6.67 is greater than the t-tabular value of 1.995 at .05 level of significance. It implies that the hypothesis which states that "there is no significant difference in the effectiveness of aerobics and traditional approach" is rejected.

Difference in the Dance Performance of the Learners

Table 9 above shows the mean gain of experimental was 3.73 and that of the control group was 2.85. The t-computed value is 22.11 as compared to 2.002 t tabular value at alpha .05 level of significance.

Table 9. t-analysis of Dance Performance Level Between Control and Experimental Groups

Groups	Means	Sd	df	t-comp	t-tabular	Interpretation
Experimental	3.73	0.18	58	22.11	2.002	Significant
Control	2.85	0.12				

α = 0.05

Discussion

The purpose of this study is to evaluate the performance, acceptability, and efficacy of teaching social dancing to fourth and third-year MAPEH students majoring in secondary education. The results of this study showed that dancers who excelled at social dance under the aerobics method also did well under the conventional method of social dance instruction. The results of the study are supported by the idea that many health and social enthusiasts try making aerobic exercise and dancing a part of their lives. Dancing to nonstop disco music keeps the dancers' interest and enthusiasm for dancing. Social dancing has no standardized teaching or learning curriculum. Social dance teachers teach steps and techniques they have come to prefer or that they feel their students prefer. The steps and techniques taught by one instructor can vary considerably from those taught by someone else. Social dancing is also dynamic. Social dance types and styles evolve over time (Hernandez, 2018). Teachers can enhance learning by providing opportunities to learn in a variety of ways (Mainwaring & Krasnow, 2010). The teacher's task is to find balance and promote an atmosphere of joy and stimulation.

Another finding from this study is consistent with the idea that teachers can employ a range of strategies to improve student performance during actual dance. These goals are aimed to motivate students to keep learning and improving while also boosting their self-esteem and reigniting their passion for dance. A dancer's capacity to master a particular skill or technique depends on a variety of factors, including physical prowess, motor and kinesthetic feedback and learning processes, physical practice, mental practice for skill enhancement, adequate physiologic rest, motor memory consolidation, the appropriate breakdown and acquisition of complex skills, growth and development, knowledge of results through appropriate external feedback mechanisms, and environment (Johnson, 2017; Saeed & Zyngier, 2012).

Aerobics is a method of teaching social dance that meets or surpasses 90% of expectations, making it very acceptable. It makes use of contemporary music to teach social dances like the cha-cha and samba; Self-empowerment is increased by including dance aerobics components into social dance instruction (Heid, 2017). Students learn quickly when using the aerobics approach to dancing because the instructor uses his dance expertise to assist students in learning skills and facilitates mastery of social dance steps. We must continue to deepen the connections between teaching and research, esteem both the researcher and the teacher, acknowledge the value of practice, and appreciate the entirety of the dance ecology. The findings of the study are supported by the fact that aerobics gained worldwide popularity following the release of Jane Fonda's exercise videos in 1982. Dance is the most effective way to express oneself. Dancing is an effective way to release thoughts, emotions, and even suppressed feelings. One can convey important messages of love, fear, joy, and even grief through dance. People dance for a variety of reasons. Some individuals dance for health reasons. Regular exercise can help one lead a healthy lifestyle. Dancing is a good form of exercise because one can dance nonstop for hours on end without becoming exhausted.

In addition to strengthening the heart, it tones and strengthens the muscles and is more thrilling and enjoyable

than playing tennis or any other sport. It can control and prevent cardiovascular disease. Furthermore, more people are dancing socially, with others, or just for fun, which promotes friendship and camaraderie. McCormick (2021). Students learn more effectively in a setting that is both challenging and enjoyable. If the pace of the lesson is too slow or the objectives are too straightforward, students may lose interest and motivation. Students may experience anxiety and frustration if the objectives are too difficult or the pace is too quick. The role of the teacher is to strike a balance and create a stimulating and enjoyable environment (Licorish et al., 2018).

Conclusions

Regarding acceptability, teaching efficacy, and dance performance, the traditional and aerobics approaches to dance performance were very different. According to the study's findings, the student-learner meets or exceeds 90% of the expectations under the aerobics approach when performing and demonstrating social dance. Although it is suitable for teaching social dances, the conventional counting method can be used as a supplement to mastery and effectiveness. Future research on non-traditional dance techniques and other social dancing styles may be able to benefit from the study's findings.

Acknowledgment

To Dr. Rodelyn M. Dalayappan, Prof. Wilfredo M. Atayan, Ernie C. Cerado, Elmer F. Festin, Susan Losanes, Cherrylou B. Magbanua, and Dr. Stephen Ayoade Fadare, who serves as our internal peer reviewer and ensures that the works go through PlagScan and are published. We express our gratitude to all of you who have provided support for this research activity. Thanks.

Conflict of interest

We declare no conflict of interest.

References

Georgios, L. (2018). The Transformation of Traditional Dance from Its First to Its Second Existence: The Effectiveness of Music - Movement Education and Creative Dance in the Preservation of Our Cultural Heritage. *Journal of Education and Training Studies, 6*(1), 104-112. https://doi.org/10.11114/jets.v6i1.2879

Gilbert, A. G. (2015). *Creative Dance for All Ages* (2nd Ed.) Human Kinetics.

Malamov, G. A. (2020). *History of Ballroom dance – How A dance is born?* Retrieved from https://www.atanasmalamov.com/author/atanas-malamov

Dance Sports Club. (2016). *Ballroom Dance Competitions.* Retrieved from https://www.dancesportclub.com/es/ballroom-dance-competitions

Bubnis, D. (2019). *What are the benefits of aerobic exercise?* Retrieved from https://www.medicalnewstoday.com/articles/327100#safety

Kohl, H.W. III., & Cook, H.D. (2013). Educating the Student Body: Taking Physical Activity and Physical Education to School. Washington (DC): National Academies Press (US). *Physical Activity and Physical Education: Relationship to Growth, Development, and Health.* Available from: https://www.ncbi.nlm.nih.gov/books/NBK201497/

Patel, H., Alkhawam, H., Madanieh, R., Shah, N., Kosmas. C.E., & Vittorio, T.J.(2017). Aerobic vs anaerobic exercise training effects on the cardiovascular system. *World journal of cardiology, 9*(2), 134.

Mainwaring, M.L., & Krasnow, H.D. (2010). Teaching the Dance. Class: Strategies to Enhance Skill Acquisition, Mastery and Positive Self-Image. *Journal of Dance Education, 10*(1), 14-21. https://doi.org/10.1080/15290824.2010.10387153

Teixeira, P.J., Carraça, E.V., Markland, D. et al. (2012). Exercise, physical activity, and self-determination theory: A systematic review. *Int J Behav Nutr Phys Act.,* 9, 78. https://doi.org/10.1186/1479-5868-9-78

Fadare, A. S., Zarma, H. A., Fadare, M. C., Bademosi, T., & Amanum, O. I. (2021). The Impact of Peer Group Pressure onAcademic Performance of AdolescentStudents: An Intervention Program to Resist Peer Pressure. *International Journal of Science and Management Studies, 4*(6), 130-141. https://doi.org/10.51386/25815946/ijsms-v4i6p114

Abdulrahaman M.D., Faruk N., Oloyede A.A., Surajudeen-Bakinde N.T., Olawoyin L.A., Mejabi O.V., Imam-Fulani Y.O., (...), Azeez A.L. (2020). Multimedia tools in the teaching and learning processes: A systematic review. *Heliyon, 6*(11), e05312. https://doi.org/10.1016/j.heliyon.2020.e05312

Sööt, A., & a Visku, E. (2014). Contemporary Approaches to Dance Pedagogy – the Challengesof the 21st Century. *Procedia - Social and Behavioral Sciences,* 112, 290-299. https://doi.org/10.1016/j.sbspro.2014.01

Bannon, F. (2010). Dance: the possibilities of a discipline. *Research in Dance Education, 11*(1), 49-59. https://doi.org/10.1080/14647890903568313

Sööt, A & Leijen, Ä. (2012). Designing Support for Reflection Activities in Tertiary Dance Education. *Procedia - Social and Behavioral Sciences,* 45, 448. https://doi.org/10.1016/j.sbspro.2012.06.581-456.

Sims, M., & Erwin, H. (2012). A Set of Descriptive Case Studies of Four Dance Faculty Members' Pedagogical Practices. *Journal of Dance Education,12*(4), 131-140. https://doi.org/10.1080/15290824.2012.654106

Salo, A. (2019). *The Power of Dance: How Dance Effects Mental and Emotional Health and Self-Confidence in Young Adults.* Master's Theses. 133. Retrieved from: https://digscholarship.unco.edu/theses/133

Risner, D., & Stinson, S.W. (2010). Moving social justice: Challenges, fears and possibilities in dance education. *International Journal of Education & the Arts, 11*(6). Retrieved from: https://libres.uncg.edu/ir/uncg/f/S_Stinson_Moving_2010.pdf

Risner, D. (2009). Challenges and opportunities for dance pedagogy: Critical social issues and "unlearning" how to teach. *Paper presented at the meeting of the Congress on Research in Dance,* Leicester, UK.

Trochim, W. M. K. (2006). *Descriptive Statistics, Research Methods Knowledge Base.* Retrieved from: http://www.socialresearchmethods.net/kb/statdesc.php

Saltikov, B. J. (2014). Selecting the most appropriate inferential statistical test for your quantitative research study. *Journal*

of Clinical Nursing, 23(12-13), 1520-1531. https://doi.org/10.1111/jocn.12343

Hanson, E. (2008). *Learning Through the Arts.* Retrieved from: http://assessment.rbe.sk.ca/sites/assessment/files/Rubric%20for%20Folk%20Dance.doc.

Hernandez,D. (2018). *The simple beauty of social dancing.* Retrieved from https://beyondthebarreusa.com/blogs/dance-skills-techniques/beauty-of-social-dancing

Johnson, D. (2017). the role of teachers in motivating students to learn. *Journal of Graduate Studies in Education, 9*(1), 46-49. Retrieved from https://files.eric.ed.gov/fulltext/EJ1230415.pdf

Saeed, S., & Zyngier, D. (2012). How motivation influences student engagement: A Qualitative Case Study. *Journal of Education and Learning, 1*(2), 252-267. http://dx.doi.org/10.5539/jel.v1n2p252

Heid, M. (2017). *Why dancing is the best thing you can do for your body.* Retrieved from https://time.com/4828793/dancing-dance-aerobic-exercise/

McCormick, K. (2021). *Neighbor that dance together bond together.* Retrieved from: https://suntrust.com.ph/homestories/neighbors-dance-together-bond-together

Licorish, S.A., & Owen, H.E., Daniel, B. et al. (2018). Students' perception of Kahoot!'s influence on teaching and learning. *RPTEL, 13*(9). https://doi.org/10.1186/s41039-018-0078-8

ПІДХІД НА ОСНОВІ АЕРОБІКИ У НАВЧАННІ СОЦІАЛЬНИХ ТАНЦІВ

Т. Хаджі Касан Яшієр[1ABCDE], Д. Сугадор Бандраз[1BCE]

[1]Державний університет Мінданао

Авторський вклад: A – дизайн дослідження; B – збір даних; C – статаналіз; D – підготовка рукопису; E – збір коштів

Реферат. Стаття: 8 с., 9 табл., 27 джерел.

Мета дослідження. Метою цього дослідження було з'ясувати результативність, прийнятність та ефективність навчання соціальних танців із використанням підходу на основі аеробіки серед студентів.

Матеріали та методи. У цьому дослідженні використовували кількісне дослідження з описово-оцінювальним та експериментальним планом дослідження, щоб визначити рівень виконання соціальних танців ча-ча-ча та самби двома групами учасників (контрольною та експериментальною групами). Автор дослідження використав загальний перелік студентів четвертого та третього курсу, які навчаються за спеціальністю «бакалавр середньої освіти» на факультеті музики, мистецтв, фізичного виховання та здоров'я, використовуючи традиційний підхід і підхід на основі аеробіки. Для навчання експериментальної групи використовувався підхід на основі аеробіки, який включав безперервну диско-музику в ча-ча-ча та самбі, а також вправи для розминки та охолодження. Цього ж соціального танцю навчали контрольну групу, в якій використовувався традиційний метод підрахунку 8 серій ударів: 1, 2, 3, 4, 5, 6, 7, 8, 6, 5, 4, 3, 2, 1. І традиційний підхід, і підхід на основі аеробіки передбачали навчання по 40 хвилин кожен.

Результати. Результати виявили значні відмінності у виконанні танців, прийнятності та ефективності між контрольною групою, у якій використовували традиційний підхід, та експериментальною групою, у якій використовували підхід на основі аеробіки.

Висновки. Аеробіка рекомендована для навчання соціальних танців, щоб сприяти кращому засвоєнню, оскільки вона дозволяє студентам навчатися у власному темпі та відповідно до власних інтересів і потреб.

Ключові слова: аеробіка, підхід, соціальні танці, навчання, традиційний.

Information about the authors:

Yashier, T. Hadji Kasan: yhkasan@msumaguindanao.edu.ph; https://orcid.org/0000-0002-0349-6457; SPEAR Dept, College of Arts and Sciences, Mindanao State University, Datu Odin Sinsuat, 9601 Maguindanao, Philippine.

Bandraz, D. Sugador: bandraz1992@gmail.com; https://orcid.org/0000-0002-4565-3158; SPEAR Dept, College of Arts and Sciences, Mindanao State University, Datu Odin Sinsuat, 9601 Maguindanao, Philippine.

Cite this article as: Yashier, T. H. K., Bandraz, D. S. (2023). Aerobics approach in Teaching Social Dance. *Physical Education Theory and Methodology, 23*(2), 221-228. https://doi.org/10.17309/tmfv.2023.2.10

Received: 11.01.2023. Accepted: 18.03.2023. Published: 28.04.2023

Теорія та методика фізичного виховання
Physical Education Theory and Methodology
Teorìâ ta Metodika Fizičnogo Vihovannâ

ISSN 1993-7989 (print)
ISSN 1993-7997 (online)
ISSN-L 1993-7989

ORIGINAL SCIENTIFIC ARTICLE

THE EFFECTS OF ONLINE PHYSICAL ACTIVITY DURING COVID-19 PANDEMIC AMONG UNDERGRADUATE STUDENTS IN THAILAND

Poramet Hemarachatanon[1ABCD], Wattana Nuttouch[1ABC], Neeranoot Weerawong[1ABC] and Soontaraporn Huntula[1ABCD]

[1]Walailak University

Authors' Contribution: A – Study design; B – Data collection; C – Statistical analysis; D – Manuscript Preparation; E – Funds Collection

Corresponding Author: Soontaraporn Huntula, Email: soontaraporn.hu@wu.ac.th
Accepted for Publication: March 18, 2023
Published: April 28, 2023

DOI: 10.17309/tmfv.2023.2.11

Abstract

Study purpose. The purpose of this study was to develop a physical activity program by using resistance band for students to improve physical activity and monitor improvements in physical performance. The university students' physical activity, which was still low before the pandemic, may be impacted by these. As a result, we want to incorporate physical activity into our course and assess the differences in physical performance before and after taking the course.

Materials and methods. 95 undergraduate college students signed up to take the course. The online course, which included resistance band training for a total of 12 weeks, addressed the principles of resistance band training/exercise. The physical performance of the participants was assessed both before and after training.

Results. According to our study findings, university students at Walailak University can increase their physical performance by using an online resistance band training. The physical fitness statistics for the wall sit test, sit up test, sit and reach test, and shuttle run test were significantly different before and after the online elastic band intervention (p=0.0463, p=0.0050, and p=0.0430, respectively), but not for the shuttle run or YMCA 3-minute step test.

Conclusions. The results of this study provide proof that resistance band training improves strength and encourages physical activity. In order to reduce anxiety and depression, which the COVID-19 has severely touched, as well as to increase the population's level of physical activity or exercise, we must continually promote physical activity or exercise at home.

Keywords: Physical activity, COVID-19 pandemic, Resistance band training, Physical performance.

Introduction

The COVID-19 epidemic, which is causing half of the world's population to be infected, is creating a dire worldwide health crisis (Peters et al., 2020). The virus is consequently aggressively spreading throughout many areas, and we could unwittingly bring it into our houses. Additionally, the COVID-19 pandemic, which was brought on by social exclusion and quarantine, can have a detrimental effect on physical activity, as well as mental health (Park et al., 2022), which has seriously harmed the quality of exercise and physical health. The population's daily physical activity may thus be adversely affected by these measures of social distance (Woods et al., 2020). Physical distance/isolation policies and the pandemic's ongoing spread are also anticipated to have an impact on the general public's mental health (Pfefferbaum & North, 2020). Excessive information, concerns about one's health and the future, annoyance over project delays, boredom, a decline in family income, and a political or economic crisis can all cause or worsen feelings of melancholy and anxiety (Lu & Lin, 2021). These issues linked to insufficient physical activity may also have a detrimental effect on mental health.

Exercise and sports are examples of physical activity (PA), which is defined as a controlled movement that causes an energy expenditure (Westerterp, 2013). Exercise has also been recognized as a crucial component in preventing future viral diseases and severe respiratory illnesses. According to prior studies, moderate exercise can enhance immunity and have an anti-inflammatory cytokine impact in addition to

lowering the risk of heart disease, diabetes, hypertension, obesity, and cancer (Booth et al., 2017; Zbinden-Foncea et al., 2020). Exercise can generally be divided into two types: (1) aerobic exercise, which is rhythmic, continuous, uses a lot of large muscle groups, and is typically prescribed to improve endurance; and (2) resistance exercise training, also known as strength training, which is well known to increase muscle size and strength. Simple elastic bands can be used for resistance training; they are inexpensive, user-friendly, and may thus have a greater potential for application in dialysis centers all over the world. According to a previous study, using resistance bands for exercise produces the same strength gains as using conventional gym equipment (Lopes et al., 2019).

To increase muscle strength, strength training is required. One of these is strength training using elastic bands. Elastic bands are recently utilized in physical therapy and rehabilitation to improve people's functional abilities, treat chronic illnesses, and train athletes' functional capacities (Verrill et al., 1992). According to research by Xinhong Liu and colleagues, elastic band training helps overweight people lose body fat more quickly than other types of exercise such as free weights and bodyweight exercises. The review was focused on 18 studies with 669 participants (Liu et al., 2022). Similar findings were made by Sundstrup et al. (2014) using dumbbell, weight machine, and resistance band techniques to increase muscular activation (Sundstrup et al., 2014). In addition, resistance bands are convenient to carry, enabling everyone to exercise everywhere, and there is a proper technique to utilize the bands in order to benefit from their ability to build muscle, which is appropriate in the COVID-19 pandemic situation. From this perspective, the purpose of this study was to create an exercise course for students to increase physical activity and track changes in physical performance. The university students' physical activity, which was still low before the pandemic, may be impacted by these. As a result, we want to incorporate physical activity into our curriculum and assess the differences in physical performance before and after taking the course.

Material and methods

Study participants

The 95 undergraduate students who are enrolled to attend the course in the first semester, from 1 June 2022 to 31 August 2022, in Tha Sala District, Nakhon Si Thammarat Province, Thailand. The design was an experimental study using an online platform. This study was approved by the Human Research Ethic Committee of Walailak University (approval number: WUEC-21-282-01). Participants with previous exposure to a physical fitness enhancement or weight loss program, had a history of being a university athlete or a vigorous exerciser, had musculoskeletal injuries, congenital diseases with exercise contraindications, or had participated in more than three research projects, were excluded. Prior to participation in the study, written informed consent was obtained from each subject. Before the session began, participants were asked to access a link to complete a Google Forms-based questionnaire, in order to compare their exercise behavior or physical activity characteristics both before and during the COVID-19 pandemic.

Study Organization

The online resistance band program Intervention

The resistance band is an elastic device used for strength training. They are commonly used in physical therapy as well, especially by people recovering from muscular injuries and those undergoing cardiac rehab. The fundamentals of resistance band exercise were covered in the online course that featured resistance band training. For a total of 12 weeks, the intervention was conducted three times a week (Mondays, Wednesdays and Fridays) from 5:00 to 6:00 pm via Zoom application platform as 3 sets and 15 repeats. It was changed to be used online that perform 60 minutes a day for three days a week: 15 minutes for warming up, 30 minutes for resistance band training, and 15 minutes for cool-down, as stated in Table 1 and Figure 1.

Table 1. Components of the online resistance band training (three times/week)

	Components	Duration
1.	Warm up	15 min
2.	Resistance band training Chest press Shoulder side lateral Alternative shoulder rise Upright row Overhead pull apart Standing bent row Triceps extension Biceps curl Shoulder press Front squat	30 min
3.	Cool down	15 min

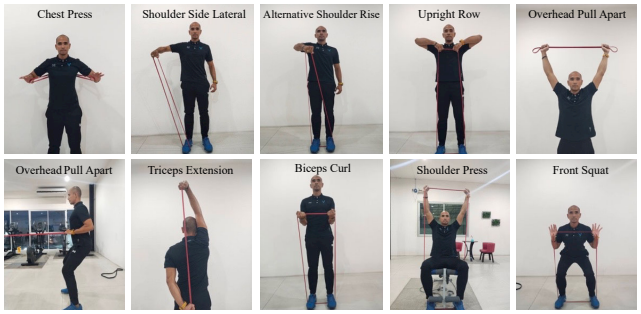


Fig. 1. The online resistance band work for upper body and lower body workouts.

Assessments of anthropometric parameters

Researchers examined the participants' physical performance both before and after training. The anthropometric assessments, including the YMCA 3-minutes step test, shuttle run, wall sit, sit up, sit and reach, and BMI.

Body Mass Index (BMI)

Height was recorded in centimeters (cm) without socks and shoes to the nearest 0.1 cm. The weight in kilograms (kg) was calculated using a digital electronic weighing scale, and it was recorded to the nearest 0.1 kg. Weight in kg divided by the square of height in meter (m) was used to compute BMI.

Shuttle Run Test

Using a shuttle run test, agility is evaluated. At a distance of 10 meters, marking cones are used to indicate the starting and finishing places on the floor. When given the signal "ready," participants place their front foot behind the starting line. At the "go" signal, competitors run to the other line, pick up an item, run back, and place it on or beyond the starting line. Without pausing, they turn and sprint back to grab the next block, which they then carry across the finishing points. The researcher arrives at the earliest moment possible (Cvejić et al., 2013).

Wall Sit Test

The lower-body muscular endurance is assessed using the wall-sit test. In the Wall-sit test, the subject begins with their backs against a wall and their legs bent at a 90-degree angle. They then have to maintain this sitting-like position for the greatest amount of time. The amount of time a performer can maintain the position is recorded (Morrow et al., 2011).

Sit Up Test

The participant was supine on the floor, elbows pointing forward, hands at the sides of their head, and knees flexed 90 degrees. The shoulders should hit the floor once the elbows have touched the knees correctly execute a sit-up (Ghigiarelli et al., 2009). To gauge the level of endurance in each test, the total number of repetitions was recorded.

Sit and Reach Test

Using a sit-and-reach box and a ruler, the sit-and-reach flexibility test measures flexibility. Without shoes, participants sit on the ground. Flat against the box are the feet. The knees are locked and flat against the ground. Participants are told to extend their arms as far forward as they can along the measurement line. When being tested, the correct stances are required, including hands reaching forward at the same level and no jerky movements. Participants in reaches out keep their stance for 1-2 seconds after which the score is recorded (Cvejić et al., 2013).

YMCA 3-minute Step Test

The alternating stepping cadence of the YMCA 3-minute step test is shown to the subject. Step one foot up on the bench to start the beat, then step up with the other foot to start the next beat, then step down with one foot to start the next beat (4th beat.) The metronome cadence is set at 96 beats per minute (4 clicks equals one step cycle), giving the subject the opportunity to practice stepping at a rate of 24 steps per minute. For three minutes, the participant moves up and down on the platform at the prescribed rate. Immediately once the exam is over, the participant stops, sits down, and does not move. The tester's job is to monitor the participant's heart rate for one full minute (Kieu et al., 2020).

Statistical analysis

Descriptive statistics; physical characteristics and physical fitness performance were presented as mean and standard error of the mean (Mean ± SEM). A Kolmogorov-Smirnov test was used to test the normal distribution of all data. The before and after online training intervention were compared using unpaired t-test comparison. All statistical analyses were carried out using the statistical program SPSS (SPSS version 26; IBM, Armonk, NY, USA), with statistical significance set at $P< 0.05$.

Results

Demographic characteristics of participants

Ninety-five students were enrolled in this study and further measured the demographic data before the online resistance training intervention. The general characteristics of participants are presented in Table 2. Weight and BMI tend to modestly drop following an online resistance band intervention, but not significantly (p=0.4552 and p=0.4675, respectively).

Table 2. General demographic characteristics of the participants (n=95). Data of gender represented as percentage in men (n=35) and women (n=60)

Characteristics	Pre-test	Post-test
Gender		
Men	35 (36.84%)	
Women	60 (63.16%)	
Age	19.88 ± 0.12	
Height	162.73 ± 0.87	
Weight	58.02 ± 1.65	56.33 ± 1.55
Men	66.94 ± 3.52	65.23 ± 3.28
Women	52.81 ± 1.22	51.13 ± 1.08
BMI	21.80 ± 0.53	21.16 ± 0.49
Men	23.03 ± 1.18	22.44 ± 1.10
Women	21.08 ± 0.48	20.42 ± 0.42

Note: Data are presented as mean ± SEM in age, height, weight, and BMI, with an unpaired t-test. BMI: body mass index

Physical performance assessment

Table 3 and Figure 2 display the results of physical performance fitness tests before and after an online resistance band intervention. The results for the 10-meter shuttle run and the YMCA 3-minute step test did not differ significantly, but the data for the wall sit, sit up for a minute, and sit and reach did. The physical fitness statistics for the wall sit test, sit up test, sit and reach test, and shuttle run test were significantly different before and after the online resistance band intervention (p=0.0463, p=0.0050, and p=0.0430, respectively), in contrast to the shuttle run and YMCA 3-minute step test, which showed no significant differences (p=0.5408 and p=0.1114, respectively). However, there was no significant difference between men and women in this study (figure 3).

Discussion

The study's findings showed that creating a physical education course for students was a good way to increase physical activity and track changes in university students' physical performance at Walailak University. Before and after elastic band intervention, with BMI in the range of 23-24.9 kg/m^2, which normal and overweight categories. To classify overweight and obesity, the WHO standard of BMI was applied. The WHO defines normal BMI as being between 18.5 and 24.9 kg/m^2, overweight as being between 25.0 and 29.9 kg/m^2, and obese as being more than or equal to 30.0 kg/m^2 (WHO, 2000). After resistance band intervention, we discovered that the BMI value tends to drop, indicating excellent health. During the COVID-19 epidemic, experts

Table 3. The results of physical performance fitness tests before and after an online resistance band intervention (n=95)

Physical Assessments	Before training intervention	After training intervention	p-value
Shuttle run 10 meters (Second)	11.46 ± 1.33	11.14 ± 5.21	0.5408
Wall sit (Second)	56.31 ± 33.27	69.05 ± 51.36*	0.0463
Sit up 1 min (time)	23.53 ± 7.97	26.88 ± 8.17**	0.0050
Sit and Reach (cm)	5.07 ± 7.48	7.19 ± 6.86*	0.0430
Step test 3 minutes (HR/min)	134.92 ± 40.93	126.57 ± 29.64	0.1114

Note: Data are present as mean ± SEM. *P < 0.05 indicates a significant difference between before- and after- online resistance band program intervention group. **P < 0.01 indicates a significant difference between before- and after- online resistance band program intervention group, with an unpaired t-test. HR: heart rate; cm: centimeter

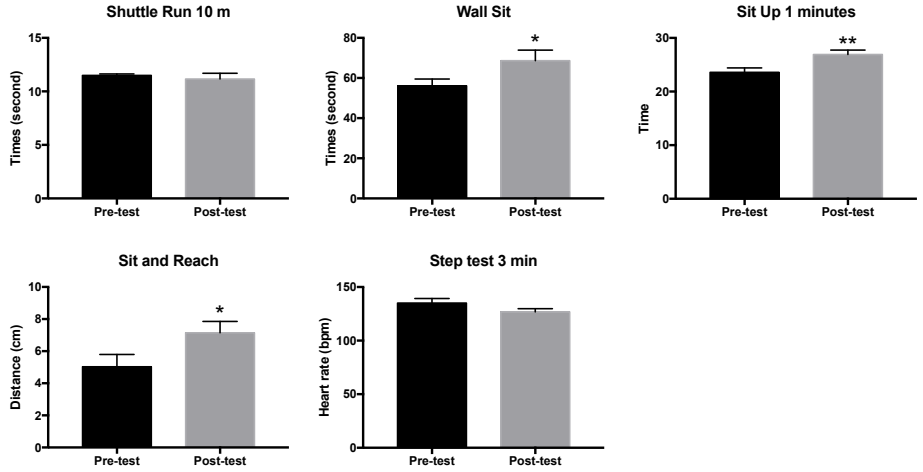


Fig. 2. The results of physical performance fitness tests before and after an online resistance band intervention (n=95)
Note: Data are present as mean ± SEM. *P < 0.05 indicates a significant difference between before- and after- online resistance band program intervention group. **P < 0.01 indicates a significant difference between before- and after- online resistance band program intervention group, with an unpaired t-test

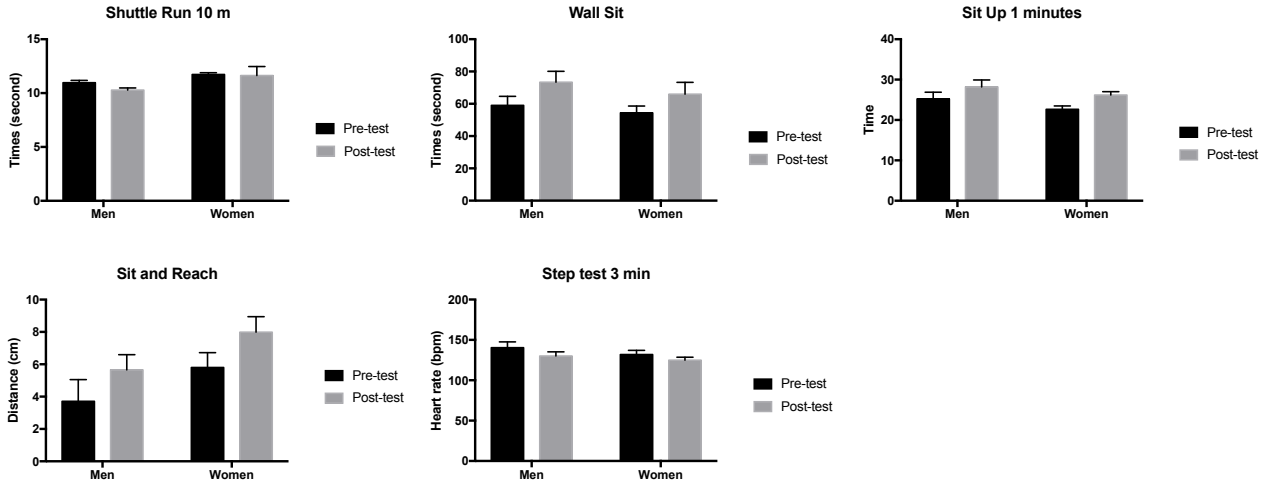


Fig. 3. The differential physical performance assessment between men and women
Note: Data are present as mean ± SEM

from all across the world have demonstrated significant interest in evaluating people's lifestyle-related behavior. Our research indicates that while the majority of respondents were able to continue their exercise regimens throughout the COVID-19 pandemic, university students at Walailak University engaged in less physical activity. However, behavior theory predicts that the pandemic would cause an increase in dread and anxiety in people's typical emotional reactions (Wattanapisit et al., 2016). Thus, it could be challenging to workout in the current environment. Similar patterns of physical activity, as well as a decline in exercise frequency and duration, were seen before and during the COVID-19 pandemic (Zhong et al., 2020). But they all resulted in physical activity or exercise, and it is possible

to adopt the straightforward strategy of remaining healthy at home. Participants were required to employ body movement as one of the physical activity measures to assess their level of physical activity and sedentary behavior during the COVID-19 pandemic, when team sports were on the decline, as shown in the behavior results.

Resistance exercise such as using a resistance band has been shown to improve muscle quality, physical self-reported functionality, and strength (Johansen et al., 2006; Cheema et al., 2007). Evidence from previous studies is consistent with systematic reviews and meta-analyses that found that using elastic resistance increased muscular strength gains in older adults (Martins et al., 2013), people with osteoarthritis (Lange et al., 2008), and people with fibromyalgia when compared to a control group (Busch et al., 2013). Ghigiarelli and colleagues implemented a 7-week strength training program and examined its impact on upper extremity strength after dividing strength training groups into three categories: resistance bands, weight chains, and conventional weights. They discovered that the elastic band group had the biggest growth (Ghigiarelli et al., 2009). In addition, Anderson and colleagues conducted a 7-week strength training program and compared resistance band and free weight strength training. In their study, they found that the elastic band strength training group considerably increased the squat and bench press movements compared to the free weight group (Anderson et al., 2008). Similarly, Colado and Triplett (2008) showed that the strength and body composition improved as a result of the elastic band strength training program (Colado & Triplett, 2008). Chang et al. (2012) conducted a resistance band training program over an eight-week period and found that lower extremity strength and function metrics significantly increased (Chang et al., 2012). The findings of the researchers previously cited were significant since they are in agreement with those of the current investigation.

Regarding the aforementioned, the online resistance band program would result in an improvement in muscle strength and flexibility as demonstrated by the results of the wall sit, sit up test, and sit and reach, hence extending the types of people who could benefit from the method's emphasized health benefits. Wall sit is a simple test of lower body muscular strength and endurance, particularly the quadriceps muscle group. After the elastic band intervention in our study, the wall sit-in had a higher value than it had previously. Additionally, the 1-minute sit-up test before and after the use of the resistance band revealed differences. The shuttle run test, which gauges an individual's aerobic capacity, did not show any changes. Additionally, there were no differences between the pre- and post-elastic band intervention cardio-respiratory tests such the YMCA 3-minute step test. Our findings showed that muscle strength and flexibility of volunteers presented a significant positive correlation with the elastic band intervention. One may argue that less research has been done on the effects of resistance training than endurance training on daily energy expenditure. Van Etten and a colleague used doubly labeled water to quantify the daily energy expenditure of young men. After 18 weeks of a resistance training program, they discovered a mean increase in daily energy expenditure that was close to 260 kcal/d, the majority of which was attributable to the resistance training program's direct caloric cost (Van Etten et al., 1997). On the other hand, Hunter and colleagues discovered that, in addition to the direct energy cost of the resistance training program, 6 months of resistance training considerably increased daily energy expenditure (Hunter et al., 2000). Since we only measured physical fitness tests and our measurements were done after the resistance training programs were over 8 weeks, the results cannot be directly compared to the findings of the current inquiry.

Although this kind of exercise has become more popular recently, studies that employ the resistance band exercise modality note challenges with intensity regulation. In order to regulate intensity and prescription parameters, writers use subjective effort perception measures. Other methods utilized include increasing stress levels by stretching or using elastic devices that are colored differently. Regarding the study's shortcomings, we specifically point out the lack of consistency of the training load conducted with elastic resistance as well as the range of protocols used. According to our study's findings, university students at Walailak University can increase their physical performance by using an online elastic band – workout that build strength and muscle. The necessity of exercise or physical activity as a top priority during the COVID-19 pandemic was also highlighted by the current investigation. The resistance band is a well-known device that can reduce the risk of diabetes and heart disease. It can also reduce age-related decline in muscle mass. Because of this, the online resistance band program may be ideal and effective for enhancing appropriate physical activity among kids, adults, and the elderly in a comfortable setting. Finally, we once again stress the significance of the results for clinical and scientific practice, offering significant proof for a form of physical exercise that is becoming more and more preferred and easily available at a low cost. In the scientific world, research on "home-based workouts" is garnering more and more attention. In this situation, the presented modality enables procedures to be initially carried out under supervision and thereafter at home, satisfying particular demands.

Conclusions

This study's findings give evidence that resistance training with elastic devices increases strength and promotes physical activity. Additionally, we must constantly promote physical activity or exercise at home in order to lower anxiety and depression, which the COVID-19 pandemic has profoundly impacted, as well as to raise the population's level of physical activity or exercise.

Acknowledgments

The study was carried out according to the research plan of the Research Institute for Health Sciences, Walailak University, to this work (registration number: WUEC-21-282-01).

Conflict of interest

The authors declare that there is no conflict of interest.

References

Peters, A., Vetter, P., Guitart, C., Lotfinejad, N., & Pittet, D. (2020). Understanding the emerging coronavirus: what

it means for health security and infection prevention. *Journal of hospital infection, 104*(4), 440-448. https://doi.org/10.1016/j.jhin.2020.02.023

Park, A. H., Zhong, S., Yang, H., Jeong, J., & Lee, C. (2022). Impact of COVID- 19 on physical activity: A rapid review. *Journal of global health,* 12, 05003. https://doi.org/10.7189/jogh.12.05003

Woods, J. A., Hutchinson, N. T., Powers, S. K., Roberts, W. O., Gomez- Cabrera, M. C., Radak, Z., . . . Ji, L. L. (2020). The COVID-19 pandemic and physical activity. *Sports Med Health Sci, 2*(2), 55-64. https://doi.org/10.1016/j.smhs.2020.05.006

Pfefferbaum, B., North, C.S. (2020). Mental Health and the Covid-19 Pandemic. *The New England journal of medicine, 383*(6), 510–512.

Lu, X., & Lin, Z. (2021). COVID-19, Economic Impact, Mental Health, and Coping Behaviors: A Conceptual Framework and Future Research Directions. *Front Psychol,* 12, 759974. https://doi.org/10.3389/fpsyg.2021.759974

Westerterp K. R. (2013). Physical activity and physical activity induced energy expenditure in humans: measurement, determinants, and effects. *Frontiers in physiology,* 4, 90. https://doi.org/10.3389/fphys.2013.00090

Booth, F. W., Roberts, C. K., Thyfault, J. P., Ruegsegger, G. N., & Toedebusch, R. G. (2017). Role of Inactivity in Chronic Diseases: Evolutionary Insight and Pathophysiological Mechanisms. *Physiol Rev, 97*(4), 1351-1402. https://doi.org/10.1152/physrev.00019.2016

Zbinden-Foncea, H., Francaux, M., Deldicque, L., & Hawley, J. A. (2020). Does High Cardiorespiratory Fitness Confer Some Protection Against Proinflammatory Responses After Infection by SARS-CoV-2? *Obesity (Silver Spring), 28*(8), 1378-1381. https://doi.org/10.1002/oby.22849

Lopes, J. S. S., Machado, A. F., Micheletti, J. K., de Almeida, A. C., Cavina, A. P., & Pastre, C. M. (2019). Effects of training with elastic resistance versus conventional resistance on muscular strength: A systematic review and meta-analysis. *SAGE open medicine,* 7. https://doi.org/10.1177/2050312119831116

Verrill, D., Shoup, E., McElveen, G., Witt, K., & Bergey, D. (1992). Resistive exercise training in cardiac patients. Recommendations. *Sports medicine, 13*(3), 171-193. https://doi.org/10.2165/00007256-199213030-00003

Liu, X., Gao, Y., Lu, J., Ma, Q., Shi, Y., Liu, J., Xin, S., & Su, H. (2022). Effects of Different Resistance Exercise Forms on Body Composition and Muscle Strength in Overweight and/or Obese Individuals: A Systematic Review and Meta-Analysis. *Frontiers in physiology,* 12, 791999. https://doi.org/10.3389/fphys.2021.791999

Sundstrup, E., Jakobsen, M. D., Andersen, C. H., Bandholm, T., Thorborg, K., Zebis, M. K., & Andersen, L. L. (2014). Evaluation of elastic bands for lower extremity resistance training in adults with and without musculo- skeletal pain. *Scand J Med Sci Sports, 24*(5), e353-359. https://doi.org/10.1111/sms.12187

Cvejić, D., Pejovic, T., & Ostojić, S.M. (2013). Assessment of physical fitness in children and adolescents. Facta universitatis. *Series physical education and sport,* 11, 135-145.

Morrow, J., Disch, J., Jackson, A., Mood, D. (2011). *Measurement and Evaluation in Human Performance,* 4th ed.; Human Kinetics: Champaign, IL, USA.

Ghigiarelli, J. J., Nagle, E. F., Gross, F. L., Robertson, R. J., Irrgang, J. J., & Myslinski, T. (2009). The effects of a 7-week heavy elastic band and weight chain program on upper-body strength and upper-body power in a sample of division 1-AA football players. *Journal of strength and conditioning research, 23*(3), 756-764. https://doi.org/10.1519/JSC.0b013e3181a2b8a2

Kieu, N. T. V., Jung, S. J., Shin, S. W., Jung, H. W., Jung, E. S., Won, Y. H., . . . Chae, S. W. (2020). The Validity of the YMCA 3-Minute Step Test for Estimating Maximal Oxygen Uptake in Healthy Korean and Vietnamese Adults. *J Lifestyle Med, 10*(1), 21-29. https://doi.org/10.15280/jlm.2020.10.1.21

World Health Organization. (2000). *Geneva: World Health Organization. Obesity: preventing and managing the global epidemic.* Technical report, (Report Series No. 894).

Wattanapisit, A., Fungthongcharoen, K., Saengow, U., & Vijitpongjinda, S. (2016). Physical activity among medical students in Southern Thailand: a mixed methods study. *BMJ Open, 6*(9), e013479. https://doi.org/10.1136/bmjopen- 2016-013479

Zhong, B. L., Luo, W., Li, H. M., Zhang, Q. Q., Liu, X. G., Li, W. T., & Li, Y. (2020). Knowledge, attitudes, and practices towards COVID-19 among Chinese residents during the rapid rise period of the COVID-19 outbreak: a quick online cross-sectional survey. *Int J Biol Sci, 16*(10), 1745-1752. https://doi.org/10.7150/ijbs.45221

Johansen, K. L., Painter, P. L., Sakkas, G. K., Gordon, P., Doyle, J., & Shubert, T. (2006). Effects of resistance exercise training and nandrolone decanoate on body composition and muscle function among patients who receive hemodialysis: A randomized, controlled trial. *J Am Soc Nephrol, 17*(8), 2307-2314. https://doi.org/10.1681/ASN.2006010034

Cheema, B., Abas, H., Smith, B., O'Sullivan, A., Chan, M., Patwardhan, A., . . . Singh, M. F. (2007). Progressive exercise for anabolism in kidney disease (PEAK): a randomized, controlled trial of resistance training during hemodialysis. *J Am Soc Nephrol, 18*(5), 1594-1601. https://doi.org/10.1681/ASN.2006121329

Martins, W. R., de Oliveira, R. J., Carvalho, R. S., de Oliveira Damasceno, V., da Silva, V. Z., & Silva, M. S. (2013). Elastic resistance training to increase muscle strength in elderly: a systematic review with meta-analysis. *Arch Gerontol Geriatr, 57*(1), 8-15. https://doi.org/10.1016/j.archger.2013.03.002

Lange, A. K., Vanwanseele, B., & Fiatarone Singh, M. A. (2008). Strength training for treatment of osteoarthritis of the knee: a systematic review. *Arthritis Rheum, 59*(10), 1488-1494. https://doi.org/10.1002/art.24118

Busch, A. J., Webber, S. C., Richards, R. S., Bidonde, J., Schachter, C. L., Schafer, L. A., . . . Overend, T. J. (2013). Resistance exercise training for fibromyalgia. *Cochrane Database Syst Rev, 2013*(12), CD010884. https://doi.org/10.1002/14651858.CD010884

Anderson, C. E., Sforzo, G. A., & Sigg, J. A. (2008). The effects of combining elastic and free weight resistance on strength and power in athletes. *Journal of strength and conditioning research, 22*(2), 567–574. https://doi.org/10.1519/JSC.0b013e3181634d1e

Colado, J. C., & Triplett, N. T. (2008). Effects of a short-term resistance program using elastic bands versus weight machines for sedentary middle-aged women. *Journal of strength and conditioning research, 22*(5), 1441–1448. https://doi.org/10.1519/JSC.0b013e31817ae67a

Chang, T. F., Liou, T. H., Chen, C. H., Huang, Y. C., & Chang, K. H. (2012). Effects of elastic-band exercise on lower-extremity function among female patients with osteoarthritis of the knee. *Disabil Rehabil, 34*(20), 1727-1735. https://doi.org/10.3109/09638288.2012.660598

Van Etten, L. M., Westerterp, K. R., Verstappen, F. T., Boon, B. J., & Saris, W. H. (1997). Effect of an 18-wk weight-training program on energy expenditure and physical activity. *Journal of applied physiology, 82*(1), 298-304. https://doi.org/10.1152/jappl.1997.82.1.298

Hunter, G. R., Wetzstein, C. J., Fields, D. A., Brown, A., & Bamman, M. M. (2000). Resistance training increases total energy expenditure and free-living physical activity in older adults. *Journal of applied physiology 89*(3), 977-984. https://doi.org/10.1152/jappl.2000.89.3.977

ВПЛИВ ФІЗИЧНОЇ АКТИВНОСТІ ОНЛАЙН ПІД ЧАС ПАНДЕМІЇ COVID-19 СЕРЕД СТУДЕНТІВ БАКАЛАВРАТУ В ТАЇЛАНДІ

Порамет Гемарачатанон[1ABCD], Ваттана Наттуч[1ABC], Ніранут Віравонг[1ABC], Сонтарапорн Хунтула[1ABCD]

[1]Університет імені Валайлаки

Авторський вклад: A – дизайн дослідження; B – збір даних; C – статаналіз; D – підготовка рукопису; E – збір коштів

Реферат. Стаття: 7 с., 3 табл., 3 рис., 29 джерел.

Мета дослідження. Метою цього дослідження було розробити програму фізичної активності з використанням еспандера для студентів, щоб покращити їхню фізичну активність і контролювати покращення фізичної результативності. Це може вплинути на фізичну активність студентів університету, яка була низькою ще до пандемії. Тому ми хочемо включити фізичну активність у наш курс та оцінити відмінності у фізичній результативності до та після проходження курсу.

Матеріали та методи. На курс записалися 95 студентів бакалаврату коледжу. Онлайн-курс, який включав тренування з еспандером протягом загалом 12 тижнів, стосувався принципів тренувань/вправ з еспандером. Фізичну результативність учасників оцінювали як до, так і після тренувань.

Результати. Відповідно до результатів нашого дослідження, студенти Університету Валайлак можуть підвищити свою фізичну результативність, використовуючи онлайн-тренування з еспандером. Статистичні дані фізичної підготовленості для тесту на присідання з опорою, тесту на присідання, тесту на нахил тулуба вперед із положення сидячи сидячи, а також тесту на човниковий біг статистично значущо різнилися до та після онлайн-тренувань з еспандером (p=0,0463, p=0,0050 та p=0,0430 відповідно), але не для човникового бігу або 3-хвилинного степ-тесту YMCA.

Висновки. Результати цього дослідження є доказом того, що тренування з еспандером підвищують силу та заохочують до фізичної активності. Щоб зменшити тривожність і депресію, на які серйозно вплинув COVID-19, а також підвищити рівень фізичної активності чи вправ серед населення, ми повинні постійно сприяти фізичній активності чи вправам удома.

Ключові слова: фізична активність, пандемія COVID-19, тренування з еспандером, фізична результативність.

Information about the authors:

Hemarachatanon, Poramet: hporamet@wu.ac.th; https://orcid.org/0000-0002-9290-0674; Department of Sport and Exercise Science, Walailak University, 222 Thaiburi, Tha Sala District, Nakhon Si Thammarat 80161, Thailand.

Wattana, Nuttouch: wattana.nu@wu.ac.th; https://orcid.org/0000-0003-3964-8560; Department of Sport and Exercise Science, Walailak University, 222 Thaiburi, Tha Sala District, Nakhon Si Thammarat 80161, Thailand.

Weerawong, Neeranoot: neeranoot.we@wu.ac.th; https://orcid.org/0000-0002-9017-7170; Department of Sport and Exercise Science, Walailak University, 222 Thaiburi, Tha Sala District, Nakhon Si Thammarat 80161, Thailand.

Huntula, Soontaraporn: soontaraporn.hu@wu.ac.th; https://orcid.org/0000-0003-0243-2539; Department of Sport and Exercise Science, Walailak University, 222 Thaiburi, Tha Sala District, Nakhon Si Thammarat 80161, Thailand.

Cite this article as: Hemarachatanon, P., Nuttouch, W., Weerawong, N., & Huntula, S. (2023).The Effects of Online Physical Activity During Covid-19 Pandemic among Undergraduate Students in Thailand. *Physical Education Theory and Methodology, 23*(2), 229-235. https://doi.org/10.17309/tmfv.2023.2.11

Received: 04.02.2023. Accepted: 18.03.2023. Published: 28.04.2023

Теорія та методика фізичного виховання
Physical Education Theory and Methodology
Teorìâ ta Metodika Fìzičnogo Vihovannâ

ISSN 1993-7989 (print)
ISSN 1993-7997 (online)
ISSN-L 1993-7989

ORIGINAL SCIENTIFIC ARTICLE

OPTIMIZATION OF THE TRAINING PROCESS OF HIGHLY QUALIFIED ATHLETES IN ATHLETICS COMBINED EVENTS AT THE STAGE OF DIRECT PREPARATION FOR COMPETITIONS

Vadym Adamchuk[1ABCDE], Natalia Shchepotina[1ABCDE], Viktor Kostiukevych[1ABCDE], Olha Borysova[2BCDE], Viktoriia Bohuslavska[1BCDE], Valeria Tyshchenko[3BCDE], Vira Ovcharuk[4BCDE], Anna Bondar[5BCDE] and Vadym Poliak[1BCDE]

[1]Vinnytsia Mykhailo Kotsiubynskyi State Pedagogical University
[2]National University of Ukraine on Physical Education and Sport
[3]Zaporizhzhia National University
[4]Vinnytsia National Technical University
[5]Vinnytsia Institute of Trade and Economics of State University of Trade and Economics

Authors' Contribution: A – Study design; B – Data collection; C – Statistical analysis; D – Manuscript Preparation; E – Funds Collection

Corresponding Author: Viktor Kostiukevych, Email: kostykevich.vik@gmail.com
Accepted for Publication: March 18, 2023
Published: April 28, 2023

DOI: 10.17309/tmfv.2023.2.12

Abstract

The purpose of the study was to develop an optimal model of the stage of direct preparation for competitions of highly qualified multieventers in athletics and experimentally justify its effectiveness.

Materials and methods. 5 highly qualified multieventers, whose sports qualification is the Master of Sports of Ukraine, participated in the pedagogical experiment. The average age of the participants was (M±SD) 25.2±1.79 years. Research methods: theoretical analysis and generalization of data from literary sources; pedagogical experiment (the study was conducted from 2019 to 2021 according to the scheme of a sequential pedagogical experiment: from 2019 to 2020 – the ascertaining stage and from 2020 to 2021 – the formative stage); pedagogical observation of training and competitive activities; pedagogical testing (running 60 m from a high start, running 2 × 200 m with a rest interval of 1 min, triple jump from a standing position, throwing a ball with two hands from below on range, the running version of the $PWC_{170(V)}$ test was used for estimation of physical capacity and aerobic productivity of athletes); mathematical and statistical methods.

Results. The total amount of training work of the studied multieventers at the stage of the formative experiment was reduced to 3148 min, compared to the ascertainment stage (4999 min), however, their intensity increased to an average of 6.11 points/min, compared to 5.72 points/min at the ascertainment stage. We managed to optimize the training process due to the developed models of microcycles at the stage of direct preparation for competitions, in which attention was focused on the leading types of each of the multieventers.

Conclusions. Reducing the amount of load at the stage of direct preparation for competitions with a simultaneous increase in their intensity allowed the athletes to reach the peak of their sports form, as evidenced by the results of the main competitions of each of the athletes. The analysis of indicators of physical and functional fitness of highly qualified track and field athletes made it possible to establish that most of the results at the stage of the formative experiment improved statistically in a reliable way by an average of 2.6-6.5 %, which confirms the effectiveness of the proposed 8-week model of the stage of direct preparation for the competition and allows to recommend it for practical use in the training process of multieventers at the stage of maximum fulfillment of individual capabilities.

Keywords: basic mesocycle, control-preparatory mesocycle, pre-competition mesocycle, combined events, multieventers, training process, load value, load amount, load intensity.

Introduction

The most important period in the training of highly qualified athletes is the stage of direct preparation for competitions. In the traditional planning of the training process, coaches and athletes often focus on the competitive results they are trying to achieve in a certain calendar year and plan the preparation for these competitions accordingly. Recently, in international practice, at all stages of long-term training, an athlete is allowed to participate in competitions during the year, but training is adjusted to the long-term needs of the athlete and not directly to secondary competitions (Nedoshchak & Sukhynyn, 2013; Kasper, 2019; Jeffreys & Moody, 2021).

The introduction into the structure of annual training at a special stage – direct preparation for the most important competitions which for a long time was associated with the concept of "narrowing" or "tapering" (according to the terminology of foreign authors), provides for the creation of conditions for full recovery after previous loads (Spilsbury, 2021; Ouergui et al., 2022; Winwood et al., 2022). According to this understanding of the essence of the stage of direct preparation and depending on the previous load, its content is built and the duration and magnitude of the load are determined, and the effectiveness and course of restorative reactions are evaluated (Bobrovnik, 2014; Ritchie, Allen & Kirkland, 2018; Botonis, Toubekis & Platanou, 2019). Determining the optimal amount of load during the construction of a "narrowing" is carried out exclusively by foreign authors based on such indicators as the volume and intensity of loads, as well as the number of training sessions in certain structural formations of the training process (Le Meur, Hausswirth & Mujika, 2012; Bazyler et al., 2017; Bompa & Buzzichelli, 2018).

Solving specific tasks in the final weeks before the main starts requires establishing optimum amounts of training work and load dynamics, combining classes with training loads of different orientations and sizes, using rest, restorative means in the form of a complete complex. It is also necessary to provide operational and ongoing control over the course of recovery and adaptation processes (Kutek & Akhmetov, 2018; Bezmylov et al., 2022). Taking into account the mentioned problems, the domestic authors developed the most rational 8-week stage of direct preparation for the main competitions, in which three mesocycles are allocated (2week basic, 3-week special preparation, 3-week pre-competition) with strictly defined tasks and corresponding them by the content of training. Direct preparation for the rest of the year's competitions is short-term and takes the form of a competitive microcycle of 5-6 to 8-9 days, in which the first 3-5 days are used for full recovery, and the next 2-4 days are devoted to pre-start training and participation in competitions (Platonov, 2018, 2020).

Positive results of using the 8-week model of the stage of direct preparation for major competitions have been noted in various sports. In athletics, the use of short-term "retraining" is practiced, in which direct preparation for the main competitions is carried out mainly at the expense of restorative means in the absence of a focus of the training process for the purpose of achieving maximum deferred training effect (Bora, 2012; Kozlova, Wei & Kozlov, 2020). At the same time, no special studies on this topic in athletics combined events were found in the available sources.

Taking into account the continuous development of the system of training athletes in athletics, the variety and scale of competitions, significant financial and rating incentives (Adamchuk et al., 2021; Bilous & Kononenko, 2022; Pahan & Singh, 2022), the problem arises of applying such a model of the stage of direct preparation for competitions in athletics combined events, the content of which will consist of the optimal parameters of training loads and which in the final result will ensure the successful performance of athletes at the main competitions.

Research hypothesis: it was assumed that the optimization of the training process on the stage of direct preparation for competitions of highly qualified multieventers will allow targeted managerial influences on the adaptive resources of athletes for the formation of training effects and the achievement of high sports results.

The purpose of the study was to develop an optimal model of the stage of direct preparation for competitions of highly qualified multieventers in athletics and experimentally justify its effectiveness.

Materials and methods

Participants

5 highly qualified multieventers, whose sports qualification is the Master of Sports of Ukraine participated in the pedagogical experiment. The average age of the participants was (M±SD) 25.2±1.79 years. The study was approved by the ethics committee of Mykhailo Kotsiubynskyi Vinnytsia State Pedagogical University, and all procedures were in accordance with the Declaration of Helsinki. Informed consent for participation in the experiment was obtained from the participants.

Research organization

The study was conducted from 2019 to 2021 according to the scheme of a sequential pedagogical experiment: from 2019 to 2020 – the ascertaining stage and from 2020 to 2021 – the formative stage. After conducting the ascertaining stage of the experiment, it was established that was 8-week stage of direct preparation, in which three mesocycles are distinguished: basic, control-preparatory and pre-competition, was the most optimal (Fig. 1).

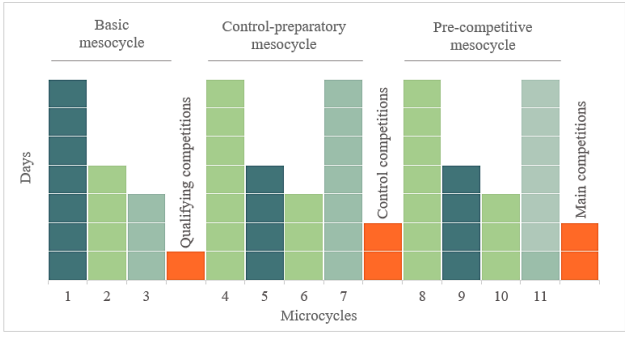


Fig. 1. The structure of the 8-week stage of direct preparation for competitions of highly qualified multieventers (summer season): – shock microcycle; – recovery microcycle; – preliminary microcycle; – competitions

Table 1. Main load parameters in mesocycles at the stage of direct preparation for competitions of highly qualified multieventers (summer season)

	Load parameters	Mesocycles		
		Basic mesocycle (14 day)	Control-preparatory mesocycle (21 day)	Pre-competitive mesocycle (21 day)
Technical preparation, min	TP-1 (hurdling)	125	138	122
	TP-2 (high jumps)	60	84	65
	TP-3 (long jumps)	65	73	55
	TP-4 (pole vault)	135	127	82
	TP-5 (shot put)	65	55	52
	TP-6 (discus throw)	40	63	40
	TP-7 (javelin throw)	55	79	45
	Σ of the training work, min	545	619	461
Physical preparation, min	S (speed)	63	95	105
	S-1 (speed endurance)	45	55	50
	SP (speed and strength training)	156	189	178
	GPT (general physical training)	68	105	98
	P (power training)	106	96	126
	E (endurance)	48	25	15
	Σ of the training work, min	486	565	572
Σ of the training work, min		1031	1185	1033
VLC*, points		6625	7379	5961
ICtl**, points/min		6.03	5.84	6.15

Notes: * VLC – value load coefficient was calculated as a result of multiplication of the duration of the exercise by its intensity in points depending on the heart rate (Kostiukevych, Shchepotina et al, 2020): intensity of exercise with the heart rate 114 bpm was evaluated in 1 point; 120 bpm – 2 points; 126 bpm – 3 points; 132 bpm – 4 points; 138 bpm – 5 points; 144 bpm – 6 points; 150 bpm – 7 points; 156 bpm – 8 points; 162 bpm – 10 points; 168 bpm – 12 points; 174 bpm – 14 points; 180 bpm – 17 points; 186 bpm – 21 points; 192 bpm – 25 points; 198 bpm – 33 points. ** ICtl – intensity coefficient of training load was determined as a ratio between VLC and the duration of a training session in minutes (Adamchuk et al, 2021)

The main parameters of the training work of highly qualified multieventers at the stage of direct preparation for the competition are given in the table. 1. In general, we note that a large volume of training work was performed in the two-week basic mesocycle, which was aimed at improving speed and strength abilities and adjusting technical elements from all combined events. The control-preparatory mesocycle began with active rest after qualifying competitions, followed by intense special training (85-90% of maximum performance). In the following days, the loads were reduced to prepare the athletes for performance in control competitions. Active recreation was planned at the beginning of the pre-competition mesocycle. Further, the loads gradually increased and 10 days before the main competition, training work with overload was performed in order to reach the peak of supercompensation.

The outlined content of the stage of direct preparation for the competition was implemented through the development and implementation of appropriate models of microcycles. As can be seen from fig. 1, the structure of the stage consisted of preliminary, shock and recovery microcycles. The structure and content of 7-day shock, preliminary and recovery microcycles are presented in detail in previous studies (Adamchuk et al., 2021). As a sample, we present the model of a 4-day shock microcycle (Table 2).

Control of the training process at the ascertaining stage of the pedagogical experiment was carried out using the methods of pedagogical observation and timing of training work, during which the heart rate of the studied multieventers was determined using a POLAR RS800CX heart rate monitor. This made it possible to establish the volume, magnitude and intensity of loads during the studied period.

The indicators of the physical and functional fitness of the sportsmen under study were the criteria for the effectiveness of building the training process of multieventers during the ascertainment and formative stages of the experiment. Using the method of pedagogical testing, the following indicators were determined (Adamchuk et al, 2021; Kostiukevych et al., 2021): running 60 m from a high start, running 2 × 200 m with a rest interval of 1 min (the total time to overcome two segments was determined), triple jump from a standing position, throwing a ball with two hands from below on range. All tests were carried out according to standard methods.

The running version of the $PWC_{170(V)}$ test was used for estimation of physical capacity and aerobic productivity of athletes: according to the method for conducting a run-based variant of the test $PWC_{170(V)}$ the athletes performed two 5-minute run loads by overcoming the distances of

Table 2. Model of the 4-day shock microcycle of the spring-summer training cycle (speed-power type)

Groups of exercises	Days of microcycle				In all
	1	2	3	4	
General physical training, min	GPT 1.1(a)–20^4	GPT 1.1(a)–20^4	GPT 2.1(a)–25^4	GPT 1.2 – 25^4	90
Special physical preparation, min	S 1.2 – 20^{13}	P-20^6 P-1.5(b) – 20^8 SP1.5(b) – 12^6	S-1.9 – 10^{13} SP 1.7 – 20^5	P-2.2 – 20^6	P–60 SP–32 S–20 S1–10
Technical preparation, min	TP-1.15 – 30^{13} TP-5.1(b) – 10^4 TP-5.2(b) –20^5	TP-4.3(a) – 45^7 TP-6.1 – 10^5 TP-6.2 – 20^6	TP-3.7 – 20^8 TP-7.1(b) – 10^4 TP-7.2(b) – 20^5	TP-1.3 – 10^5 TP-2.3 – 20^8	TP-1–40 TP-2–20 TP-3–20 TP-4–45 TP-5–30 TP-6–30 TP-7–30
Σ of the training work, min	100	147	105	75	427
VLC, points	870	917	630	430	2847
ICtl, points/min	8,70	6,23	6,0	5,73	6,67

Notes: record of the exercise like TP-3.7 – 20^8 means: TP-3.7 – code of the training exercise; 20^8 – duration of exercise in minutes (20) and its intensity in points depending on the heart rate (8)

700-900 and 1100-1300 m accordingly, with their heart rate being recorded at the end of the first and second load (the period of rest between run loads made 5 minutes). $PWC_{170(V)}$ was determined using the formula:

$$PWC_{170}(V) = V_1 + (V_2 - V_1)\frac{170 - f_1}{f_2 - f_1} \quad , (1)$$

whereas: V_1 and V_2 represent run speed during the first and second run loads (determined as a ratio between the distance length and the time for overcoming the distance), m/s;
f_1 and f_2 represent heart rate immediately after the first and second run load, bpm.

The following formula was used to convert $PWC_{170(V)}$ in m/s into PWC_{170} in kgm/min:

$PWC_{170}=417 \cdot PWC1_{70(V)}-83$, (2)

Absolute index of maximum oxygen consumption (VO_2max, ml/min) was determined using the formula:

$VO_2max=1,7 \cdot PWC_{170}+1240$, (3)

Relative index of maximum oxygen consumption ($VO_2max(rel)$, ml/min/kg) was determined as a ratio of an absolute index to the body mass of the studied athletes.

Pedagogical testing of athletes was carried out at the beginning and at the end of the stage of direct preparation for competitions in the process of performing the main training work.

Statistical analysis

Descriptive statistics (Albert et al., 2017; Byshevets et al., 2019; Kostiukevych, Lazarenko et al., 2020) were used during the mathematical processing of the results of pedagogical testing, which involved determining the mean value (M) and the standard deviation (SD). Statistical reliability in the difference of results at the beginning and at the end of the ascertaining and formative stages of the pedagogical experiment was determined by the non-parametric Wilcoxon T-test. Differences between groups were considered statistically significant at $p<0.05$.

Results

Summarizing the results of pedagogical observation and timing of training work allows us to determine the dynamics of volumes (Fig. 2), as well as the magnitude and intensity (Fig. 3) of the training loads of the studied multieventers during the ascertaining and formative stages of the pedagogical experiment.

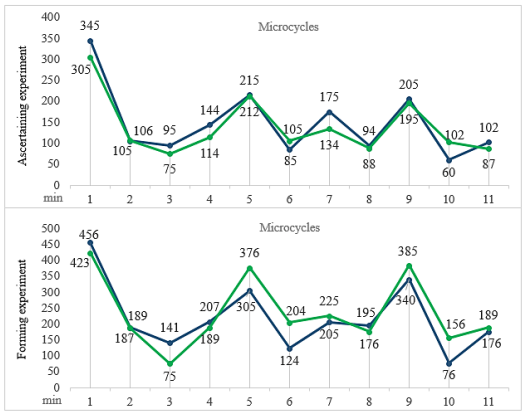


Fig. 2. Dynamics of volumes of the training loads of the studied multieventers during the ascertaining and formative stages of the pedagogical experiment: ▬ – special physical preparation; ▬ – technical preparation

The duration of training work in different microcycles at the ascertaining and formative stages differed. The largest amount of training work was found in shock microcycles (1st, 5th and 9th) – within 681-879 min at the stage of ascertaining experiment and within 400650 min at the stage of formative experiment. In addition, it is precisely in these microcycles that the highest coefficients of the size and intensity of the training load were found – respectively within the range of 4120-5283 points and 6.01-6.57 points/min at the stage

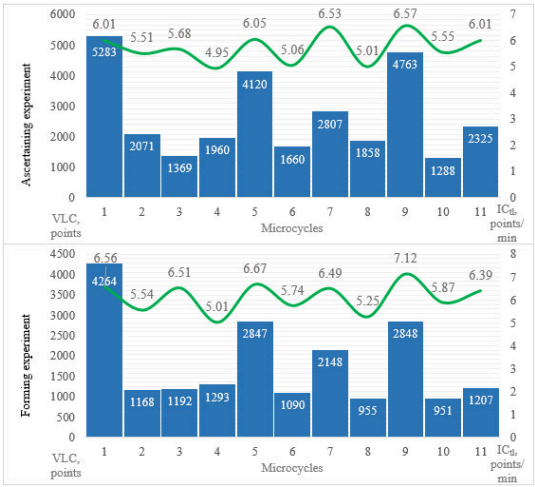


Fig. 3. The magnitude and intensity of the training loads of the studied multieventers during the ascertaining and formative stages of the pedagogical experiment: – VLC – value load coefficient; – ICtl – intensity coefficient of training load

of the ascertainment experiment and within the range of 2847-4264 points and 6.56-7.12 points/min at the stage of the formative experiment. Such a structure and content of the training process in impact microcycles are connected with the need to solve the tasks of physical and technical training of athletes.

The shortest duration of training work in recovery microcycles (2nd, 4th, 6th, 8th and 10th) at the stage of the ascertaining experiment within 232-396 minutes at the stage of the formative experiment – within 162-258 minutes. Solving the tasks of restoring the functional systems of the athletes' bodies in these microcycles after significant loads of shock microcycles and competitions determined the lowest indicators of the magnitude and intensity of the loads – within 1288-2071 points and 4.95-5.55 points/min, respectively, at the ascertainment stage of the experiment and within 951-1293 points and 5.01-5.87 points/min at the stage of formative experiment.

Preliminary microcycles (3rd, 7th and 11th) were used before the control and main competitions. They were characterized by a small amount of training work – 216430 min at the stage of the ascertainment experiment and 170-309 min at the stage of formative experiment. In order to avoid overtraining and exhaustion of the functional systems of the sportsmen's body before the competition, the magnitude and intensity of the loads were smaller than the impact microcycles – respectively 13692807 points and 6.34-6.53 points/min at the stage of the ascertainment experiment and 1192-2148 points and 5.95-6.39 points/min at the stage of the formative experiment, and the training process was aimed at ensuring the best condition and high performance of the athletes before the competition.

The total amount of training work of the studied multieventers at the stage of the formative experiment was reduced to 3148 min, compared to the ascertainment stage (4999 min), however, their intensity increased to an average of 6.11 points/min, compared to 5.72 points/min at the ascertainment stage.

As already mentioned, the criteria for the effectiveness of the training process were the indicators of the physical and functional readiness of the multieventers and their dynamics at the stages of the pedagogical experiment. Pedagogical testing was carried out in shock microcycles in the process

Table 3. Indicators of physical and functional preparedness of multieventers at the stage of direct preparation for summer season competitions at different stages of the experiment

Indicators of physical and functional fitness	Research phase	weekend data		Final data		Changes (ΔM)		T	p
		M	SD	M	SD	Absolute	%		
Running for 60 m, s	AE	6.84	0.07	6.76	0.09	0.08	1.2	2	>0.05
	FE	6.82	0.06	6.65	0.08	0.17	2.6	0	<0.05
Running 200 m and 200 m after 1 min of rest, s	AE	49.75	1.18	49.69	1.00	0.06	0.1	3	>0.05
	FE	49.72	0.67	49.04	0.52	0.68	1.4	1	>0.05
Triple jump from a place, m	AE	8.90	0.45	9.15	0.39	0.25	2.8	1	>0.05
	FE	8.85	0.28	9.38	0.31	0.53	6.0	0	<0.05
Throwing a shot (6kg) with two hands from below, m	AE	16.05	0.48	16.56	0.44	0.51	3.2	1	>0.05
	FE	15.94	0.34	16.98	0.59	1.04	6.5	0	<0.05
PWC_{170} (V), m/s	AE	4.77	0.68	4.94	0.71	0.17	3.4	0	<0.05
	FE	4.81	0.56	5.09	0.42	0.28	5.8	0	<0.05
PWC_{170}, kgm/min	AE	1906.0	283.6	1974.4	295.3	68.4	3.4	0	<0.05
	FE	1921.3	232.6	2048.7	174.1	127.4	6.6	0	<0.05
VO_2max, ml/min	AE	4480.2	482.2	4596.4	502.0	116.2	2.5	2	>0.05
	FE	4506.3	395.4	4722.7	295.9	216.4	4.6	0	<0.05
VO_2max (rel), ml/min / kg	AE	53.8	8.0	55.1	6.4	1.3	2.4	2	>0.05
	FE	54.1	6.7	56.6	4.0	2.5	4.6	0	<0.05

Notes: PWC_{170}(V) is a running version of the test; PWC_{170} is an indicator of physical working capacity; VO_2max is an absolute indicator of maximum oxygen consumption; VO_2max(rel) is a relative indicator of maximum oxygen consumption; AE – ascertaining experiment; FE – forming experiment

of performing the main training work. Since the studied indicators at the beginning of the ascertaining and formative stages of the experiment did not differ statistically significantly ($p>0.05$), this gave us grounds for continuing the pedagogical experiment and obtaining objective data at the end.

Analysis of the dynamics of indicators of physical and functional fitness of multieventers at the stages of the pedagogical experiment allows us to note positive dynamics (Table 3). At the same time, more pronounced changes were revealed by the results of the formative stage of the experiment. In particular, we note a statistically significant improvement in indicators characterizing the level of manifestation of speed abilities, where the increase in results was 2.6 % ($p<0.05$). In test exercises reflecting speed and strength abilities, the increase in results ranged from 2.8 to 6.5 % ($p<0.05$). We attribute the increase in these indicators to the fact that at the stage of direct preparation for the main competitions, the training work focused on leading physical qualities. Also, the increase in results occurred due to a decrease in the amount of energy-consuming exercises, which made it possible to "decrease" the athletes' load before the competition.

During the formative stage of the experiment, we also noted positive dynamics in the indicators of speed endurance, where an increase of 1.4 % was observed, but without a significant difference ($p>0.05$). We associate this with the fact that the test exercise was performed 10 days before the main competition. This corresponded to the time frame when athletes needed to maintain an optimal level of fatigue to prevent overtraining.

In the indicators characterizing the functional preparedness of multieventers, positive dynamics were revealed both during the ascertaining and formative stages of the experiment. In particular, during the formative stage, we note a statistically significant increase in results in indicators of physical performance of multieventers within the range of 5.8-6.6 % ($p<0.05$), and in indicators of aerobic productivity – 4.6 % ($p<0.05$).

Participation in the main competitions of the summer season showed positive dynamics of the results in the decathlon of highly qualified athletes who were involved in the pedagogical experiment (Fig. 4).

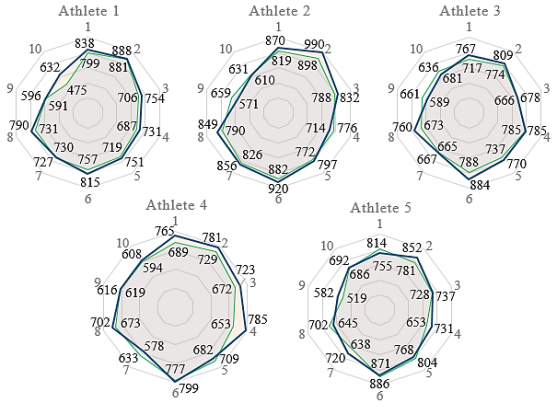


Fig. 4. The results of the decathlon of highly qualified multieventers at the stages of ascertaining and formative experiments, points: 1 – 100 meters; 2 – long jump; 3 – shot put; 4 – high jump; 5 – 400 meters; 6 – 110 meters hurdles; 7 – discus throw; 8 – pole vault; 9 – javelin throw; 10 – 1500 meters

The analyzed data serve as a sufficient reason to believe that the influence of the training program and the microcycle program at the stage of direct preparation for the competition allowed the athletes to reach the peak of their sports form and demonstrate high sports results.

Discussion

Despite its relatively short duration, the stage of direct preparation for important competitions and, especially, its final pre-competition mesocycle, plays a major role in achieving the final result of long-term work and success in competitions. This stage solves such defining tasks as maintaining the achieved level of training, improving training movements, checking and clarifying technical elements, psychological preparation for the competition, providing active rest before the competition (Platonov, 2018; Chojnicki, Smoleńska & Muszkieta, 2021; Sobol et al., 2021). The implementation of the stage of direct preparation for the main competitions of highly qualified athletes has shown its effectiveness in various sports (Botonis, Toubekis, Platanou , 2019; Ouergui et al., 2022; Winwood et al., 2022), including athletics (Bora, 2012; Bobrovnik, 2014; Spilsbury, 2021), but it has not found its theoretical and methodological justification in combined events, which is technically the most difficult and physically demanding track and field discipline. In this regard, the models of the structure and content of the outlined stage, micro- and mesocycles reflected in the study represent a significant contribution to the scientific work on the problem of training athletes in athletics combined events. According to the results of the conducted research, the expediency of using the 8-week model of the stage of direct preparation for competitions in the annual training cycle of highly qualified multieventers was confirmed (Bompa & Buzzichelli, 2018; Platonov, 2018).

Management of the training process of highly qualified multieventers in relation to the assessment of their functional state in the context of increasing physical loads requires practical justification. The principle of supercompensation has become basic for sports training at the stage of direct preparation for major competitions. According to the theory of supercompensation, several concepts of training during the "tapering" period were developed, of which the most acceptable was the modified scheme of the sum of training loads, which involves the accumulation of fatigue from several training sessions in the supercompensation phase and full recovery after reaching a certain level of the total load. At the current stage, the use of the 8-week model of the stage of direct preparation for the main competitions dominates, which provides for consistent preparation for overload , the creation of conditions for the development of the delayed training effect and the achievement of an adaptation jump before the main competitions (Bora, 2012; Bompa & Buzzichelli, 2018; Platonov, 2018). In the context of the above, the presented 8-week model of the stage of direct preparation for competitions of highly qualified athletes in athletics combined events substantiates the practical mechanism of timely implementation of the supercompensation phase in a responsible sports competition. Such an effect was achieved due to the optimization of training loads. Reducing the volume of physical exertion and increasing its intensity allowed highly qualified multieventers to reach their peak

sports form and to generate additional reserves in the body at the stage of direct preparation for competitions.

We managed to optimize the training process due to the developed models of microcycles at the stage of direct preparation for competitions, in which attention was focused on the leading types of each of the multieventers. An individual approach to the selection of technical and physical training was carried out, but at the stage of the formative experiment we reduced the number of exercises with a large amount of load, which "relieved" the multieventers from excessive training work. Thus, it was confirmed the expediency of paying the main attention to the improvement of performance in the types of combined events, to which the athlete has a pronounced tendency to develop, and mainly the supporting nature of the training in relation to the rest of the combined events types (Dobrynska, 2015; Chapon, Navarro & Edouard, 2022).

Appropriate application of loads of different orientation influenced the formation of adaptive reactions and the development of sports form. Based on the analysis of the average indicators of the load intensity factor at the stage of direct preparation for the competition, its wave-likeness is well observed. The distribution of volume and intensity was carried out with the provision of a wave-like alternation of training loads and recovery. Emphasis was done on the development of the basic components of special physical training and the main technical elements of the leading types of each multieventers. At the stage of the formative experiment, a uniform load distribution was implemented in individual types of combined events with a reduction in the duration of daily training by 20-30 %.

In general, the obtained results also significantly complement the existing scientific work on the rational distribution of training loads of highly qualified athletes at the stage of direct preparation for competitions (Nedoshchak & Sukhynyn, 2013; Kutek & Akhmetov, 2018; Platonov, 2018).

Conclusions

1. For highly qualified multieventers, the most optimal is an 8-week stage of direct preparation for the main competitions, which includes impact, recovery and water microcycles of different durations, depending on the competition calendar.

2. Reducing the amount of load at the stage of direct preparation for competitions with a simultaneous increase in their intensity allowed the athletes to reach the peak of their sports form, as evidenced by the results of the main competitions of each of the athletes.

3. The analysis of indicators of physical and functional fitness of highly qualified multieventers made it possible to establish that most of the results at the stage of the formative experiment improved statistically in a reliable way by an average of 2.6-6.5%, which confirms the effectiveness of the proposed 8-week model of the stage of direct preparation for the competition and allows to recommend it for practical use in the training process of multieventers at the stage of maximum fulfillment of individual capabilities.

Acknowledgements

The research was carried out within the framework of the plan of the research work of the Department of Theory and Methodology of Sports of Vinnytsia Mykhailo Kotsiubynskyi State Pedagogical University for 2016-2020 "Theoretical and Methodological Foundations of Programming and Modeling of the Training Process of Sportsmen of Different Qualifications" (state registration number 0116U005299) and for 2021-2025 "Organizational and methodological principles of programming the training process of gratified and highly gratified athletes" (state registration number 0121U109550).

Conflict of interests

The authors state that there is no conflict of interests.

References

Nedoshchak, V.S., & Sukhynyn, V.A. (2013). Organization of the training process at the pre-competition stage. *Scientific Journal of National Pedagogical Dragomanov University. Series 15. Scientific and Pedagogical Problems of Physical Culture (physical Culture and Sports),* 94-100.

Kasper, K. (2019). Sports training principles. *Current Sports Medicine Reports, 18*(4), 95-96. https://doi.org/10.1249/JSR.0000000000000576

Jeffreys, I., & Moody, J. (2021). *Strength and conditioning for sports performance.* Routledge.

Spilsbury, K.L. (2021). Tapering and Peaking for an Event or Major Competition. *The Science and Practice of Middle and Long Distance Running,* 132-144.

Ouergui, I., Daira, I., Chtourou, H., Bouassida, A., Bouhlel, E., Franchini, E., & Ardigò, L.P. (2022). Effects of intensified training and tapering periods using different exercise modalities on judo-specific physical test performances. *Biology of Sport, 39*(4), 875-881. https://doi.org/10.5114/biolsport.2022.108702

Winwood, P. W., Keogh, J. W. L., Travis, S. K., & Pritchard, H. J. (2023). The Tapering Practices of Competitive Weightlifters. *Journal of Strength and Conditioning Research, 37*(4), 829-839. https://doi.org/10.1519/JSC.0000000000004324

Bobrovnik, V. I. (2014). Structure and logical organization of current studies in track and field sports. *Pedagogics, psychology, medical-biological problems of physical training and sports, 18*(3), 3-18. https://doi.org/10.6084/m9.figshare.936956

Ritchie, D., Allen, J.B., & Kirkland, A. (2018). Where science meets practice: Olympic coaches' crafting of the tapering process. *Journal of sports sciences, 36*(10), 1145-1154. https://doi.org/10.1080/02640414.2017.1362717

Botonis, P.G., Toubekis, A.G., & Platanou, T.I. (2019). Training loads, wellness and performance before and during tapering for a Water-Polo tournament. *Journal of Human Kinetics, 66*(1), 131-141. https://doi.org/10.2478/hukin-2018-0053

Le Meur, Y., Hausswirth, C., & Mujika, I. (2012). Tapering for competition: A review. *Science & Sports, 27*(2), 77-87. https://doi.org/10.1016/j.scispo.2011.06.013

Bazyler, C.D., Mizuguchi, S., Harrison, A.P., Sato, K., Kavanaugh, A.A., DeWeese, B.H., & Stone, M.H. (2017). Changes in muscle architecture, explosive ability, and track and field throwing performance throughout a

competitive season and after a taper. J*ournal of Strength & Conditioning Research, 31*(10), 27852793. https://doi.org/10.1519/JSC.0000000000001619

Bompa, T.O., & Buzzichelli, C. (2018). *Periodization: theory and methodology of training.* Human kinetics.

Kutek, T., & Akhmetov, R. (2018). Improvement of sports training of qualified athletes. *Health, Sport, Rehabilitation, 3*(2), 44-49. http://dx.doi.org/10.34142/zenodo.1110381

Bezmylov, M., Shynkaruk, O., Byshevets, N., Qi, G., & Zhigong, S. (2022). Morphofunctional Characteristics of Basketball Players with Different Roles as Selection Criteria at the Stage of Preparation for Higher Achievements. *Physical Education Theory and Methodology, 22*(1), 92-100. https://doi.org/10.17309/tmfv.2022.1.13

Platonov, V.N. (2018). The structure and content of the direct preparation of highly qualified athletes for the main competition. *Science in Olympic Sports,* 2, 1741.

Platonov, V. (2020). Sports science of Ukraine: chapters of history. S*cience in Olympic Sport,* 3, 4-47. https://doi.org/10.32652/olympic2020.3_1.

Bora, P. (2012). Direct competition preparation in elite high jumping. *New Studies in Athletics,* 3, 23-28.

Kozlova, E., Wei, W., & Kozlov, K. (2020). Individual peculiarities of long jump technique of skilled athletes. *Journal of Physical Education and Sport,* 20, 408412. https://www.doi.org/10.7752/jpes.2020.s1058

Adamchuk, V., Shchepotina, N., Kostiukevych, V., Vozniuk, T., Kulchytska, I., Didyk, T., & Poliak, V. (2021). Technological Aspects of Introduction of 8-Week Model at the Phase of Direct Training for Competitions of Highly Qualified Multi-Sport Athletes in Track-And-Field Athletics. P*hysical Education Theory and Methodology, 21*(3), 200-210. https://doi.org/10.17309/tmfv.2021.3.03

Bilous, N., & Kononenko, N. (2022). The peculiarities of the physical training of the female heptathletes. *Scientific Journal of National Pedagogical Dragomanov University. Series 15. Scientific and Pedagogical Problems of Physical Culture (physical Culture and Sports), 11*(157), 30-35. https://doi.org/10.31392/NPU-nc.series15.2022.11(157).08

Pahan, M. K., & Singh, M. K. (2022). Reactive Stress Tolerance in Preadolescent Sports Participants: A Comparison of Six Individual Non-Contact Sports. *Physical Education Theory and Methodology, 22*(1), 121-127. https://doi.org/10.17309/tmfv.2022.1.17

Kostiukevych, V., Shchepotina, N., Shynkaruk, O., Koliadych, Y., Hatsoieva, L., Voronova, V., Vozniuk, T., Kaplinskyi, V., Diachenko, A., Chernyshenko, T., & Konnova, M. (2020). Highly qualified grass hockey sportswomen's adaptation to training intensity in the macrocycle preparatory period. *Journal of Physical Education and Sport, 20*(S1), 385-394. https://doi.org/10.7752/jpes.2020.s1055

Kostiukevych, V., Lazarenko, N., Shchepotina, N., Vozniuk, T., Shynkaruk, O., Voronova, V., Kutek, T., Konnov, S., Stasiuk, I., Poseletska, K., & Dobrynskiy, V. (2021). Factor Analysis of Special Qualities of Elite Field Hockey Players. *Sport Mont, 19*(S2), 41-47. https://doi.org/10.26773/smj.210908

Albert, J., Glickman, M.E., Swartz, T.B., & Koning, R.H. (2017). *Handbook of statistical methods and analyses in sports.* CRC Press.

Byshevets, N., Denysova, L., Shynkaruk, O., Serhiyenko, K., Usychenko, V., Stepanenko, O., & Syvash, I. (2019). Using the methods of mathematical statistics in sports and educational research. *Journal of Physical Education and Sport, 19*(3), 1030-1034. https://www.doi.org/10.7752/jpes.2019.s3148

Kostiukevych, V., Lazarenko, N., Vozniuk, T., Shchepotina, N., Shynkaruk, O., Valentina, V., Borysova, O., Didyk, T., Perepelytsia, O., Hudyma, S., & Bezmylov, N. (2020). Choice and experimental substantiation of tests for controlling physical and technical preparedness of hockey players. *Journal of Physical Education and Sport, 20*(5), 2735-2744. https://doi.org/10.7752/jpes.2020.05372

Chojnicki, D., Smoleńska, O., & Muszkieta, R. (2021). Key psychological factors in long distance running. *Health, Sport, Rehabilitation, 7*(3), 31-42. https://doi.org/10.34142/HSR.2021.07.03.02

Sobol, E., Svatyev, A., Doroshenko, I., Kokareva, S., Korzh, N., & Doroshenko, E. (2021). Formation of National Teams Taking into Account the Factors of Football Players' Club Migration. *Physical Education Theory and Methodology, 21*(4), 389-396. https://doi.org/10.17309/tmfv.2021.4.15

Dobrynska, N. (2015). *Improvement of specialized preparedness of highly skilled athletes in combined track and field events* [author's abstract]. Kyiv: NUUPES. (in Ukrainian)

Chapon, J., Navarro, L., & Edouard, P. (2022). Relationships between performance and injury occurrence in athletics (track and field): a pilot study on 8 national-level athletes from sprints, jumps and combined events followed during at least five consecutive seasons. *Frontiers in sports and active living,* 4, 852062. https://doi.org/10.3389/fspor.2022.852062

ОПТИМІЗАЦІЯ ТРЕНУВАЛЬНОГО ПРОЦЕСУ ВИСОКОКВАЛІФІКОВАНИХ СПОРТСМЕНІВ У ЛЕГКОАТЛЕТИЧНОМУ БАГАТОБОРСТВІ НА ЕТАПІ БЕЗПОСЕРЕДНЬОЇ ПІДГОТОВКИ ДО ЗМАГАНЬ

Вадим Адамчук[1ABCDE], Наталя Щепотіна[1ABCDE], Віктор Костюкевич[1ABCDE], Ольга Борисова[2BCDE], Вікторія Богуславська[1BCDE], Валерія Тищенко[3BCDE], Віра Овчарук[4BCDE], Анна Бондар[5BCDE], Вадим Поляк[1BCDE]

[1]Вінницький державний педагогічний університет імені Михайла Коцюбинського
[2]Національний університет фізичного виховання і спорту України
[3]Запорізький національний університет
[4]Вінницький національний технічний університет
[5]Вінницький торговельно-економічний інститут Київського національного торговельно-економічного університету

Авторський вклад: A – дизайн дослідження; B – збір даних; C – статаналіз; D – підготовка рукопису; E – збір коштів

Реферат. Стаття: 10 с., 3 табл., 4 рис., 30 джерел.

Метою дослідження було розробити оптимальну модель етапу безпосередньої підготовки до змагань висококваліфікованих багатоборців у легкій атлетиці й експериментально обґрунтувати її ефективність.

Матеріал і методологія. У педагогічному експерименті брали участь 5 висококваліфікованих багатоборців, спортивна кваліфікація яких – Майстер спорту України. Середній вік учасників становив (M±SD) 25,2±1,79 років. Методи дослідження: теоретичний аналіз і узагальнення даних літературних джерел; педагогічний експеримент (дослідження проводилося з 2019 по 2021 рр. за схемою послідовного педагогічного експерименту: з 2019 по 2020 рр. – констатувальний етап і з 2020 по 2021 рр. – формувальний етап), педагогічне спостереження за тренувальною та змагальною діяльністю; педагогічне тестування (біг 60 м з високого старту, біг 2×200 м з інтервалом відпочинку 1 хв, потрійний стрибок з місця, метання ядра двома руками знизу на дальність, біговий варіант тесту $PWC_{170(V)}$ використовувався для оцінки фізичної працездатності й аеробної продуктивності організму); математико-статистичні методи.

Результати. Загальний обсяг тренувальної роботи досліджуваних багатоборців на етапі формувального експерименту був зменшений до 3148 хв, порівняно з констатувальним етапом (4999 хв), однак збільшено їх інтенсивність у середньому до 6,11 бал/хв, порівняно з 5,72 бал/хв на констатувальному етапі. Нам вдалось оптимізувати тренувальний процес за рахунок розроблених моделей мікроциклів на етапі безпосередньої підготовки до змагань, у яких акцентувалась увага на провідні види кожного з багатоборців.

Висновки. Зменшення обсягів навантаження на етапі безпосередньої підготовки до змагань з одночасним збільшенням їх інтенсивності дало змогу вийти спортсменам на пік своєї спортивної форми, про що свідчать результати головних змагань кожного зі спортсменів. Аналіз показників фізичної та функціональної підготовленості висококваліфікованих легкоатлетів-багатоборців дав змогу встановити, що більшість результатів на етапі формувального експерименту статистично достовірно покращились у середньому на 2.6-6.5 %, що підтверджує ефективність запропонованої 8-тижневої моделі етапу безпосередньої підготовки до змагань і дозволяє її рекомендувати для практичного застосування в тренувальному процесі багатоборців на етапі максимальної реалізації індивідуальних можливостей.

Ключові слова: базовий мезоцикл, контрольно-підготовчий мезоцикл, передзмагальний мезоцикл, легкоатлетичне багатоборство, багатоборці, тренувальний процес, величина навантаження, обсяг навантаження, інтенсивність навантаження.

Information about the authors:

Adamchuk, Vadym: vadim-adamchuk@ukr.net; https://orcid.org/0000-0002-5009-7221; Department of Theory and Methodology of Sports, Vinnytsia Mykhailo Kotsiubynskyi State Pedagogical University, Ostrozkogo St, 32, Vinnytsia, 21001, Ukraine.

Shchepotina, Natalia: shchepa@mbox.vn.ua; https://orcid.org/0000-0002-9507-3944; Department of Theory and Methodology of Physical Education, Vinnytsia Mykhailo Kotsiubynskyi State Pedagogical University, Ostrozkogo St, 32, Vinnytsia, 21001, Ukraine.

Kostiukevych, Viktor: kostykevich.vik@gmail.com; https://orcid.org/0000-0002-6215-764X; Department of Theory and Methodology of Sports, Vinnytsia Mykhailo Kotsiubynskyi State Pedagogical University, Ostrozkogo St, 32, Vinnytsia, 21001, Ukraine.

Borysova, Olha: borisova-nupesu@ukr.net; https://orcid.org/0000-0002-2311-1921; Department of Professional, non-Olympic and Adaptive Sports, National University of Ukraine on Physical Education and Sport, Fizkultury St, 1, Kyiv, 03680, Ukraine.

Bohuslavska, Viktoriia: vik.bogusl@gmail.com; https://orcid.org/0000-0003-3609-5518; Department of Theory and Methodology of Sports, Vinnytsia Mykhailo Kotsiubynskyi State Pedagogical University, Ostrozkogo St, 32, Vinnytsia, 21001, Ukraine.

Tyshchenko, Valeria: valeritysh@ukr.net; https://orcid.org/0000-0002-9540-9612; Department of Theory and Methods of Physical Training and Sports, Zaporizhzhia National University, Zhukovsky St, 66, Zaporizhzhia, 69600, Ukraine.

Ovcharuk, Vira: ovcharukvira@gmail.com; https://orcid.org/0000-0002-0648-7994; Department of Physical Education, Vinnytsia National Technical University, Khmelnytsky highway 95, Vinnytsya, 21021, Ukraine.

Bondar, Anna: grinchukanna366@gmail.com; https://orcid.org/0000-0001-6051-1898; Department of Physical Education and Sports, Vinnytsia Institute of Trade and Economics of Kyiv National University of Trade and Economics, Soborna St, 87, Vinnytsia, 21100, Ukraine

Poliak, Vadym: polyak989@gmail.com; https://orcid.org/0000-0002-1165-8831; Department of Theory and Methodology of Sports, Vinnytsia Mykhailo Kotsiubynskyi State Pedagogical University, Ostrozkogo St, 32, Vinnytsia, 21001, Ukraine

Cite this article as: Adamchuk, V., Shchepotina, N., Kostiukevych, V., Borysova, O., Bohuslavska, V., Tyshchenko, V., Ovcharuk, V., Bondar, A., & Poliak, V. (2023). Optimization of the Training Process of Highly Qualified Athletes in Athletics Combined Events at the Stage of Direct Preparation for Competitions. *Physical Education Theory and Methodology, 23*(2), 236-245. https://doi.org/10.17309/tmfv.2023.2.12

Received: 08.02.2023. Accepted: 18.03.2023. Published: 28.04.2023

Теорія та методика фізичного виховання
Physical Education Theory and Methodology
Teorìâ ta Metodika Fìzičnogo Vihovannâ

ISSN 1993-7989 (print)
ISSN 1993-7997 (online)
ISSN-L 1993-7989

ORIGINAL SCIENTIFIC ARTICLE

CHANGES IN INDICATORS OF SPECIAL PHYSICAL PREPAREDNESS IN BADMINTON PLAYERS AGED 10–11 UNDER THE INFLUENCE OF SPECIALLY SELECTED EXERCISES

Oleg Shevchenko[1ABCD], Kateryna Mulyk[1ABCDE], Volodymyr Paievskyi[1ABC], Aleksander Skaliy[2ABC], Anatolii Guba[1ABD], Tetiana Skaliy[2ABC] and Olena Anosova[1ABC]

[1]Kharkiv State Academy of Physical Culture
[2]University of Economy in Bydgoszcz

Authors' Contribution: A – Study design; B – Data collection; C – Statistical analysis; D – Manuscript Preparation; E – Funds Collection

Corresponding Author: Kateryna Mulyk, E-mail: kateryna.mulyk@gmail.com
Accepted for Publication: April 3, 2023
Published: April 28, 2023

DOI: 10.17309/tmfv.2023.2.13

Abstract

Study purpose. The study purpose was to determine changes in indicators of special physical preparedness and speed of attacking strokes in badminton players aged 10–11 under the influence of specially selected exercises.

Materials and methods. The study participants were young badminton players aged 10–11 (12 boys), whose sports experience was 2-3 years. The study lasted 3 months and included: testing of special physical preparedness and assessment and analysis of the speed of attacking attacking strokes of young badminton players.

Results. Analysis of the results of the study showed positive changes in the results of special physical preparedness, accuracy and speed of attacking strokes. The complex development of the speed-strength abilities of young badminton players was determined by the exercises of throwing a ball weighing 1 kg, triple long jump and jumping rope. This was manifested in the execution of attacking strokes from the place and in jumping and moving, but there was a significant increase in results in the triple jump and jumping rope. The development of speed endurance determined the 4-point center-to-center movement exercise, but the results did not change significantly over the course of the study. Accuracy indicators of attacking strokes significantly increased by an average of 2,58%. The results of the speed of attacking strokes also had a significant increase by an average of 29.41%. The use of complexes for training the accuracy of attacking strokes along with targets with a gradual complication of exercises increased the results of test exercises for accuracy and speed of execution. The indicators of the speed of attacking strokes on the left and on the right correlate with each other. The accuracy results of the right hand strokes along the line significantly correlate with right hand strokes along the diagonal and the triple long jump from a place. This indicates the connection of speed-strength abilities with the performance of attacking strokes by young badminton players. Indicators of a triple long jump from a place, jumping rope for 1 min. and throwing a ball weighing 1 kg are significantly correlated with each other, which indicates the complex development of the speed-strength abilities of young badminton players.

Conclusions. The presented complexes of special preparatory exercises had a positive effect on changes in the indicators of special physical preparedness, accuracy and speed of the attacking strokes, which makes it possible to recommend them to 10–11-year-old badminton players in the training process.

Keywords: young badminton players, attacking strokes, performance, accuracy.

Introduction

The competitive activity of badminton players requires effective and stable attacking strokes, which require well-developed physical qualities, perfect mastery of the accuracy of body movements and the accuracy of strokes to the court. As competitive practice shows, the matches of athletes are held with greater speed and duration, with a large number of attacking strokes from different positions (Abdullah, 2014; Abián et al., 2014; Cabello-Manrique et al., 2003).

The effectiveness, speed, accuracy of attacking strokes in badminton is influenced by a large number of factors that have been studied by a number of specialists. Experts point out the need to constantly keep the shuttlecock in sight, timely and

correctly approach it and direct the strokes to the appropriate point on the site (Luo et al., 2020). An analysis of technical and tactical actions shows that for an opponent, the closer to the net and sidelines of the court an attacking stroke is performed, the more difficult it is to receive it, and that the most important thing is to get a positive result in the game (Karatnyk et al., 2015). At the same time, highly qualified athletes showed positive relationships between the effectiveness of technical skills with speed-strength abilities and flexibility (Mahulkar, 2016; Okun et al., 2020; Rovniy et al., 2018).

A number of authors proposed a technique for assessing the trajectory of strokes on the target of a short serve (Vial et al., 2019) and determined that the time of day and temperature affect the accuracy of serving in badminton (Preeti et al., 2019).

In the works of other authors, it is emphasized that with the appropriate angle of the flight path and the force of impact, the speed of the shuttlecock increases (Vial et al., 2019), the ability to track the trajectory of impact on the shuttlecock to correlate the movement of the racket to the target due to computer technology (Chi et al., 2021). The use of video technology made it possible to carry out a kinematic analysis of the movements of the shoulders, elbows and wrists when performing an attacking stroke in badminton (Rusdiana et al., 2021).

Many authors have been involved in the selection of special exercises for training badminton players (Sturgess et al., 2008; Guven et al., 2017; Ozmen et al., 2017; Shevchenko et al., 2021), which indicates a rational approach in our research. Also Zhang, 2023 determined that the explosive power of the upper limbs and the flexible and fast lower limbs are one of the important factors for the success of athletes in competitions.

Thus, the available results confirm the relevance of studying new ways to improve attacking hits in the training of badminton players in basic training groups. Based on the above, the purpose of this study is to determine the changes in indicators of special physical preparedness and the speed of attacking hits in badminton players aged 10-11 under the influence of specially selected exercises.

Material and methods

Participants

The study involved 12 boys (age = 10,4±0,53 y, body mass = 40,5±1,55 kg, and height = 148,8±1,67 cm), who practiced badminton for 2-3 years. Young athletes belonged to the same sports club and trained with the same coach. Classes were held 8 hours a week. In the training process of young badminton players, special preparatory exercises were used for 3 months. Testing was carried out twice: at the beginning and at the end of the introduction of a complex of special preparatory exercises. Permission was obtained from all parents for the participation of young athletes in the study, as well as in the supplementary exercise program in accordance with the Declaration of Helsinki.

Procedure

To determine the current level of special physical preparedness of the participants, tests were selected that characterize the level of special qualities of badminton players. Selected test exercises: triple long jump with two legs push (m); jumping rope for 1 min. (number of times); throwing a ball weighing 1 kg with a hand that performs an attacking stroke (m); moving from the center to 4 points with the transfer of shuttlecocks, 4 series (min).

When determining the speed of the attacking strokes, targets of the area size (100 × 75 cm) were used. This smash accuracy assessment system allows a badminton player to score points from 1 to 5 from 40 attacking strokes from different points and directions for each stroke on the target, misses were not evaluated. To assess the speed of the attacking strokes, computer analysis was used using the American multi-sensor movements "Zepp tennis 2" (km/h). The testing with the sensor took place simultaneously with the test for the accuracy of attacking strokes. The sensor was put on the end of the racket and, using a Bluetooth wireless communication system, was combined with an iPad Air6 (2019) tablet computer. The test session was held during two days of training sessions after a day of rest.

Complexes of special running exercises for training speed-strength abilities and agility, development of coordination abilities and improvement of footwork technique, movement and imitation of attacking hits were used at the end of the special preparatory and at the beginning of the main part of the lesson. Complexes for the development and improvement of accuracy in the main part of the training with a gradual complication of tasks. Accuracy training ended with playing exercises or playing on the score.

A set of special running exercises.

Method of execution: in a circle. Dosage: perform each exercise 8-10 m 2 times.

1. Fast running sideways and backwards with a quick change of direction;
2. Running with a side step;
3. Running with a cross step;
4. Performing jerks forward, sideways, backward from the starting position of the badminton player.
5. Acceleration from a low start and a half-squat on a visual signal.

A set of exercises for training speed-strength abilities and agility:

1. Jumping rope on one leg. Dosage: 3×20 s on one and then 20 s on the other leg for 20 s (rest 15 s after the end of the cycle for both legs).
2. Spring squats followed by jumping up and changing the position of the legs in the jump. Dosage: 3×20 s. Guidelines: maintaining balance.
3. Jumping with both feet with 360° rotation. Dosage: perform 10 times in different directions.
4. Jumping on the spot with the maximum turn of the feet in both directions, from the "strip" position, jump up with a change in the position of the legs in the air and land in the starting position. Dosage: 3×20 s. Guidelines: maintaining balance.
5. A variety of jumps: up, side-long, side-up, up-back, from a place, from a fast and slow run. Dosage: 10 times each kind of jump. Guidelines: Maintain balance.
6. Throwing a medicine ball 1 kg with the movement of an attacking strike from the left and right. Dosage: 2×10 times each hand. Methodical instructions: to control the correct movement of the blow.

A set of exercises for the development of coordination abilities:

1. Catching a tennis ball in different ways (one or two hands, left, right, overhead, etc.). Performing against the wall or with a trainer. Dosage: 3×20 s. Methodical instructions: monitor the error-free performance.

2. Shuttle throws by the movement of the attacking blow according to the indication of the flight range. Dosage: 5 times in each distance of 3-6-9 m.

3. Juggle a shuttlecock and a tennis ball. Dosage: 3×20 s.

When performing exercises, the control over the safety of the structure of the competitive movement of the athlete was carried out. Emphasis was placed on the impulse during an attacking hits, followed by complete relaxation for the coordination of the badminton player's movements.

A set of exercises to improve the technique of footwork, movement and imitation of attacking hits.

Way of execution: repeated. Dosage: 3 times. Rest between repetitions 1 min. Guidelines: at the base point, you always need to take the position of the game stand, all the rest must be stepped on with your right foot. Movement at maximum speed with the execution of imitation of attacking hits.

It is proposed to use the complex by points:

point №1 – base. The center of the circle is 1 m from the front service line in the center of the court;

point №2 – located at a distance of 1 m from the front service line and 1 m from the right side line (front zone);

point №3 – at a distance of 1 m from the front service line and 1 m from the left side line (front zone);

point №4 – at a distance of 1 m from the front serve and from the right touchline (middle zone);

point №5 – at a distance of 1 m from the front service line and 1 m from the leading side line (middle zone);

point №6 – located at a distance of 50 cm from the back service line and 50 cm from the right side line (rear zone);

point №7 – is located 50 cm from the back service line and 50 cm from the left side line (rear zone).

Accuracy training took place during the implementation of the above-mentioned complexes, taking into account various conditions and the use of targets: alternating hits from one, from different points of the site, according to the accuracy of the hit; the accuracy of the flight path of the shuttlecock; the sharpness and variety of the plating of the shuttlecock; hits from a place or in motion.

Complexes of development and improvement of the accuracy of attacking hits of badminton players

Way of execution: repeated. Dosage: 10 hits at each point.

Complex №1 (performing hits on the spot).

1. From point №1 to point №2.
2. From point №1 to point №3.
3. From point №1 to point №4.
4. From point №1 to point №5.
5. From point №1 to point №6.
6. From point №1 to point №7.

Complex №2 (performing hits in different directions)

1. From point №1 to point №2 and point №6 in turn.
2. From point №1 to point №3 and point №7 in turn.
3. From point №1 to point №2 and point №7 in turn.
4. From point №1 to point №3 and point №6 in turn.

The same, the execution of strikes from points №4 and №5 in the directions indicated in the complex №2.

Complex №3 (performing hits in motion and in a jump)

1. From point №1 move to point №4, hit to point №6.
2. From point №1, move to point №5, hit to point №7.
3. From point №1, move to point №4, hit to point №7.
4. From point №1, move to point №5, hit to point №6.
5. From point №1, move to point №4, hit to point №2.
6. From point №1, move to point №4, hit to point №3.
7. From point №1, move to point №5, hit to point №2.
8. From point №1, move to point №5, hit to point №3.
9. From point №1, move to point №6, hit to point №6.
10. From point №1, move to point №7, hit to point №7.
11. From point №1, move to point №6, hit to point №7.

From point №1, move to point №7, hit to point №6.

Statistical analysis

Statistical processing of the obtained data was carried out using the MS Excel licensed program. Characteristics of descriptive statistics were determined: arithmetic mean (X), standard deviation (σ) and representativeness error of the arithmetic mean (m). The significance of differences was assessed using the t-test (Student's t-test), the differences were considered significant at ($p<0.05$), given the small size of the groups.

Results

The results of changes in indicators of special physical preparedness are presented in Table 1. Thus, under the influence of a complex of special preparatory exercises, significant changes in young badminton players were obtained in terms of triple long jump ($t=4.69$; $p<0.001$) and jumping rope ($t=4.03$; $p<0.01$).

The development of speed endurance was determined by the exercise of moving from the center to 4 points, but the results did not change significantly during the study.

Table 1. Changes in indicators of special physical preparedness of young badminton players before and after the study (n=12)

Indicators	before	after	Reliability assessment	
	X±m	X±m	t	p
Triple long jump with push of two legs (m)	4.24±0.23	5.70±0.21	4.69	<0.001
Jumping rope for 1 min. (number of times)	99.20±3.47	116.40±2.49	4.03	<0.01
Throwing a ball with a mass of 1 kg with the hand that is used for the attacking strokes (m)	5.29±0.29	5.79±0.19	1.53	>0.05
Moving from the center to 4 points with the transfer of shuttlecocks, 4 series (min)	1.19±0.03	1.07±0.05	2.06	>0.05

Table 2. Changes in the indicators of the accuracy of the attacking strokes of young badminton players before and after the study (n=12)

Indicators	before	after	Reliability assessment	
	X±m	X±m	t	p
Backhand strokes speed down the line (points)	8.8±0.55	12.7±0.65	4.58	<0.001
Diagonal left strokes speed (points)	8.8±0.47	11.6±0.60	3.67	<0.01
Forehand strokes speed down the line (points)	8.9±0.46	13.9±0.72	5.85	<0.001

Table 3. Changes in the indicators of the speed of the attacking strokes of young badminton players before and after the study (n=12)

Indicators	before	after	Reliability assessment	
	X±m	X±m	t	p
Backhand stroke down the line (km/h)	53.9±2.19	115.6±6.61	8.86	<0.001
Diagonal left stroke (km/h)	55.6±1.66	119.0±5.42	11.19	<0.001
Forehand strokes down the line (km/h)	56.2±1.95	118.8±5.55	10.64	<0.001

Table 4. Correlation analysis of indicators of accuracy, speed of attacking strokes and special physical preparedness in badminton players 10-11 years old after a pedagogical experiment, n=12

Indicators	1	2	3	4	5	6	7	8	9	10	11	12
1	1											
2	0.33	1										
3	0.56	-0.04	1									
4	0.27	0.97	0.08	1								
5	0.48	0.26	0.63	0.33	1							
6	0.32	0.99	0.03	0.99	0.29	1						
7	0.29	-0.01	0.69	0.12	0.78	0.04	1					
8	0.34	0.98	0.09	0.99	0.31	0.99	0.07	1				
9	0.14	0.42	0.41	0.48	0.66	0.45	0.27	0.47	1			
10	-0.06	0.11	0.38	0.18	0.54	0.14	0.24	0.16	0.93	1		
11	-0.14	0.17	0.21	0.15	0.19	0.15	-0.14	0.18	0.73	0.59	1	
12	-0.43	-0.12	-0.48	-0.14	-0.29	-0.14	-0.02	-0.17	-0.62	-0.64	-0.45	1

1 – backhand stroke down the line, points; 2 – backhand strokes speed down the line, km/h; 3 – diagonal left hand stroke, points; 4 – diagonal left hand stroke speed, km/h; 5 – forehand strokes down the line, points; 6 – forehand strokes speed down the line, km/h; 7 – diagonal right hand stroke, points; 8 – diagonal right hand stroke speed, km/h; 9 – triple long jump, m; 10 – jumping rope for 1 minute, times; 11 – throwing a ball weighing 1 kg, m; 12 – movement from the center in 4 directions, 4 series, s.

Changes in the indicators of accuracy and speed of execution of attacking strokes by badminton players are shown in tables 2, 3. Thus, the accuracy indicators of attacking strokes increased by an average of 2.58%, and the results of the speed of attacking strokes – by 29.41%, which is confirmed by a significant difference (p<0.01-0.001) between initial and final results.

The use of complexes for training the accuracy of attacking s strokes along with targets with a gradual complication of exercises increased the results of test exercises for accuracy and speed of execution. Table 4 presents the results of the correlation analysis after the pedagogical experiment.

The indicators of the speed of attacking stroke on the left and on the right significantly correlate with each other (r=0.97-0.99). The accuracy results of right-hand stroke along the line significantly correlate with right hand stroke along the diagonal (r=0.78) and with the triple long jump from the spot (r=0.66). This indicates the connection of speed-strength abilities with the performance of attacking stroke by young badminton players. Indicators of a triple long jump from a place, jumping rope for 1 min. (r=0.99) and throwing a ball weighing 1 kg (r=0.73) are significantly correlated with each other, which indicates the complex development of speed-strength abilities of young badminton players.

Discussion

This study aims to determine the effect of specially selected exercises on changes in indicators of special physical preparedness and speed of attacking hits in badminton players 10-11 years old. Our results show that the presented

complexes of special preparatory exercises, which were used 8 hours a week for 3 months, are effective for improving the indicators of special physical preparedness, accuracy and speed of the attacking hits of 10-11 year old badminton players.

Our study is confirmed by the works of scientists on the predominant development of speed and speed-strength abilities of badminton players (Jaworski et al., 2015). Correlations of interrelations between indicators of agility, coordination, speed-strength abilities were determined in the works (Ahmed et al., 2022; Tiwari et al., 2011). The expediency of using computer technologies in the training of badminton players, which allows the coach to have instant adaptive feedback in the training process, is confirmed in scientific papers (Lin et al., 2021; Chernykh et al., 2022).

Our studies confirmed the data of scientists on the effect of specially selected exercises on improvement: technique techniques with a characteristic tension for playing badminton, coordination, tempo and rhythm of movement (Sobko et al., 2020), lower limb strength, dynamic balance and coordination abilities (Preeti et al., 2019; Zhang, 2023), speed and speed-strength abilities and agility of young badminton players (Guven et al., 2017; Ozmen et al., 2017), flexibility (Yadav, 2017).

To assess the influence of specially selected exercises on changes in the indicators of special physical preparedness and the speed of attacking hits among young badminton players, different tests were used. To determine the level of special physical preparedness of the participants, both specific and non-specific tests for this sport were selected. Similar tests were used in studies by Kwan et al. (2010); Nasruddin et al. (2016); Sturgess et al. (2008). The use of selected tests made it possible to obtain a comprehensive assessment of the level of special qualities of young badminton players.

When determining the speed of the attacking hits, computer analysis was used using the American Zepp tennis 2 multi-motion sensor. The Zepp Tennis 2 device was used by Giménez-Egido et al. (2020) and is the only smart sensor that can be used with all types of rackets, including juniors.

Correlation analysis is widely used in sports science. Comparison of the accuracy, speed of attacking hits and special physical preparedness of young badminton players allows us to assess the relationship between physical qualities and technical preparedness, which is formed in the process of sports training.

The correlation between lower body power and physical ability in young badminton players was investigated by Santos et al. (2022). The main practical implication of this study is that phase angle has a modest relationship with lower limb strength and physical ability in young badminton players. Thus, phase angle may play an important role in training load control as it can be used to assess aerobic and anaerobic capacity in young badminton players.

In our study, it was found that the indicators of the speed of attacking hits from the left and right correctly correlated with each other. Line accuracy forehand results are significantly correlated with diagonal righthand and triple long jump. This indicates the connection of speed-strength abilities with the performance of attacking hits by young badminton players.

Given the above, it can be argued that the use of a set of specially selected exercises had a positive effect on the special physical preparedness and speed of attacking hits in badminton players 10-11 years old. The use of the proposed complex can also be used in the training of young tennis players.

Conclusions

The presented complexes of specially selected exercises had a positive impact on changes in the indicators of special physical preparedness, accuracy and speed of the attacking hits, which allows us to recommend badminton players 10-11 years old in the training process. Thus, under the influence of a complex of special preparatory exercises, significant changes in young badminton players were obtained in terms of triple long jump ($p<0.001$) and jumping rope ($p<0.01$). Indicators of accuracy and speed of execution of attacking hits by young badminton players are also positive changes under the influence of specially selected exercises.

Acknowledgement

We would like to express our gratitude to the Kharkiv State Academy of Physical Culture for providing support for the imple-mentation of this research.

Conflicts of interest

Authors have no conflict of interest to disclose

References

Abdullah, S. (2014). Effect of high intensity interval circuit training on the development of specific endurance to some of essential skills in youth badminton players. *Journal of Advanced Social Research, 4*(3), 77-85.

Abián, P., Castanedo, A., Feng, X.Q., Sampedro, J. & Abian-Vicen, J. (2014). Notational comparison of men's singles badminton matches between Olympic Games in Beijing and London. *International Journal of Performance Analysis in Sport,* 14, 42-53. https://doi.org/10.1080/24748668.2014.11868701

Cabello-Manrique, D., & González-Badillo, J.J. (2003). Analysis of the characteristics of competitive badminton. *British Journal of Sports Medicine,* 37, 62-66. https://doi.org/10.1136/bjsm.37.1.62

Luo, L.N., Yang, S.T., Tan, B.H., & Ma, Y.F. (2020). The Effectiveness Research of Agility Training for Amateur Badminton Player by Free Distributing Reaction Time Equipment Made by Ourselves. *Basic & Clinical Pharmacology & Toxicology,* 126, 139-139.

Karatnyk, I., Hrechaniuk, O., & Pityn, M. (2015). Structure and content of competitive activity of 15-17 years old badminton players. *Journal of Physical Education and Sport, 15*(4), 834-837. https://doi.org/10.7752/jpes.2015.04128

Mahulkar, S. S. (2016). Relationship of strength and flexibility with skill performance in badminton players. *International journal of Physical Education, Sports and Health, 3*(5), 38-40.

Okun, D., Korolova, M., Stadnik, S., Rozhkov, V., Mulyk, K., Grynova, T., Kalmykova, Y., Bondar, A., & Petrenko, I.

(2020). Selection of girls for canoe slalom on the basis of morphological and functional indicators during puberty. *Journal of Physical Education and Sport, 20*(6), 3497-3503.

Rovniy, A., Mulyk, K., Perebeynos, V., Ananchenko, K., Pasko, V et al. (2018). Optimization of judoist training process at a stage of gradual decline of sporting achievements. *Journal of Physical Education and Sport,* 4, 2447-2453. https://doi.org/10.7752/jpes.2018.04367

Vial, S., Cochrane, J., J. Blazevich, A., & L. Croft, J. (2019). Using the trajectory of the shuttlecock as a measure of performance accuracy in the badminton short serve. *International Journal of Sports Science and Coaching, 14*(1), 91-96. https://doi.org/10.1177/1747954118812662

Preeti, Kalra, S., Yadav, J., & Pawaria, S. (2019). Effect of Pilates on Lower Limb Strength, Dynamic Balance, Agility and Coordination Skills in Aspiring State Level Badminton Players. *Journal of Clinical and Diagnostic Research, 13*(7), YC1-YC6. https://doi.org/10.7860/JCDR/2019/41713.12978

Chi, J. & Alahmadi, D. (2021). Badminton players' trajectory under numerical calculation method. *Applied Mathematics and Nonlinear Sciences, 0*(0). https://doi.org/10.2478/amns.2021.1.00125.

Rusdiana, A., Subarjah, H., B, B., Budiman, D., Wibowo, R., Nurjaya, D.R., Pramutadi, A., Mustari, A.S., Kusdinar, Y., & Syahid, A.M. (2021). Kinetics Analysis of Overhead Standing Smash in Badminton. *Jurnal Pendidikan Jasmani dan Olahraga.* https://doi.org/10.17509/jpjo.v6i1.32577.

Sturgess, S., & Newton, R. U. (2008). Design and Implementation of a Specific Strength Program for Badminton. *Strength & Conditioning Journal, 30*(3), 33-41. https://doi.org/12.10.1519/SSC.0b013e3181771008

Guven, F., Inceler, A., Aktas, S., Koc, S., Yilgin, A. & Er, Y. (2017). Effects of badminton training on some physical parameters in badminton players aged 10 to 12 years. *Turkish Journal of Sport and Exercise, 19*(3), 345-349. https://doi.org/10.15314/tsed.349484

Ozmen, T., & Aydogmus, M. (2017). Effect of plyometric training on jumping performance and agility in adolescent badminton players. *Turkish Journal of Sport and Exercise, 19*(2), 222-227. https://doi.org/10.15314/tsed.319749

Shevchenko, O., Koval, S., & Merzlikin, M. (2021), Kompleksnyi rozvytok tekhnichnoi ta fizychnoi pidhotovlenosti tenisystok 7-8 rokiv. *Slobozhanskyi naukovo-sportyvnyi visnyk, 3*(83), 19-25. https://doi.org/10.15391/snsv.2021-3.003

Jaworski, J. & Żak, M. (2015).The Structure of Morpho-Functional Conditions Determining the Level of Sports Performance of Young Badminton Players. *Journal of Human Kinetics, 47*(1), 215-223. https://doi.org/10.1515/hukin-2015-0077

Ahmed, S., Saraswat, A. & Esht, V. Correlation of core stability with balance, agility and upper limb power in badminton players: a cross-sectional study. *Sport Sci Health,* 18, 165-169 (2022). https://doi.org/10.1007/s11332-021-00789-w

Tiwari, L. M., Rai, V., & Srinet, S. (2011). Relationship of selected motor fitness components with the performance of badminton player. *Asian Journal of Physical Education Computer Science in Sports, 5*(1), 88-91.

Lin, KC., Wei, CW., Lai, CL. et al. Development of a badminton teaching system with wearable technology for improving students' badminton doubles skills. *Education Tech Research Dev,* 69, 945-969 (2021). https://doi.org/10.1007/s11423-020-09935-6

Chernykh, T., Mulyk, V., Mulyk, K., Skaliy, A., Ostrowski, A., & Skaliy, T. (2021). The relationship between the effectiveness of performing technical elements and indicators of static and dynamic balance in young acrobats 6-7 years old. *Health, Sport, Rehabilitation, 7*(4), 58-68. https://doi.org/10.34142/HSR.2021.07.04.05

Sobko, I. M., Zharkova, Ye. Ye., & Vitsko, S. M. (2020). Optymizatsiia spetsialnoi fizychnoi ta tekhnichnoi pidhotovky badmintonistiv 13-14 rokiv. *Sportyvni ihry, 4*(18), 72-83.

Zhang, L. (2023) Physical strength training methods in badminton teaching and training. *Revista Brasileira de Medicina do Esporte,* 29, art. no. e2022_0253. https://doi.org/10.1590/1517-8692202329012022_0253

Yadav, S.K. (2017). Relationship of selected motor fitness variables with the performance of badminton players. *International journal of physical education, sports and health,* 4, 145-147.

Kwan, M. S., Cheng, C. L., Tang, W. T., & Rasmussen, J. (2010). Measurement of badminton racket deflection during a stroke. *Sports Engineering, 12*(3), 143-153. https://doi.org/10.1007/s12283-010-0040-5

Nasruddin, F. Azmy, Harun, M. Noor, Syahrom, A., Abdul Kadir, M. Rafiq, Omar, A. Hafidz, & Öchsner, A. (2016). *Finite Element Analysis on Badminton Racket Design Parameters.* Springer International Publishing. https://doi.org/10.1007/978-3-319-21735-2

Giménez-Egido, J.M., Ortega, E., Verdu-Conesa, I., Cejudo, A., & Torres-Luque, G. (2020). Using smart sensors to monitor physical activity and technical–tactical actions in junior tennis players. *International Journal of Environmental Research and Public Health, 17*(3), art. no. 1068. https://doi.org/10.3390/ijerph17031068

Santos, M.A.P., Rossi, F.E., Silva, A.S., Veras-Silva, A.S., Silvino, V.O., & Ribeiro, S.L.G. (2022). Phase angle is moderately correlated with lower-body power and fitness capacity in junior Badminton players. *Revista Andaluza de Medicina del Deporte, 15*(2), 60-64. https://doi.org/10.33155/j.ramd.2021.08.003

ЗМІНИ ПОКАЗНИКІВ СПЕЦІАЛЬНОЇ ФІЗИЧНОЇ ПІДГОТОВЛЕНОСТІ БАДМІНТОНІСТІВ 10-11 РОКІВ ПІД ВПЛИВОМ СПЕЦІАЛЬНО ПІДІБРАНИХ ВПРАВ

Олег Шевченко[1ABCD], Катерина Мулик[1ABCDE], Володимир Паєвський[1ABC], Олександр Скалій[2ABC], Анатолій Губа[1ABD], Тетяна Скалій[2ABC], Олена Аносова[1ABC]

[1]Харківська державна академія фізичної культури
[2]Університет економіки в Бидгощі

Авторський вклад: A – дизайн дослідження; B – збір даних; C – статаналіз; D – підготовка рукопису; E – збір коштів

Реферат. Стаття: 7 с., 4 табл., 28 джерел.

Мета. Визначити зміни показників спеціальної фізичної підготовленості та швидкості нападаючих ударів у бадмінтоністів 10-11 років під впливом спеціально-підібраних вправ.

Матеріали і методи. Учасники – юні бадмінтоністи 10-11 років (12 хлопців), спортивний стаж яких 2-3 роки. Дослідження тривало 3 місяці і включало: тестування спеціальної фізичної підготовленості, оцінку та аналіз швидкості атакуючих ударів юних бадмінтоністів.

Результати. Аналіз отриманих результатів дослідження виявив позитивні зміни результатів спеціальної фізичної підготовленості, точності та швидкості нападаючих ударів. Комплексний розвиток швидкісно-силових здібностей юних бадмінтоністів визначали вправи метання м'яча масою 1 кг, потрійний стрибок у довжину та в стрибки на скакалці. Це проявлялося у виконанні нападаючих ударів з міста та у стрибку та переміщеннях, але достовірне підвищення результатів мали у потрійному стрибку та стрибках на скакалці. Розвиток швидкісної витривалості визначала вправа переміщення з центру в 4 точки, але результати суттєво не змінилися протягом дослідження. Показники точності нападаючих ударів достовірно збільшилися в середньому на 2,58%. Результати швидкості нападаючих ударів також мали достовірне підвищення в середньому на 29,41%. Використання комплексів для тренування точності нападаючих ударів разом з мішенями з поступовим ускладненням вправ підвищило результати тестових вправ на точність та швидкість виконання. Показники швидкості нападаючих ударів зліва та справа достовірно корелюють між собою. Результати точності удару справа по лінії достовірно корелюють з ударами справа по діагоналі та з потрійним стрибком в довжину з місця. Це вказує на зв'язок швидкісно-силових здібностей з виконанням нападаючих ударів юними бадмінтоністами. Показники потрійного стрибка в довжину з місця, стрибки на скакалці за 1 хв. та метання м'яча масою 1 кг достовірно корелюють між собою, що вказує на комплексний розвиток швидкісно-силових здібностей юних бадмінтоністів.

Висновки. Представлені комплекси спеціально-підготовчих вправ позитивно вплинули на зміни показників спеціальної фізичної підготовленості, точності та швидкості нападаючого удару, що дозволяє рекомендувати в тренувальному процесі бадмінтоністів 10-11років.

Ключові слова: юні бадмінтоністи, нападаючий удар, показники, точність.

Information about the authors:

Shevchenko, Oleg: shevchenko7777oleg@gmail.com; https://orcid.org/0000-0002-2856-9640; Department of Sports and Moving Games, Kharkiv State Academy of Physical Culture, Klochkivska St, 99, Kharkiv, 61022, Ukraine.

Mulyk, Kateryna: kateryna.mulyk@gmail.com; https://orcid.org/0000-0002-6819-971X; Department of Winter Sports, Cycling and Tourism, Kharkiv State Academy of Physical Culture, Klochkivska St, 99, Kharkiv, 61022, Ukraine.

Paievskyi, Volodymyr: v.paevskiy1971@gmail.com; https://orcid.org/0000-0002-9068-1422; Department of Sports and Moving Games, Kharkiv State Academy of Physical Culture, Klochkivska St, 99, Kharkiv, 61022, Ukraine.

Skaliy, Aleksander: skaliy@wp.pl; https://orcid.org/0000-0001-7480-451X; Instytut Sportu i Kultury Fizycznej, University of Economy in Bydgoszcz, Garbary 2, 85-229 Bydgoszcz, Poland.

Guba, Anatolii: a.v.guba2018@gmail.com; https://orcid.org/0000-0002-4075-1891; Kharkiv State Academy of Physical Culture, Klochkivska St, 99, Kharkiv, 61022, Ukraine.

Skaliy, Tetiana: tatiana.skaliy@byd.pl; https://orcid.org/0000-0002-6779-877X; Instytut Sportu i Kultury Fizycznej, University of Economy in Bydgoszcz, Garbary 2, 85-229 Bydgoszcz, Poland.

Anosova, Olena: alena.anosova84@gmail.com; https://orcid.org/0000-0003-1185-0740; Department of Physical Culture Management, Kharkiv State Academy of Physical Culture, Klochkivska St, 99, Kharkiv, 61022, Ukraine.

Cite this article as: Shevchenko, O., Mulyk, K., Paievskyi, V., Skaliy, A., Guba, A., Skaliy, T., & Anosova, O. (2023). Changes in Indicators of Special Physical Preparedness in Badminton Players Aged 10–11 under the Influence of Specially Selected Exercises. *Physical Education Theory and Methodology, 23*(2), 246-252. https://doi.org/10.17309/tmfv.2023.2.13

Received: 12.02.2023. Accepted: 03.04.2023. Published: 28.04.2023

Теорія та методика фізичного виховання
Physical Education Theory and Methodology
Teorìâ ta Metodika Fizičnogo Vihovannâ

ISSN 1993-7989 (print)
ISSN 1993-7997 (online)
ISSN-L 1993-7989

ORIGINAL SCIENTIFIC ARTICLE

PHYSIOLOGICAL CHARACTERISTICS OF YOUNG PEOPLE IN THE ABSENCE OF MANDATORY PHYSICAL ACTIVITY REQUIRED AT THE UNIVERSITY

Volodymyr Banakh[1ABCD], Gennadii Iedynak[2ADE], Dmytro Sovtisik[2ADE], Lesia Galamanzhuk[2ABE], Alina Bodnar[2BDE], Oksana Blavt[3BDE], Larisa Balatska[4BDE] and Oleksandr Alieksieiev[2BDE]

[1]Kremenets Taras Shevchenko Regional Academy of Humanities and Pedagogy
[2]Kamianets-Podilskyi Ivan Ohiienko National University
[3]Lviv Polytechnic National University
[4]Yuriy Fedkovych Chernivtsi National University

Authors' Contribution: A – Study design; B – Data collection; C – Statistical analysis; D – Manuscript Preparation; E – Funds Collection

Corresponding Author: Oksana Blavt, E-mail: oksanablavt@ukr.net
Accepted for Publication: March 18, 2023
Published: April 28, 2023

DOI: 10.17309/tmfv.2023.2.14

Abstract

The purpose of the study was to determine the parameters of the physiological characteristics of young men with different somatotypes, which they achieved by performing physical activity in the conditions of the Covid-19 quarantine.

Materials and methods. 39 young men aged 17.6±0.5, who had no restrictions in the use of different amounts of physical activity and belonged to different somatotypes, took part in the study. Somatotypes were diagnosed using the Shtefko-Ostrovsky method in the modification of S. Darskaja. To obtain the necessary data, well-known functional tests were used to establish blood pressure, heart rate in various states, vital capacity, vital capacity index, index maximum isometric strength, and Robinson index. We evaluated the parameters of these characteristics in representatives of each somatotype during the academic year and compared these parameters in different somatotypes. In the latter case, the results at the beginning (January) and at the end (May-June) of the study were used; they lasted for one academic year.

Results. At the beginning, and to an even greater extent at the end of the school year, the parameters of the studied characteristics in the representatives of the existing somatotypes differed among themselves (p at the level from 0.05 to 0.0001). The volumes and conditions of physical activity used during the academic year led to the deterioration of the physiological characteristics of all young men. However, there were peculiarities caused by belonging to a certain somatotype.

Conclusions. Establishing the specifics of changes in the parameters of the physiological characteristics of young freshmen, taking into account their somatotypes, is an important task for the modernization of physical education in a higher education institution. The obtained data contribute to the individualization of the substantive and normative foundations of physical education of young people, using for this purpose data on the manifestation and change of parameters in various characteristics, including physiological ones.

Keywords: physiological characteristics, differentiation, students, physical activity, Covid-19.

Introduction

The physical activity of students during their free time from studying is today considered the most effective means of solving physical education tasks in universities (Get Active, 2020; Global action plan on physical activity 2018-2030; Physical education, 2018). One of the reasons is that the number of physical education classes during the week, which are provided by the programs of the first and second years of study at the universities of Ukraine, does not provide the necessary effect in achieving the goal (Sliusarchuk et al., 2022; Chernenko et al., 2020; Solohubova et al., 2020). Another, but no less important, the reason is related to the peculiarities of the educational process in universities caused by the Covid-19 pandemic (Romero-Blanco et al., 2020; López-Valenciano et al., 2021; Piestrzyński et al., 2021).

Taking into account the above, we note the actualization of the problem of students achieving a high level of functional characteristics during their studies at the university. This is because the state of solving such a task today differs from the necessary one, that is, it does not contribute to the qualitative performance of professional duties by young people in the near future and various types of activities in everyday life, including for maintaining health and ensuring a high quality of life (Institute of Medicine, 2013; Schmidt & Lee, 2013; Abrantes et al., 2022).

The conducted analysis revealed that today there is not enough information about the peculiarities of the physiological characteristics of students, and this complicates the development of new approaches and ways to improve the existing situation. One of the effective ones is the determination of the individual trajectory of achieving the goal, that is, the design of an educational route for each specific student, the implementation of which allows him to achieve a positive result (Banakh, 2019). Designing such an effective route is impossible without taking into account the individual characteristics that characterize the physiological characteristics of students (Wilmore, Costill, & Kenney, 2022). One of the reasons for such features is belonging to a certain somatotype, as evidenced by the results of researchers (Iedynak et al., 2017). According to other results obtained (Brtková et al., 2014; Kvintová & Sigmund, 2016; Iedynak et al., 2021), taking into account the somatotype of children and youth is effective in the implementation of an individual approach in the process of physical education. Taking into account all the above, they noted the need to conduct research in a certain direction.

Materials and methods

Study participants

39 young men took part in the study, the age of each was within the range of 17.6±0.5 years, they had no restrictions in the use of various amounts of physical activity, but differed in somatotypes. So, 8 had asthenic somatotype (A-type), 12 – had thoracic somatotype (T-type), 10 – were muscular (M-type), and 9 – were digestive (D-type). The main attention was focused on obtaining parameters that reflected the state of functional capabilities of various body systems. The results were recorded during one calendar year, namely at the beginning of the study (January) and at the end of the study (May-June).

Study organization

Somatotypes were diagnosed at the beginning of the experiment, the Shtefko-Ostrovsky scheme was used in the modification of S. Darskaja. Based on the basic characteristics of a very similar to it, there is the Heath-Carter scheme, which is most often used by researchers from Europe and the United States. Selection Shtefko-Ostrovsky scheme causes the possibility to establish a certain trend, especially manifestations and changes of physical readiness in comparison with the data of other researchers (Ashmore, 2005; Sands, 2012; Iedynak et al., 2021).

The parameters of the characteristics reflecting the activity of the cardiovascular, respiratory, and neuromuscular systems of young men were studied. Used well-known functional tests recommended by researchers (American College of Sports Medicine, 2017; Bar-Or & Rowland, 2004; Wilmore et al., 2022). Determined: blood pressure (systolic – SBP, diastolic – DBP); heart rate (HR) in different states (at rest, after exercising, during recovery); vital capacity (VC); vital capacity index (VCI = VC / body mass), index maximum isometric strength (IMIS = maximum isometric strength/body mass); Robinson index (RI = SBP x HR / 100).

All requirements were met during the tests. In this case, HR reflected the state of the heart, and together with blood pressure and RI – the state of the cardiovascular system at rest; the value of VC indicated the ability of the lungs to receive oxygen, the value of VCI – the state of the respiratory system in terms of a full supply of oxygen to the body. The value of IMIS allowed the establishment of the state of development of skeletal muscles of young men. This indirectly indicates the state of excessive accumulation in the muscles of structural and energy potentials that increase their working capacity. We used certified equipment: to determine the blood pressure – BP AG1-30 Microlife, to determine the IMIS – handgrip Camry dynamometer, to determine the VC and VCI – Cardio-Spiro, NDD EasyOne Plus System 2000-2 spirometer. VCI and IMIS provided for the determination of body mass, for which OMRON BF 511 was used.

Data for the study were quantitative values of functional samples. They were established at the beginning and the end of the study, then compared with each other first in each somatotype, then in different somatotypes. So determined the increase or decrease in the value of a particular functional characteristic or its manifestation at the achieved level.

The study was planned and carried out following the principles of bioethics set forth by the World Medical Association (WMA-2013) in the Helsinki Declaration "Ethical Principles of Medical Research Involving Humans" and UNESCO in the "General Declaration on Bioethics and Human Rights". In this regard, the requirements of the principles of voluntariness, anonymity, and trust were met; all young men provided written informed consent to participate in the study. The study protocol was approved by the Ethical Committee of Kremenets Taras Shevchenko Regional Academy of Humanities and Pedagogy.

Statistical analysis

All statistical analyzes were performed using SPSS Version 21. For each assessment, the following calculations were performed: arithmetic mean (M), standard deviation (SD), and Kolmogorov-Smirnov Test (KS). The latter made it possible to establish a normal distribution of individual values in each sample of young men. Therefore, when comparing two means, Student's t-test was used for related and unrelated samples; the 0.05, 0.01, 0.001 levels of probability were used to indicate statistical significance (Vincent, 2005).

Results

Before starting the analysis of the data obtained at the beginning of the study, the conformity of the values of each physiological characteristic to the normal distribution was

determined. For this, the K-S Test was applied, and the results obtained showed a normal distribution of values in all indicators (Table 1).

A comparison of the parameters of young men with different somatotypes revealed large differences between them. The largest number was found in representatives of the T-type. When comparing their results with those obtained by representatives of other somatotypes, it was noted that in each pair of such samples, the parameters of 6 out of all 9 characteristics differed from each other by a statistically significant amount (Table 2).

But there were peculiarities: in T-type young men, the parameters in all 6 indicators were better than the parameters of A-type and D-type young men; parameters of HR after exercise, VCI and RI of T-type young men were better, but the parameters of VC, HR at rest and SBP, on the contrary, were significantly worse than those of M-type young men.

At the same time, all parameters that differed by a statistically significant value when compared were better in M-type boys than in A- and D-type boys. Thus, in M-type there was greater VC and lower HR at rest than in A-type, as well as D-type; a lower value of HR is evidence of a more

Table 1. Results of young men with different somatotypes at the beginning of the study

N	The name of the parameter	On beginning				
		M_1	SD	Min	Max	K-S, p
		A-type (n=8)				
1	VC, ml	2767.50	326.00	2380.0	3340.0	>0.20
2	HR at rest, bpm^{-1}	79.75	2.31	77.0	84.0	>0.20
3	HR after loading, bpm^{-1}	124.13	4.42	116.0	130.0	>0.20
4	SBP, mmHg	120.00	4.00	114.0	126.0	>0.20
5	DBP, mmHg	70.88	2.36	66.0	74.0	>0.20
6	Recovery time after load, sec	140.50	8.93	120.0	150.0	>0.20
7	VCI, $ml \cdot kg^{-1}$	50.00	3.78	44.0	54.0	>0.20
8	IMIS, %	50.50	3.34	46.0	54.0	>0.20
9	RI, conditional units	96.50	3.63	89.0	102.0	>0.20
		T-type (n=12)				
1	VC, ml	3070.00	156.90	2750.0	3250.0	>0.20
2	HR at rest, bpm^{-1}	77.50	3.75	73.0	85.0	>0.20
3	HR after loading, bpm^{-1}	117.42	7.55	109.0	130.0	>0.20
4	SBP, mmHg	122.50	4.25	116.0	130.0	>0.20
5	DBP, mmHg	76.25	3.25	72.0	82.0	>0.20
6	Recovery time after load, sec	143.58	11.12	120.0	160.0	>0.20
7	VCI, $ml \cdot kg^{-1}$	57.25	4.85	46.0	64.0	>0.20
8	IMIS, %	56.75	3.47	50.0	62.0	>0.20
9	RI, conditional units	81.25	5.29	72.0	90.0	>0.20
		M-type (n=10)				
1	VC, ml	3332.00	223.89	3000.0	3700.0	>0.20
2	HR at rest, bpm^{-1}	74.20	2.97	68.0	77.0	>0.20
3	HR after loading, bpm^{-1}	128.00	7.10	118.0	140.0	>0.20
4	SBP, mmHg	124.10	5.57	117.0	131.0	>0.20
5	DBP, mmHg	76.40	3.27	70.0	81.0	>0.20
6	Recovery time after load, sec	131.50	8.58	116.0	142.0	>0.20
7	VCI, $ml \cdot kg^{-1}$	50.60	3.66	45.0	58.0	>0.20
8	IMIS, %	57.2	4.39	49.0	63.0	>0.20
9	RI, conditional units	96.80	6.07	90.0	109.0	>0.20
		D-type (n=9)				
1	VC, ml	2838.89	236.88	2550.0	3150.0	>0.20
2	HR at rest, bpm^{-1}	80.00	2.55	75.0	84.0	>0.20
3	HR after loading, bpm^{-1}	133.11	9.79	116.0	145.0	>0.20
4	SBP, mmHg	125.44	6.58	118.0	139.0	>0.20
5	DBP, mmHg	80.00	2.50	76.0	84.0	>0.20
6	Recovery time after load, sec	139.56	12.99	116.0	152.0	>0.20
7	VCI, $ml \cdot kg^{-1}$	42.78	3.42	40.0	50.0	<0.15
8	IMIS, %	49.78	2.86	46.0	56.0	>0.20
9	RI, conditional units	98.44	5.83	90.0	106.0	>0.20

Note: a reliably significant difference between the two means is highlighted in color

Table 2. Differences in results of young men with different somatotypes at the beginning of the study

Result (points)	The name of the parameter								
	1	2	3	4	5	6	7	8	9
					A – T				
t	-2.791	1.507	2.256	-1.318	-4.011	-.654	-3.560	-4.007	7.085
F	4.317	2.630	2.915	1.131	1.903	1.552	1.643	1.079	2.132
p	0.012	0.149	0.037	0.204	0.001	0.521	0.002	0.001	0.000
					A – M				
t	-4.354	4.325	-1.344	-1.749	-4.006	2.172	-0.341	-3.562	-0.123
F	2.120	1.651	2.580	1.937	1.929	1.083	1.068	1.731	2.803
p	0.000	0.001	0.198	0.099	0.001	0.045	0.738	0.003	0.904
					A – D				
t	-0.521	-0.211	-2.382	-2.027	-7.715	0.172	4.138	0.481	-0.812
F	1.894	1.213	4.902	2.705	1.125	2.117	1.222	1.360	2.589
p	0.610	0.836	0.038	0.061	0.000	0.865	0.000	0.638	0.429
					T – M				
t	-3.221	2.250	-3.362	-0.764	-0.107	2.806	3.569	-0.269	-6.421
F	2.036	1.593	1.130	1.713	1.014	1.681	1.755	.791	1.315
p	0.004	0.036	0.003	0.454	0.916	0.011	0.002	10.604	0.000
					T – D				
t	2.693	-1.718	-4.156	-1.247	-2.875	0.765	7.627	4.900	-7.055
F	2.279	2.168	1.682	2.392	1.691	1.364	2.008	1.467	1.214
p	0.014	0.102	0.000	0.228	0.010	0.454	0.000	0.000	0.000
					M – D				
t	4.664	-4.537	-1.313	-0.483	-2.670	-1.611	4.799	4.307	-0.601
F	1.119	1.361	1.900	1.397	1.714	2.293	1.144	2.354	1.083
p	0.000	0.000	0.207	0.636	0.016	0.126	0.000	0.001	0.556

Note: a reliably significant difference between the two means is highlighted in color

efficient activity of the heart at rest. In addition, VCI and IMIS parameters were higher in M-type young men than in D-type young men, i.e., evidenced a better development of the respiratory system in terms of a full supply of oxygen to the body and the development of the muscular system.

When comparing the results of A- and D-type young men, it was found that HR parameters after exercise were better in the former, as they were 124.13±4.42 bpm^{-1} and 133.11±9.79 bpm^{-1}, respectively (t=-2.382; p <0.05), and also VCI – 50±3.78 and 42.78±3.42 $ml \bullet kg^{-1}$ (t=4.138; p <0.0001).

At the end of the academic year, the parameters of young men of each somatotype showed a similar trend and certain features. The tendency was that during the academic year, there were changes in the parameters of the studied indicators. It was found in all somatotypes, but there were certain peculiarities. Thus, in young men with A-type, a statistically significant change was found in the parameters of 4 out of all 9 studied characteristics, in young men with T-type – 3 characteristics, M- and D-types – 2 and 5 characteristics, respectively (Table 3). At the same time, in A-type, this referred to the state of activity of the cardiovascular system at rest (HR at rest and HR after exercise), under the influence of physical exertion (RI) and neuromuscular system, namely indicates the state of excessive accumulation in the muscles of structural and energy potentials that increase their working capacity (IMIS). Changes in all these indicators indicated a negative trend, i.e. reflected a deterioration in the state of functioning of the specified systems.

In young men with T-type, at the end of the study, HR after exercise was higher, on average, by 11.08 bpm^{-1} than at the beginning (t=-7.571; p <0.0001). The same applied to the recovery of the body after exercising, because at the beginning of the study, the average result was 143.58±11.12 seconds, and at the end of the study – 148.08±7.63 (t=-2.642; p <0.05). The state indicates the state of excessive accumulation in the muscles of structural and energy potentials that increase their working capacity (IMIS) at the beginning of the academic year was at the level of 56.72±3.47%, at the end – only 52.17±2.86% (t=5.093; p <0.0001).

In M-type young men, as well as in T-type, HR parameters after exercise and recovery of the body after exercising worsened during the academic year. Only the achieved values differed, because the HR after exercise increased by 8.1 bpm^{-1}, compared to the parameters at the beginning of the study (t=-16.809; p <0.0001); the recovery

Table 3. Results of young men with different somatotypes at the end of the study and the statistical reliability of their change

N	The name of the parameter	At the end				($M_1 - M_2$)	
		M_2	SD	Min	Max	t	p
		A-type (n=8)					
1	VC, ml	2645.0	286.65	2380.0	3150.0	0.1615	0.876
2	HR at rest, bpm^{-1}	85.875	1.1260	84.0	87.0	-11.158	0.000
3	HR after loading, bpm^{-1}	137.125	3.3991	131.0	140.0	-17.197	0.000
4	SBP, mmHg	120.75	2.96	116.0	125.0	-1.528	0.171
5	DBP, mmHg	71.0	2.07	69.0	75.0	-0.174	0.867
6	Recovery time after load, sec	142.88	7.00	127.0	148.0	-2.040	0.081
7	VCI, $ml \cdot kg^{-1}$	47.06	5.82	35.50	54.50	1.355	0.224
8	IMIS, %	49.38	2.62	46.00	52.0	3.813	0.007
9	RI, conditional units	105.18	1.98	102.70	108.40	-5.174	0.001
		T-type (n=12)					
1	VC, ml	2991.67	92.52	2800.0	3100.0	2.065	0.063
2	HR at rest, bpm^{-1}	78.08	2.91	73.0	82.0	2.065	0.349
3	HR after loading, bpm^{-1}	128.50	8.30	117.0	142.0	-7.571	0.000
4	SBP, mmHg	123.5	3.53	119.0	128.0	-1.509	0.160
5	DBP, mmHg	76.75	2.42	73.0	81.0	-1.149	0.275
6	Recovery time after load, sec	148.08	7.63	132.0	158.0	-2.642	0.023
7	VCI, $ml \cdot kg^{-1}$	56.00	3.57	47.0	61.0	2.068	0.063
8	IMIS, %	52.17	2.86	48.0	57.0	5.093	0.000
9	RI, conditional units	83.00	4.11	77.0	88.0	-1.473	0.169
		M-type (n=10)					
1	VC, ml	3276.00	162.70	3000.000	3540.000	1.292	0.228
2	HR at rest, bpm^{-1}	75.60	1.65	73.000	78.000	-2.040	0.072
3	HR after loading, bpm^{-1}	136.10	6.47	127.000	146.000	-16.809	0.000
4	SBP, mmHg	123.80	5.71	116.000	132.000	0.410	0.691
5	DBP, mmHg	77.00	2.71	72.000	80.000	-1.616	0.141
6	Recovery time after load, sec	137.00	4.94	129.000	144.000	-2.811	0.020
7	VCI, $ml \cdot kg^{-1}$	49.50	2.07	46.000	54.000	2.079	0.129
8	IMIS, %	55.90	2.47	50.000	58.000	1.647	0.134
9	RI, conditional units	96.00	4.00	91.000	104.000	1.037	0.327
		D-type (n=9)					
1	VC, ml	2654.44	188.89	2400.000	2950.000	8.829	0.000
2	HR at rest, bpm^{-1}	81.22	1.64	78.000	83.000	-1.976	0.084
3	HR after loading, bpm^{-1}	145.00	6.60	134.000	152.000	-8.686	0.000
4	SBP, mmHg	125.00	4.18	120.000	134.000	0.457	0.660
5	DBP, mmHg	81.11	2.52	78.000	86.000	-1.754	0.117
6	Recovery time after load, sec	147.44	12.71	124.000	160.000	-12.909	0.000
7	VCI, $ml \cdot kg^{-1}$	40.56	3.43	38.000	47.000	8.000	0.000
8	IMIS, %	46.89	2.42	45.000	53.000	6.353	0.000
9	RI, conditional units	100.44	3.32	95.000	104.000	-1.732	0.122

Note: a reliably significant difference between the two means is highlighted in color

time of the body after exercising increased by 5.5 seconds (t=-2.811; p <0.02).

But the largest number of functional characteristics, the parameters of which changed during the school year, were found in D-type young men. In particular, their VC decreased by 184.45 ml, HR increased by 12.0 bpm^{-1} after exercise, and the recovery time of the body after exercising increased by 7.88 seconds (p <0.0001). In addition, VCI parameters decreased by 2.22 $ml \bullet kg^{-1}$, and IMIS parameters – by 2.89% in D-type young men. The results in both cases showed a decrease in the ability of the body to supply oxygen to the systems involved in physical activity and the ability of skeletal muscles to perform their main function.

The identified changes led to an increase in discrepancies between the parameters achieved by young men with a certain somatotype at the end of the school year (Table 4). Yes, in the T-type, the number of such characteristics was 7 out of all 9 studied (at the beginning – 6 each), but there were also peculiarities: all the singled-out parameters were better in them than in the A-type, D-type, and 3 (HR after

Table 4. Differences in results of young men with different somatotypes at the end of the study

Result (points)	The name of the parameter								
	1	2	3	4	5	6	7	8	9
				A – T					
t	-3.939	7.178	2.770	-1.814	-5.505	-1.543	-4.277	-2.213	14.109
F	9.599	6.659	5.956	1.418	1.363	1.190	2.664	1.192	4.314
p	0.001	0.000	0.013	0.086	0.000	0.140	0.000	0.040	0.000
				A – M					
t	-5.900	15.021	.404	-1.365	-5.164	2.088	-1.238	-5.428	-5.909
F	3.104	2.138	3.625	3.713	1.711	2.004	7.925	1.121	4.082
p	0.000	0.000	0.692	0.191	0.000	0.053	0.234	0.000	0.000
				A – D					
t	6.992	-6.757	-2.325	.164	-2.865	-1.877	7.026	9.700	-2.043
F	1.293	1.272	1.224	1.583	1.855	10.291	14.033	2.957	1.548
p	0.000	0.000	0.035	0.872	0.012	0.080	0.000	0.000	0.059
				T – M					
t	-5.151	2.395	-2.357	-.151	-.229	3.945	5.081	-3.243	-7.474
F	3.092	3.116	1.643	2.619	1.256	2.384	2.975	.1336	1.057
p	0.000	0.027	0.029	0.881	0.821	0.001	0.000	0.004	0.000
				T – D					
t	5.411	-2.900	-4.907	-0.891	-4.018	.144	9.998	4.465	-10.413
F	4.168	3.135	1.582	1.405	1.089	2.772	1.081	1.391	1.533
p	0.000	0.009	0.000	0.384	0.001	0.877	0.000	0.000	0.000
				M – D					
t	7.708	-7.442	-2.966	-0.517	-3.412	-2.410	6.967	8.015	-2.617
F	1.348	1.006	1.039	1.864	1.153	6.608	2.753	1.041	1.451
p	0.000	0.000	0.009	0.612	0.003	0.280	0.000	0.000	0.018

Note: a reliably significant difference between the two means is highlighted in color

exercise, VCI, and RI) – than in M-type. In representatives of the M-type, 5 parameters were better than in the A-type (the rest did not differ in magnitude) and 8 parameters were better than in the D-type, except for SBP, which did not differ in them from the age norm. As for young men of A- and D-types, the parameters of HR after exercise, VCI and IMIS were better in the former, and VC and HR at rest, on the contrary, in the latter.

Discussion

One of the main tasks of physical education at the university involves students achieving a high level of functional characteristics. But the realities are such that the parameters of these characteristics during the entire period of their training differ from the necessary ones (Banakh, 2019; Piestrzyński et al., 2021). In a practical aspect, the existing condition to some extent does not allow the university graduate to perform his professional duties at the proper level, as well as various types of activities in the household, which contribute to the maintenance of his health and ensure a high quality of life (Schmidt & Lee, 2013; Abrantes et al., 2022). In connection with this and other existing shortcomings of physical education at the university (López-Valenciano et al., 2021; Piestrzyński et al., 2021), the problem of determining an individual trajectory for each specific student for his physical activity, which is implemented in different, but in certain forms, and contributes to achieving a positive result (Banakh, 2019). Thus, the effectiveness of considering individual characteristics inherent in representatives of existing somatotypes is emphasized (Brtková et al., 2014; Kvintová & Sigmund, 2016).

Taking into account the above, an experimental study was conducted, which already at the beginning proved the existence of differences in the parameters of the physiological characteristics of young men with different somatotypes. In the end, there were also peculiarities, and they related to the unequal number of parameters and their values in the representatives of the existing somatotypes. The above was associated with a complex of reasons, one of the common ones being the unequal pace of morpho-functional maturation. Thus, representatives of the T-type lag behind the M-type, on average, by six months, representatives of the A-type – by one year, and representatives of the D-type – by one and a half to two years (Ashmore, 2005; Iedynak et al., 2021). This feature affects the manifestation of various characteristics, including physiological ones (Kvintová & Sigmund, 2016; Wilmore, Costill & Kenney, 2022). In this regard, it is noted (Katzmarzyk & Silva, 2013) that the development of the organism's capabilities largely depends on the morphological and functional maturation of the organs and systems involved in the manifestation of a certain characteristic. This is consistent with modern ideas about somatotype as an external reflection of the human constitution (Carter & Heath, 1990; Iedynak et al., 2021). It (constitution) is considered as the integrity of morpho-functional properties that are inherited and acquired, are relatively stable over time, associated with the pace of individual development, the

features of the body's reactivity, the style of activity and the material prerequisites of human abilities (Carter & Heath, 1990; Malina, et al, 2004; Frisancho, 2008; Stewart et al., 2014). In this regard, the different characteristics of each young person are marked by the peculiarities of the parameters, but when creating samples based on the "somatotype" feature, we can immediately see a certain trend in the manifestation of these parameters. According to the obtained results, the physical activity used during the academic year was one of the important reasons for the deterioration of the parameters of the studied characteristics. 2 out of 9 young men with M-type had such characteristics, 3 young men with T-type, 4 with A-type, and 5 with D-type. In this regard, it was noted that the Covid-19 epidemic caused a decrease in the amount of physical activity of young people, primarily due to the lack of mandatory physical education classes in the educational institution (Piestrzyński et al, 2021). Young people's use of physical activity other than the required amount indicated a lack of internal motivation to systematically implement such activity in their free time from school (Wiium & Säfvenbom, 2019; Coimbra et al., 2021). At the same time, the most unfavorable trend was found in D-type, then in A- and T-types, and the smallest was in M-type.

Consolidating the results in all somatotypes, the following was noted: the best values of HR after exercise, VCI and RI were in young men with T-type, and the values of the rest of the characteristics, except for SBP and DBP, were better in young men with M-type. The peculiarities of blood pressure parameters were not established, because according to the researchers, they were within the age norm in all young men (Wilmore et al., 2022). As for A-type representatives, the parameters of HR after exercise, VCI and RI were better in them than in young men with D-type; in the latter, the parameters of VC and HR at rest were better, and the parameters of other characteristics were practically the same. The obtained data to some extent confirm the results of other researchers (Gutnik et al., 2015; Iedynak et al., 2021).

The identified features should be considered in practical activities, in particular, when modeling the achievements of young people over a certain period, during the analysis of achievements, taking into account the features characteristic of representatives of a certain somatotype (D'Andréa et al., 2013; Cinarli & Kafkas, 2019).

The obtained results are important for the modernization of the content of physical education of young men in the direction of its individualization to achieve high parameters in various characteristics; to develop a differentiated system for evaluating the achievements of young people (Ryan-Stewart, 2018; Zhang, Lu & Wu, 2020). This, among other things, will also contribute to strengthening their motivation to engage in physical activity, because the proposed normative assessments will be realistic to achieve. Such a positive result is an incentive to continue the physical activity and even increase its volume (Noh et al., 2014; Kvintová & Sigmund, 2016). In addition, the obtained data can be used in the practice of sports activities, in particular when predicting achievements, and planning the amount of physical activity for athletes with a certain somatotype (Saha, 2014; Campa et al., 2020; Cinarli et al., 2022).

It is advisable to direct further research to the study of parameters of other characteristics, in particular physical qualities, and psychophysiological properties. Another possible direction is the development of a program to improve physiological and some other characteristics of young men during physical education at the university, as well as individual programs of such orientation.

Conclusions

Against the background of the implementation of quarantine in connection with Covid-19, the physiological characteristics of first-year boys during the academic year are marked by features determined by somatotype. At the beginning, most characteristics, the parameters of which differ significantly (at the level of $p<0.05\div0.0001$), were found in the T-type: there were 6 of all 9 studied, but not all of them were better, compared to those obtained in other somatotypes. The parameters in the M-type were better in all cases, and their number, when compared with the D-type, is 5, with the A-type – 4; in the latter parameters, HR after exercise and VCI were better than in D-type.

During the school year, parameters deteriorate: in D-type in 5 characteristics, in A-type – 4, T-type – 3, and M-type – 2. In the end, young men reach parameters that differ significantly from each other. In the T-type, there were 7 of all 9 subjects and all of them were better than in the A-, D-types, and 3 (HR after exercise, VCI and RI) – than in the M-type. The parameters of the latter are better in all cases, and the number is: when compared with the D-type – 5, with the A-type – 4. The parameters of HR after exercise and VCI in the A-type were better than in the D-type.

To increase the effectiveness of physical education of young people at the university, it is advisable to differentiate it and individualize the content, taking into account the peculiarities of the manifestation and changes of parameters, primarily psychophysiological and characteristics of physical capabilities.

Conflicts of interest

No conflicts of interest exist.

References

Get Active – Physical Education, Physical Activity and Sport for Children and Young People – A Guiding Framework (2020). Roinn: Department of Education and Skills Ireland. https://www.gov.ie/en/publication/d53e68-get-active-physical-education-physical-activity-and-sport-for-childr/

Global action plan on physical activity 2018–2030: more active people for a healthier world. (2018). *Geneva: World Health Organization.* Licence: CC BY-NC-SA 3.0 IGO. https://apps.who.int/iris/bitstream/handle/10665/272722/9789241514187-eng.pdf

Physical education, sport and physical activity strategy for children & young people (2013). *Bournemouth & Poole physical education, sport and physical activity strategy*. http://debbie.priest@bournemouth.gov.uk

Sliusarchuk, V., Iedynak, G., Blavt, O., Chaplinskyi, R., Galamanzhuk, L., Stasyuk, V., & Klius, O. (2022). The structure of change in the general physical fitness of girls – future officers during training at the military academy.

Physical Education Theory and Methodology, 22(1), 28-35. https://doi.org/10.17309/tmfv.2022.1.04

Chernenko, S., Oliynyk, O., Dolynniy, I., Honcharenko, O., & Hordieieva, K. (2020). Peculiarities of Functional and Motor Fitness of 1St–5Th Year Students of Special Medical Department. *Physical Education Theory and Methodology, 20*(4), 212-218. https://doi.org/10.17309/tmfv.2020.4.03

Solohubova, S., Lakhno, O., Shyyan, V., & Shyyan, O. (2020). The Assessment of Physical Fitness and Morphofunctional State of Female First-Year Students in Non-Linguistic Higher Education Institutions. *Physical Education Theory and Methodology, 20*(3), 157-164. https://doi.org/10.17309/tmfv.2020.3.05

Romero-Blanco, C., Rodríguez-Almagro, J., Onieva-Zafra, M.D., Parra- Fernández, M. L., del Carmen Prado-Laguna, M., & Hernández-Martínez, A. (2020). Physical activity and sedentary lifestyle in university students: changes during confinement due to the COVID-19 pandemic. *Int. J. Environ. Res. Public Health,* 17, 6567. https://doi.org/10.3390/ijerph17186567

López-Valenciano, A., Suárez-Iglesias, D., Sanchez-Lastra, M.A., & Ayán, C. (2021). Impact of COVID-19 Pandemic on University Students' Physical Activity Levels: An Early Systematic Review. *Front. Psychol.,* 11, 624567. https://doi.org/10.3389/fpsyg.2020.624567

Piestrzyński, W., Stasiuk, I., Sarzała, D., Iedynak, G., Marzec, A., Hudyma, N., Šrobárová, S., Mykhalskyi, A., Woźniak, W., & Mykhalska, Y. (2021). Physical activity and sense of security in schoolchildren during the Covid-19 lockdown period. *Journal of Physical Education and Sport, 21*(5), 3075-3083. https://doi.org/10.7752/jpes.2021.s5409

Institute of Medicine (2013). *Educating the Student Body: Taking Physical Activity and Physical Education to School*. Washington, DC: The National Academies Press. https://doi.org/10.17226/18314

Schmidt, R. A., & Lee, T. (2013). *Motor learning and performance: from principles to application*. Champaing, IL: Human Kinetics.

Abrantes, L.C.S., De Morais, N.S., Gonçalves, V.S.S., Ribeiro, S.A.V., Sediyama, C.M.N.O., Franceschini, S.C.C., Amorim, P.R.S., & Priore, S.E. (2022). Physical activity and quality of life among college students without comorbidities for cardiometabolic diseases: systematic review and meta-analysis. *Quality of Life Research,* 31, 1933-1962. https://doi.org/10.1007/s11136-021-03035-5

Banakh, V. (2019). Personalized approach to physical education of student youth. Bulletin of Kamyanets-Podilskyi Ivan Ogiienko National University. *Physical Education, Sports and Human Health,* 15, 11-15. https://doi.org/10.32626/2309-8082.2019-15.11-15 (in Ukrainian).

Wilmore, J.H., Costill, D.L., & Kenney, L.W. (2022). *Physiology of sports and exercise.* 5th ed. Champaign, IL: Human Kinetics.

Iedynak, G., Galamandjuk, L., Kyselytsia, O., Nakonechnyi, I., Hakman, A., & Chopik, O. (2017). Special aspects of changes in physical readiness indicators of young men with different somatotypes between 15 and 17 years of age. *Journal of Physical Education and Sport, 17*(4), 2690-2696. https://doi.org/10.7752/jpes.2017.04311

Brtková, I., Bakalár, P., Matúš, I., Hančová, M., & Rimárová, K. (2014). Body composition of undergraduates – comparison of four different measurement methods. *Physical Activity Review,* 2, 38-44.

Kvintová, J., & Sigmund, M. (2016). Physical activity, body composition and health assessment in current female University students with active and inactive lifestyles. *Journal of Physical Education and Sport, 16*(1), 627-632. https://doi.org/10.7752/jpes.2016.s1100

Iedynak, G., Galamandjuk, L., Mysiv, V., Zubal, M., & Klyus, O. (2021). *Somatotypes and physical condition of children and youth.* Kamianets-Podilskyi: Drukarnia Ruta. (in Ukrainian).

Ashmore, P.C. (2005). Role of physical anthropology in intermediate and secondary education. *Am. J. Phys. Antropol,* 41, 154-162.

Sands, R.R. (2012). *The anthropology of sports and human movement: a biocultural perspective.* Ed. by R.R. Sands, L.R. Sands. London: Lexington Books.

American College of Sport Medicine (2017). *Physical activity in children and adolescents.* https://www.acsm.org/docs/default-source/brochures/physical-activity-in-children-and-adolescents.pdf

Bar-Or, O., & Rowland, T. W. (2004). *Pediatric Exercise Medicine: from physiologic principles to health care application.* Champaign, IL: Human Kinetics.

Vincent, W.J. (2005). *Statistic in kinesiology.* 3-rd edition. NY: Human Kinetics Publishers.

Katzmarzyk, P. T., & Silva, M. J. C. (2013). *Growth and maturation in human biology and sports*. Coimbra: University press.

Carter, J.E.L., & Heath, B.H. (1990). *Somatotyping Development and Applications.* Cambridge University Press: Cambridge, UK.

Malina, R.M., Bouchard, C., & Bar-Or, O. (2004). *Growth, Maturation and Physical Activity.* 2nd ed. Champaign, IL: Human Kinetics.

Frisancho, A.R. (2008). *Anthropometric standards.* In An Interactive Nutritional Reference of Body Size and Body Composition for Children and Adults; University of Michigan Press: Ann Arbor, MI, USA.

Stewart, A., Crockett, P., Nevill, A., & Benson, P. (2014). Somatotype: a more sophisticated approach to body image work with eating disorder sufferers. *Advances in Eating Disorders: Theory, Research and Practice, 2*(2), 125-135. https://doi.org/10.1080/21662630.2013.874665

Wiium, N., & Säfvenbom, N. (2019). Participation in Organized Sports and Self-Organized Physical Activity: Associations with Developmental Factors. *Res. Public Health, 16*(4), 585. https://doi.org/10.3390/ijerph16040585

Coimbra, M., Cody, R., Kreppke, J-N., & Gerber, M. (2021). Impact of a physical education-based behavioral skill training program on cognitive antecedents and exercise and sport behavior among adolescents: A cluster-randomized controlled trial. *Physical Ed. and Sport Pedagogy, 26*(1), 16-35. https://doi.org/10.1080/17408989.2020.1799966

Gutnik, B., Zuoza, A., Zuozienė, I., Alekrinskis, A., Nash, D., & Scherbina, S. (2015). Body physique and dominant

somatotype in elite and low-profile athletes with different specializations. *Medicina (Kaunas),* 51, 247–252.

D'Andréa, G.J.M., Cuğ, M., Dülgeroğlu, D., Brech, G.C., & Alonso, A.C. (2013). Relationship between anthropometric factors, gender, and balance under unstable conditions in young adults. *Biomed Res Int,* 850424-850424.

Cinarli, F.S., & Kafkas, M.E. (2019). The effect of somatotype characters on selected physical performance parameters. *J. Phys. Educ. Stud,* 23, 279-287.

Ryan-Stewart, H., Faulkner, J., & Jobson, S. (2018). The influence of somatotype on anaerobic performance. *PLoS ONE,* 13, e0197761.

Zhang, T., Lu, G. & Wu, X.Y. (2020). Associations between physical activity, sedentary behaviour and self-rated health among the general population of children and adolescents: a systematic review and meta-analysis. *BMC Public Health,* 20, 1343. https://doi.org/10.1186/s12889-020-09447-1

Noh, J., Kim, J., Kim, M., Lee, J., Lee, L., Park, B., & Kim, J. (2014). Somatotype analysis of elite boxing athletes compared with nonathletes for sports physiotherapy. *Journal of Physical Therapy Science, 26*(8), 1231-1235. https://doi.org/10.1589/jpts.26.1231

Saha, S. (2014). Somatotype, body composition and explosive power of athlete and non-athlete. *J. Sports Med. Doping Stud,* 4, 2.

Campa, F., Silva, A.M., Talluri, J., Matias, C.N., Badicu, G., & Toselli, S. (2020). Somatotype and Bioimpedance Vector Analysis: A New Target Zone for Male Athletes. *Sustainability, 12*(11), 4365. https://doi.org/10.3390/su12114365

Cinarli, F.S., Buyukcelebi, H., Esen, O., Barasinska, M., Cepicka, L., Gabrys, T., Nalbant, U., & Karayigit, R. (2022). Does Dominant Somatotype Differentiate Performance of Jumping and Sprinting Variables in Young Healthy Adults? *Int. J. Environ. Res. Public Health,* 19, 11873. https://doi.org/10.3390/ijerph191911873

ФІЗІОЛОГІЧНІ ХАРАКТЕРИСТИКИ ЮНАКІВ ЗА ВІДСУТНОСТІ ОБОВ'ЯЗКОВОЇ ФІЗИЧНОЇ АКТИВНОСТІ, ЩО ПЕРЕДБАЧЕНА В УНІВЕРСИТЕТІ

Володимир Банах[1ABCD], Геннадій Єдинак[2ADE], Дмитро Совтисік[2ADE], Леся Галаманжук[2ABE], Аліна Боднар[2BDE], Оксана Блавт[3BDE], Лариса Балацька[4BDE], Олександр Алєксєєв[2BDE]

[1]Кременецька обласна гуманітарно-педагогічна академія імені Тараса Шевченка
[2]Кам'янець-Подільський національний університет імені Івана Огієнка
[3]Національний університет «Львівська політехніка»
[4]Чернівецький національний університет імені Юрія Федьковича

Авторський вклад: A – дизайн дослідження; B – збір даних; C – статаналіз; D – підготовка рукопису; E – збір коштів

Реферат. Стаття: 10 с., 4 табл., 40 джерел.

Мета дослідження полягала у визначенні параметрів фізіологічних характеристик юнаків із різними соматотипами, яких вони досягли здійснюючи фізичну активність в умовах карантину Covid-19.

Матеріал та методи. У дослідженні взяли участь 39 юнаків 17,6±0,5 років, вони не мали обмежень у використанні різних обсягів фізичної активності та належали до різних соматотипів. Діагностували соматотипи, використовуючи методику Shtefko-Ostrovsky в модифікації S. Darskaja. Для одержання необхідних даних використовували добре відомі функціональні тести для встановлення blood pressure, heart rate у різних станах, vital capacity, vital capacity index, index maximum isometric strength, Robinson index. Оцінювали параметри цих характеристик у представників кожного соматотипу протягом навчального року та порівнювали ці параметри в різних соматотипах. У останньому випадку використовували результати на початку (січень) та наприкінці (травень-червень) дослідження; тривало воно протягом одного навчального року.

Результати. На початку, а ще більшою мірою наприкінці навчального року, параметри досліджуваних характеристик у представників наявних соматотипів відрізнялися між собою (p на рівні від 0.05 до 0.0001). Використані протягом навчального року обсяги та умови реалізації фізичної активності призвели до погіршення фізіологічних характеристик усіх юнаків. Проте мали місце особливості, зумовлені приналежністю до певного соматотипу.

Висновки. Встановлення особливостей змін у параметрах фізіологічних характеристик юнаків-першокурсників із урахуванням їхніх соматотипів є важливим завданням для модернізації фізичного виховання у закладі вищої освіти. Отримані дані сприяють індивідуалізації змістової і нормативної основ фізичного виховання юнаків, використовуючи для цього дані про вияв і зміну параметрів у різних характеристиках, у тому числі фізіологічних.

Ключові слова: фізіологічні характеристики, диференціація, студенти, фізична активність, Covid-19.

Information about the authors:

Banakh, Volodymyr: anvitvl@ukr.net; https://orcid.org/0000-0002-0903-5002; Department of Medical and Biological Basis of Physical Education, Kremenets Taras Shevchenko Regional Academy of Humanities and Pedagogy, Litseina St, 1, Kremenets, Ternopilska oblast, 47003, Ukraine.

Iedynak, Gennadii: yedinak.g.a@gmail.com; https://orcid.org/0000-0002-6865-0099; Department of Theory and Methods of Physical Education, Kamianets-Podilskyi Ivan Ohiienko National University, Ohiienko St, 62, Kamianets-Podilskyi, 32300, Ukraine.

Sovtisik, Dmitrii: sovtysik@kpnu.edu.ua; https://orcid.org/0000-0003-3893-2930; Department of Physical Rehabilitation and Medical and Biological Fundamentals of Physical Education, Kamianets-Podilskyi Ivan Ohiienko National University, Ohiienko St, 62, Kamianets-Podilskyi, 32300, Ukraine.

Galamanzhuk, Lesia: astralesg@gmail.com; https://orcid.org/0000-0001-9359-7261; Department of Theory and Methods of Physical Education, Kamianets-Podilskyi Ivan Ohiienko National University, Ohiienko St, 62, Kamianets-Podilskyi, 32300, Ukraine.

Bodnar, Alina: bodnar.alina@kpnu.edu.ua; https://orcid.org/0000-0002-6865-0099; Department of Theory and Methods of Physical Education, Kamianets-Podilskyi Ivan Ohiienko National University, Ohiienko St, 62, Kamianets-Podilskyi, 32300, Ukraine.

Blavt, Oksana: oksanablavt@ukr.net; https://orcid.org/0000-0001-5526-9339; Department of Physical Education, Lviv Polytechnic National University, Bandera St, 12, Lviv, 79013, Ukraine.

Balatska, Larisa: l.-balatska@ukr.net; https://orcid.org/0000-0002-7963-2726; Department of Theory and Methods of Physical Education and Sports, Yuriy Fedkovych Chernivtsi National University, Kotsjubynskyi St, 2, Chernivtsi, 58012, Ukraine.

Alieksieiev, Oleksandr: alieksieiev@ukr.net; https://orcid.org/0000-0002-7963-2726; Department of Sport and Sports Games, Kamianets-Podilskyi Ivan Ohiienko National University, Ohiienko St, 62, Kamianets-Podilskyi, 32300, Ukraine.

Cite this article as: Banakh, V., Iedynak, G., Sovtisik, D., Galamanzhuk, L., Bodnar, A., Blavt, O., Balatska, L., & Alieksieiev, O. (2023). Physiological Characteristics of Young People in the Absence of Mandatory Physical Activity Required at the University. *Physical Education Theory and Methodology, 23*(2), 253-262. https://doi.org/10.17309/tmfv.2023.2.14

Received: 20.02.2023. Accepted: 18.03.2023. Published: 28.04.2023

Теорія та методика фізичного виховання
Physical Education Theory and Methodology
Teorìâ ta Metodika Fizičnogo Vihovannâ

ISSN 1993-7989 (print)
ISSN 1993-7997 (online)
ISSN-L 1993-7989

ORIGINAL SCIENTIFIC ARTICLE

THE ACCOUNTABILITY OF FOOTBALL AS A FORM OF PUBLIC GOOD ON LOCAL COMMUNITIES: A PILOT STUDY

Gaetano Raiola[1ABE], Francesca D'Elia[1ABC], Giovanni Esposito[1CDE], Gaetano Altavilla[2ABC] and Tiziana D'Isanto[1BDE]

[1]University of Salerno
[2]University of Salento

Authors' Contribution: A – Study design; B – Data collection; C – Statistical analysis; D – Manuscript Preparation; E – Funds Collection

Corresponding Author: Giovanni Esposito, E-mail: gioesposito@unisa.it
Accepted for Publication: March 18, 2023
Published: April 28, 2023

DOI: 10.17309/tmfv.2023.2.15

Abstract

Study purpose. Football is a social phenomenon, especially due to the enormous use of the media and the economic and financial implications that derive from its complex sporting activities. Amateur sports associations (ASD) are part of this phenomenon since they represent socio-educational agencies that pursue the aims of sports training by adopting specific educational, social, and economic models. Individually, they have modest dimensions but considered in an aggregate manner, they present a significant and not negligible dimension in society. The purpose of the study is to try to understand the stakeholders' perceptions concerning the issues of youth football and the accountability that football, understood as a public good, produces in local communities.

Materials and methods. The study was conducted through a survey submitted to a sample made up by presidents and trainers of 112 amateur sports clubs in the province of Salerno, a city in Southern Italy. The survey includes two thematic sections. The first section presents 6 items, common for both presidents and trainers, about the various social and educational issues related to the practice of the sport. The second section presents 4 items, that analyse the contribution that the U.S. Salernitana 1919 football club, considered as a "public good", brings to the territory in terms of economic and social return. Validity and reliability were calculated. The collected data were analysed using the Chi-square (χ^2) test to check the correlation between the responses given by the stakeholders.

Results. The results show a concordance of opinions among the stakeholders regarding the most relevant educational aspects related to the practice of football, and the major critical issues involving the youth academy of U.S. Salernitana 1919 football club.

Conclusions. These results highlight the stakeholders' full awareness of the potential positive social effects of the presence of football ASDs in the territory, even considering the limitations of the study sample and the territorially circumscribed objective of the research.

Keywords: football, public good, local community, stakeholder.

Introduction

The value of sports has grown rapidly in recent decades, to the point that it has assumed a central economic and cultural role in many societies worldwide (Andon & Free, 2019). The increasing commercial value of sports has led many sports organizations to adopt a more "business-like" management approach with decision-making driven by purely economic logic, resulting in a significant transformation of the global sports industry (Clune et al., 2019). Although sports organizations have always had business ties, the intensity of these ties is one of the most relevant aspects of today's sports industry (Hoye et al., 2018). The sports industry has transformed financially into other business sectors, such as television broadcasting and merchandising (Morrow, 2000). However, this commercialization process has yet to be challenged by stakeholders who are often critical of sports organizations' responses to their needs (Cooper & Johnston, 2012).

Diverging views among fans, management, shareholders, and players about how organizations should balance commercial returns, field success, entertainment value, fan interests, and traditional cultural values have created significant tensions among stakeholders. These tensions

between economic, social, and cultural characteristics have seen academic interest progressively direct attention to the role of accounting in sporting contexts (Potter & Lightbody, 2016). Sport has become a privileged vector of communication for companies wishing to improve their brand and conquer new markets (Ratten, 2016; Turner & Shilbury, 2005). The prestige of sporting success can be leveraged for large commercial returns, but often in ways that have little to do with conventional business decision-making. All this has occurred especially, in recent times within football. This sport represents a social phenomenon, especially because of its enormous media influence and the financial and economic implications that flow from it. In essence, the sports enterprise owes its reason for existence to the presence of its customer/consumer, with whom it concretizes an essential bond that leads it to realize profits (Cooper & Johnston, 2012). All this involves a strategic approach unknown to the world of sports, which must rethink its role by accepting a new vision that combines the principles proper to sound economic management with the ability to compete and meet the needs of its customers/consumers.

The few studies that have examined the role of accountability in sports have tended to focus on so-called professional sports organizations. In this sense, the figure of the customers/consumer has not yet been considered and deliberately marginalized. Divergent views on how organizations should balance commercial returns, on-field success, entertainment value, fan interests, and traditional cultural values have created significant tensions among stakeholders (András & Havran, 2015; Williams, 2007). Because of such critical issues, sports clubs should adopt those corporate governance measures that safeguard all stakeholders interacting with them. This social phenomenon also consists of small territorial stakeholders within ASD, which can be defined as socio-educational agencies that pursue sports training by adopting a specific socio-economic model with educational value. Individually, ASD are modest in size but, when considered in aggregate, have a significant size that is not negligible in society (Agenzia delle entrate, 2022; García & Welford, 2015).

It would be useful to adopt original survey methods, such as those on perception and awareness (Raiola et al., 2022; Witkowski et al., 2016), to methodologically finalize the survey with similar instruments. The purpose of the study is to try to understand the stakeholders' perceptions concerning the issues of youth football and the accountability that football, understood as a public good, produces in local communities. This contribution aims to scale down the exclusively 'technical' view of public accounting to reach a wider audience through a more comprehensible language.

Materials and methods

Study participants and design

The investigation was conducted through an online survey targeting a sample characterized by 112 presidents (mean ± standard deviation = 45 ± 2.99 years old) and 112 trainers (33 ± 3.52 years old) in non-professional football associations located in the province of Salerno (Italy). They carry out competitive activities and are affiliated with the Italian Football Federation.

Study organization

After choosing the target population, data collection was carried out considering both methodological implications and available economic and human resources. On this basis, it was decided to administer a survey the writing of which was based on the conceptual dimensions and related indicators identified during the definition of the research objective. Some studies in the literature have demonstrated the validity of the survey's validity in detecting stakeholders' perceptions (Forneris et al., 2012; Harker, 2019; Fuller & Myerscough, 2001).

Validity Procedure

Validity refers to the fact that an instrument measures exactly what it purports to measure (Souza et al., 2017). In this study, face and content validity were assessed. Face validity refers to the conciseness of the items of the instrument concerning clarity, brevity, and completeness (Sangoseni et al., 2013). Content validity refers to the degree to which items in an instrument reflect all aspects of the construct and is based on the judgement of a group of experts in a specific area of interest (Haynes et al., 1995). To guarantee these two types of validity, the surveys were revised by two study groups. The first group were survey construction experts who adapted the structure of the surveys as they saw fit. The second group were sports management experts who assessed whether the questions correctly captured the topic. Items with a content validity index (CVI) greater than 0.78 were included in the final instrument. The final version of both surveys consisted of two thematic sections. The first section presents 6 items, common for both presidents and trainers, about the various social and educational issues related to the practice of sport. The second section presents 4 items, that analyse the contribution that U.S. Salernitana 1919 brings to the territory in terms of economic and social return. The survey administered to the stakeholder is shown in Table 1.

Reliability Procedure

Reliability is the ability to reproduce a result consistently across time and space or from different observers (Souza, Alexandre & Guirardello, 2017). The reliability criteria calculated in this study were stability, which measures how similar the results measured at two different points in time are through the test-retest with a sample of at least 50 subjects and the calculation of the intraclass correlation coefficient (ICC) (Terwee et al., 2017), and internal consistency, which shows whether all items of an instrument measure the same characteristic through Cronbach's α coefficient (Streiner, 2003).

Statistical analysis

To validate the surveys, we first assessed its internal consistency through Cronbach's α and associated 95% confidence intervals (CI). A Cronbach's α of 1 indicated perfect reliability, with a cut-off of 0.70 indicating an acceptable internal consistency (Cronbach, 1951). Then, we assessed the test-retest reliability by administering the surveys after 1 month to a sub-sample of 50 presidents and 50 trainers who

Table 1. The survey administered to the stakeholder

Q1	What is the most relevant educational aspect related to playing football? a) Being fair and equitable b) Being consistent in training c) Being with friends d) Improving one's results and records
Q2	What is the main positive effect associated with the practice of sports discipline? a) Keeping fit b) Positive repercussions on self-esteem c) Reducing stress d) Development of greater determination to make decisions
Q3	In what ways can football be considered predominantly a vehicle for social inclusion? a) Counter gender discrimination b) Encourage the participation of non-disabled athletes c) Encourage the participation of non-EU athletes d) Not exclude anyone
Q4	What are the main training objectives that a football academy should pursue? a) The technical and physical development of the athletes b) The development of all areas of the athletes' personality c) The development of non-competitive recreational practice d) The development of the application of the rule to play and have fun
Q5	How could fair play be promoted in football academies? a) By creating and enforcing rules of the game and spreading awareness of the need to respect them. b) Ensuring equal opportunities beyond sporting aptitude. c) Valuing people regardless of victories and defeats d) By avoiding putting excessive pressure on athletes to achieve a good result
Q6	What do you consider to be the main critical issues related to playing football? a) Excessive emphasis on results b) Premature specialisation c) Selection at the grassroots level d) Premature recourse by families to the figure of the sports agent
Q7	Does the presence within the territory of a football club participating in the top league contribute to a greater approach to the practice of football? a) Extremely convinced b) Somewhat convinced c) Not at all convinced d) Needs a study to verify this
Q8	Has the promotion of the U.S. Salernitana 1919 club to the top league of Italian football contributed to the economic development of the territory? a) Absolutely yes, given the assiduous attendance at matches b) Not much, given the period of economic uncertainty that has characterized the club so far c) Not at all, given also the uncertainty of the pandemic period d) Needs a study to verify this.
Q9	9) How do you assess the intention of the new president of U.S. Salernitana 1919 to revitalize the club's youth academy so that it can afford to self-manage and self-finance itself? a) Very positive b) Positive but I don't think it is feasible c) Utopian d) Given the drift of professional soccer with the phenomenon of capital gains, it is a hypothesis for balance sheet consolidation
Q10	What is the main critical issue related to the youth academy of U.S. Salernitana 1919? a) Inadequate investment and interest on the part of the club. b) Inadequate preparation of the figures in charge of technical training c) Inadequate involvement of local youths d) Unproductiveness of the use of resources

agreed to be contacted again about the study (Aliberti et al., 2022). The ICC was interpreted using the criteria suggested by Portney and Watkins (2009) as poor reliability (ICC ≤ 0.50), moderate reliability (ICC 0.50–0.75), good reliability (ICC 0.75–0.90), and excellent reliability (ICC ≥ 0.90). A chi-square analysis (χ^2) was performed to test the independence within and between subjects (trainers and presidents) on their perceptions concerning the issues of youth football

and the accountability that football, understood as a public good, produces in local communities. Significance was set at $p < 0.05$. Data analyses were performed using the Statistical Package for Social Science software (IBM SPSS Statistics for Windows, version 25.0. Armonk, NY).

Results

Data Quality Check

The internal consistency of the survey for presidents was excellent (Cronbach's α coefficient [95% CI] 0.92 [0.89–0.94]; $p < 0.000$). In addition, the survey for trainers had a good internal consistency (Cronbach's α coefficient [95% CI] 0.85 [0.81–0.89]; $p < 0.000$). The test-retest reliability of the survey for presidents ranged from moderate to excellent, while that for trainers was from good to excellent. A detailed description is shown in Table 2.

Chi-Square Associations

Chi-Square showed four significant associations between stakeholder perceptions, specifically regarding how football can be seen as a vehicle for social inclusion (χ^2=13,0; p=0.00); the contribution that the top league football club makes to the practice of football (χ^2=14,6; p=0.00); the new president's intention to revitalize the youth academy (χ^2=15,7; p=0.00); finally the main critical issues related to the youth academy of U.S. Salernitana 1919 (χ^2=16,4; p=0.00) A detailed description is shown in Table 3.

Discussion

From data processing, it can be said that there is an agreement of opinion between stakeholders. A child up to the age of ten approaches football because he is looking for play and fun, to satisfy the need to experience his body and what he has learnt through physical activity (Croce, 2016). In the first question concerning the most relevant educational aspect of playing football, trainers and presidents most frequently selected the option "to be consistent in training", followed by "to be loyal and fair". However, it must be considered that in both childhood and pre-adolescence, children present a predominantly extrinsic motivation (Trecroci et al., 2021). From the age of 12, however, they approach football mainly because they feel the need to belong and interact with peers. From adolescence onwards (12-17 years), sport becomes the context in which they experience themselves, their abilities and those of their peers. It is only at this stage of life that consistency in training can prevail, not before, on pain of early specialization (Sarmento et al., 2018).

Concerning the main positive effect associated with the practice of sport, both trainers and presidents agree in indicating more frequently the option "developing greater determination to make decisions", followed by "fostering positive effects on self-esteem". Options considered more relevant than "keeping fit" and "reducing stress". However, it should not be underestimated that practising discipline on a three-weekly basis contributes to the development of children's physical efficiency. According to World Health Organization (WHO, 2022) guidelines, the 5–17-year age group should engage in at least 60 minutes of moderate to vigorous physical activity daily, supporting natural physical development, being fun and carrying out under safe conditions. Indeed, three workouts per week alone are not enough, but they provide an opportunity for recreation and stress reduction for children whom the school and extracurricular activities often overload. The answer "don't exclude anyone" was the most selected by stakeholders to promote social inclusion. As part of the activities related to the theme of integration, the Italian Football Federation, in agreement with the Ministry of the Interior, has developed the "RETE!" project. It represents an initiative aimed at young people throughout the country, to promote and foster peer interaction and social and intercultural inclusion processes through football. The aim is to promote ethically correct behaviour through value education, using sporting activity as a model for civil society (Italian Football Federation, 2022).

Concerning the main educational objectives that the football academy's educational project must pursue, the presidents selected "encourage the development of all areas of the athletes' personality" as the most important, while trainers indicated 'the necessity of the application of the rule' as the fist. Respect on how to promote fair play within the football academy, the presidents were divided between "fostering equal opportunities beyond sporting

Table 2. Test re-test reliability

Survey for Presidents	Test-Retest Reliability		Survey for Trainers	Test-Retest Reliability	
Variable	ICC (95%CI)	p	Variable	Variable	ICC (95%CI)
Q1	0.93 (0.88-0.96)	<0.000	Q1	0.94 (0.84-0.95)	<0.000
Q2	0.66 (0.41-0.77)	<0.000	Q2	0.95 (0.92-0.96)	<0.000
Q3	0.91 (0.85-0.95)	<0.000	Q3	0.86 (0.74-0.92)	<0.000
Q4	0.95 (0.92-0.97)	<0.000	Q4	0.93 (0.88-0.96)	<0.000
Q5	0.86 (0.74-0.92)	<0.000	Q5	0.95 (0.92-0.97)	<0.000
Q6	0.96 (0.92-0.97)	<0.000	Q6	0.97 (0.95-0.98)	<0.000
Q7	0.87 (0.78-0.92)	<0.000	Q7	0.93 (0.90-0.95)	<0.000
Q8	0.94 (0.92-0.97)	<0.000	Q8	0.90 (0.87-0.92)	<0.000
Q9	0.86 (0.75-0.92)	<0.000	Q9	0.91 (0.84-0.94)	<0.000
Q10	0.97 (0.95-0.98)	<0.000	Q10	0.91 (0.84-0.93)	<0.000

Table 3. Differences in perception between presidents and trainers

		Presidents	Trainers	χ^2	P
Q1) What is the most relevant educational aspect related to playing football?	a) Being fair and equitable	34	37	0,21	0,97
	b) Being consistent in training	42	41		
	c) Being with friends	23	22		
	d) Improving one's results and record	13	12		
Q2) What is the main positive effect associated with the practice of sports discipline?	a) Keeping fit	13	17	5,81	0,12
	b) Positive repercussions on self-esteem	23	35		
	c) Reducing stress	22	13		
	d) Development of greater determination to make decisions	54	47		
Q3) In what ways can football be considered predominantly a vehicle for social inclusion?	a) Counter gender discrimination	12	24	13,0	0,00
	b) Encourage the participation of non-disabled athletes	10	14		
	c) Encourage the participation of non-EU athletes	10	20		
	d) Not exclude anyone	80	54		
Q4) What are the main training objectives that a football academy should pursue?	a) The technical and physical development of the athletes	38	32	1,79	0,61
	b) The development of all areas of the athletes' personality	34	41		
	c) The development of non-competitive recreational practice	17	20		
	d) The development and application of the rules to play and have fun	23	19		
Q5) How could fair play be promoted in football academies?	a) By creating and enforcing rules of the game and spreading awareness of the need to respect them.	33	44	5,99	0,11
	b) Ensuring equal opportunities beyond sporting aptitude	44	48		
	c) Valuing people regardless of victories and defeats	16	8		
	d) By avoiding putting excessive pressure on athletes to achieve a good result.	19	12		
Q6) What do you consider to be the main critical issues related to playing football?	a) Excessive emphasis on results	38	37	4,48	0,21
	b) Premature specialisation	34	41		
	c) Selection at the grassroots level	15	10		
	d) Premature recourse by families to the figure of the sports agent	25	24		
Q7) Does the presence within the territory of a football club participating in the top league contribute to a greater approach to the practice of football?	a) Extremely convinced	28	12	14,6	0,00
	b) Somewhat convinced	21	40		
	c) Not at all convinced	8	3		
	d) Needs a study to verify this	55	57		
Q8) Has the promotion of the U.S. Salernitana 1919 club to the top league of Italian football contributed to the economic development of the territory?	a) Absolutely yes, given the assiduous attendance at matches	21	26	6,60	0,08
	b) Not much, given the period of economic uncertainty that has characterized the club so far	34	20		
	c) Not at all, given also the uncertainty of the pandemic period	12	8		
	d) Needs a study to verify this.	45	58		
Q9) How do you assess the intention of the new president of U.S. Salernitana 1919 to revitalize the club's youth academy so that it can afford to self-manage and self-finance itself?	a) Very positive	41	34	15,7	0,00
	b) Positive but I don't think it is feasible	38	19		
	c) Utopian	4	3		
	d) Given the drift of professional soccer with the phenomenon of capital gains, it is a hypothesis for balance sheet consolidation	45	56		
Q10) What is the main critical issue related to the youth academy of U.S. Salernitana 1919?	a) Inadequate investment and interest on the part of the club.	14	22	16,49	0.00
	b) Inadequate preparation of the figures in charge of technical training	35	21		
	c) Inadequate involvement of local youths	41	25		
	d) Unproductiveness of the use of resources	22	44		

aptitude" and "creating and enforcing rules of play and spreading awareness of the need for their observance". The first option prevailed among trainers. However, the 'need to avoid putting excessive pressure on others to achieve a good result, a frequent variable, should also be mentioned. The application of fair play in trainings should be extended to a competitive level with the participation of athletes in official competitions. Therefore, it is important to analyze the attitudes of players and their readiness to contravene the laws of the game.

Regarding the main critical issues related to football, presidents were more likely to indicate 'early specialization',

while the trainers preferred "excessive emphasis on results". Both are the major, critical issues currently present. However, one must also consider the problem of selections carried out at an early age or the premature recourse of parents to the figure of the sports agent. Engaging in intensive training programmes at an early age can cause negative outcomes for some young athletes. Firstly, by working on the few qualities a child knows, he is only allowed to discover some of the others, which are only expressed if they can be experienced in free play. Secondly, compulsory repetition and teaching the same way for everyone are obstacles to creativity and the free expression of talent (Güllich et al., 2022).

The second thematic section assessed stakeholders' perceptions of the contribution that the top league football club U.S. Salernitana 1919, made to the territory. The analysis showed that most stakeholders affirmed the need for an ad hoc study to demonstrate that the club's presence in the area contributes to the dissemination of sport, on the one hand, and economic development on the other. Many stakeholders agreed that the corporate uncertainty plagued the club so far has certainly not contributed to these phenomena. In most cases, general scepticism prevailed among both trainers and presidents in assessing the intention of the new president of U.S. Salernitana 1919 to revitalize the club's youth academy. Awareness of the difficult economic conditions in which Italian football currently finds itself has probably prevailed. As documented in the latest annual report of the Italian football federation (FIGC), from 2014 to 2019, i.e., in the pre-Covid period, the cumulative losses of the professional leagues amounted to 1.6 billion (FIGC, 2022). A context sick for years that Covid has only aggravated. In this scenario, the initiative proposed by the new club president is nothing more than one of the hypotheses to restore the balance sheets. Finally, most of the stakeholders indicated "inadequate investment and interest" as the main critical issue attributable to Salernitana 1999.

The work offers both practical and theoretical implications. As for the practical implications, the article highlights how the role of accounting in sports has grown and developed hand in hand with the increase in professionalization, assuming a role of considerable importance (Andon & Free, 2019). However, whether on the one hand the accounting practice has been enriched and modelled in relation to the growth and needs of sports organizations, on the other hand, it has partly lost its informative essence, representing a self-destructive tool through which professional clubs have justified the huge losses generated by the market, artificially "playing" on the intangible components within the financial statements. Furthermore, regarding accountability, the work notes the full stakeholders' awareness of the potential positive effects (in social and economic terms) deriving from the presence of an elite society inserted in a territorial context. However, the ambiguity of interests of the ownership structure and the lack of communicative transparency of the companies contribute to thinning the fiduciary bond between the various stakeholders involved, an essential factor to grasp the plurality of effects generated. Through a partnership approach with key stakeholders, a football team can be a valuable collective social anchoring organization and an important place for community development. A third implication refers to the orientation of sports organizations to the commercial logics of profit. In particular, the business orientation of the sports industry has slowly eroded the logic of dominant social well-being, threatening its ability to uphold the traditional values of sport (Miller et al., 2008). All this reflects on youth football, driven by logics oriented towards sporting and commercial success, which negatively affects young people's growth.

As regards the theoretical implications, given the economic, cultural, and social importance of sports organizations, there is ample room for increasing studies on the understanding of how forms of accounting are involved in sports to enrich the literature on the link between accounting and sports. A starting point for future research could be to carry out studies aimed at identifying the parameters that affect the fiduciary bond between the elite companies and the plurality of stakeholders inserted in a territorial context. The objective could be to verify how territorial public administrations contribute to increasing localised development practices. The localization approach to the topic covered by the study could help define a survey model to develop future studies preliminarily. It should be noted that the questions here administered were based on elaborating on the sport's educational and social value, following the line of social reporting.

This study is not free from limitations. The first limit is the subjectivity in detecting and identifying the main trends in the literature (Marrone et al., 2020). The second limit is reflected in the low sample size of our study, inserted in a circumscribed territorial perimeter. In this regard, it would be interesting to carry out a comparative study on populations inserted in different territorial contexts to verify the reliability of the generalization of the research results.

Conclusions

These results highlight the stakeholders' full awareness of the potential positive social effects of the presence of football ASDs in the territory. There is a need for im-plementing provisions that decline applications for different specific cases. Regarding the method of the study and considering the sampling limitations of the study, the lack of demographic data, and the primitive wording of the surveys, it is necessary to replicate it in order to provide useful elements to the legislator.

Conflict of interest

The authors declare that there is no conflict of interest.

References

Andon, P., & Free, C. (2019). Accounting and the business of sport: past, present and future. *Accounting, Auditing & Accountability Journal, 32*(7), 1861-1875. https://doi.org/10.1108/AAAJ-08-2019-4126

Clune, C., Boomsma, R., & Pucci, R. (2019). The disparate roles of accounting in an amateur sports organisation: the case of logic assimilation in the gaelic athletic association. *Accounting, Auditing & Accountability Journal, 32*(7), 1926-1955. https://doi.org/10.1108/AAAJ-06-2018-3523

Hoye, R., Smith, A.C., Nicholson, M., Stewart, B. (2018). *Sport management: principles and applications,* 5th ed.; Routledge, London, 234-241.

Morrow, S. (2000). Football clubs on the Stock Exchange: an inappropriate match? The case of Celtic plc. *Irish Accounting Review, 7*(2), 61-90.

Cooper, C., & Johnston, J. (2012). Vulgate accountability: insights from the field of football. *Accounting, Auditing & Accountability Journal, 25*(4), 602-634. https://doi.org/10.1108/09513571211225060

Potter, B., & Lightbody, M. (2016). Accounting's past in sport-an introduction. *Accounting History, 21*(1), 3-4. https://doi.org/10.1177/1032373215623958

Ratten, V. (2016). The dynamics of sport marketing: Suggestions for marketing intelligence and planning. *Marketing Intelligence & Planning, 34*(2), 162-168. https://doi.org/10.1108/MIP-07-2015-0131

Turner, P., & Shilbury, D. (2005). Determining the professional sport broadcasting landscape: An Australian football club perspective. *Sport Management Review, 8*(2), 167-193. https://doi.org/10.1016/S1441-3523(05)70038-3

András, K., & Havran, Z. (2015). New business strategies of football clubs. *APSTRACT-Applied Studies in Agribusiness and Commerce, 9*(1-2), 67-74. http://dx.doi.org/10.19041/APSTRACT/2015/1-2/13

Williams, J. (2007). Rethinking sports fandom: The case of European soccer. *Leisure Studies, 26*(2), 127-146. https://doi.org/10.1080/02614360500503414

Agenzia delle entrate (2022). *Associazioni sportive dilettantistiche*. Available online: https://www.agenziaentrate.gov.it/portale/documents/20143/233527 (accessed on 18 October 2022).

García, B., & Welford, J. (2015). Supporters and football governance, from customers to stakeholders: A literature review and agenda for research. *Sport Management Review, 18*(4), 517-528. https://doi.org/10.1016/j.smr.2015.08.006

Raiola, G., D'Isanto, T., Di Domenico, F., & D'Elia, F. (2022). Effect of Teaching Methods on Motor Efficiency, Perceptions and Awareness in Children. *International Journal of Environmental Research and Public Health, 19*(16), 10287. https://doi.org/10.3390/ijerph191610287

Witkowski, K., Proskura, P., Piepiora, P. (2016). The role of a combat sport coach in the education of youth – a reference to the traditional standards and perception of understanding the role of sport in life of an individual and society. *Arch Budo Sci Martial Art Extreme Sport,* 12, 123-130

Forneris, T., Camiré, M., & Trudel, P. (2012). The development of life skills and values in high school sport: Is there a gap between stakeholder's expectations and perceived experiences? *International Journal of Sport and Exercise Psychology, 10*(1), 9-23. https://doi.org/10.1080/1612197X.2012.645128

Harker, J. (2019). Identification and crisis: An exploration into the influence of sports identification on stakeholder perceptions of sports-related crisis. *Journal of Sports Media, 14*(1), 171-199. https://doi.org/10.1353/jsm.2019.0001

Fuller, C. W., & Myerscough, F. E. (2001). Stakeholder perceptions of risk in motor sport. *Journal of safety research, 32*(3), 345-358. https://doi.org/10.1016/S0022-4375(01)00058-5

Souza, A. C. D., Alexandre, N. M. C., & Guirardello, E. D. B. (2017). Psychometric properties in instruments evaluation of reliability and validity. Propriedades psicométricas na avaliação de instrumentos: Avaliação da confiabilidade e da validade. *Epidemiologia e servicos de saude,* 26, 649-659. https://doi.org/10.5123/S1679-49742017000300022

Sangoseni, O., Hellman, M., & Hill, C. (2013). Development and validation of a questionnaire to assess the effect of online learning on behaviors, attitudes, and clinical practices of physical therapists in the United States regarding evidenced-based clinical practice. *Internet Journal of Allied Health Sciences and Practice, 11*(2), 7. https://doi.org/10.46743/1540-580X/2013.1439

Haynes, S. N., Richard, D., & Kubany, E. S. (1995). Content validity in psychological assessment: A functional approach to concepts and methods. *Psychological assessment, 7*(3), 238. https://doi.org/10.1037/1040-3590.7.3.238

Terwee, C. B., Bot, S. D., de Boer, M. R., van der Windt, D. A., Knol, D. L., Dekker, J., ... & de Vet, H. C. (2007). Quality criteria were proposed for measurement properties of health status questionnaires. *Journal of clinical epidemiology, 60*(1), 34-42.https://doi.org/10.1016/j.jclinepi.2006.03.012

Streiner, D. L. (2003). Starting at the beginning: an introduction to coefficient alpha and internal consistency. *Journal of personality assessment, 80*(1), 99-103. https://doi.org/10.1207/S15327752JPA8001_18

Cronbach, L. J. (1951). Coefficient alpha and the internal structure of tests. *Psychometrika, 16*(3), 297-334. https://doi.org/10.1007/BF02310555

Aliberti, S., Rago, V., D'Elia, F., & Raiola, G. (2022). Questionnaire of inclusion in Paralympic dance: validation and pilot study. *Sport Sciences for Health, 18*(4), 1339-1347. https://doi.org/10.1007/s11332-022-00905-4

Portney, L. G., & Watkins, M. P. (2009). *Foundations of clinical research: applications to practice* (Vol. 892, pp. 11-15). Upper Saddle River, NJ: Pearson/Prentice Hall.

Croce I. (2016). Il calcio dei bambini; Correre, Milano, 27-31.

Trecroci, A., Invernizzi, P. L., Monacis, D., & Colella, D. (2022). Physical illiteracy and obesity barrier: how physical education can overpass potential adverse effects? A narrative review. *Sustainability, 14*(1), 419. https://doi.org/10.3390/su14010419

Sarmento, H., Anguera, M. T., Pereira, A., & Araújo, D. (2018). Talent identification and development in male football: A systematic review. *Sports medicine,* 48, 907-931. https://doi.org/10.1007/s40279-017-0851-7

World Health Organization (2022). *WHO guidelines on physical activity and sedentary behaviour*. Available online: https://apps.who.int/iris/bitstream/handle/10665/336656/9789240015128-eng.pdf (accessed on 18 October 2022).

Italian Football Federation (2022). *RETE! Project 2015*. Available online: https://www.figc.it/it/giovani/progetto-rete/rete/ (accessed on 18 October 2022).

Güllich, A., Macnamara, B. N., & Hambrick, D. Z. (2022). What makes a champion? Early multidisciplinary practice, not early specialization, predicts world-class performance. *Perspectives on Psychological Science, 17*(1), 6-29. https://doi.org/10.1177/1745691620974772

Italian Football Federation (2022). *Report Calcio 2021.* Available online: https://www.figc.it/media/144528/report-calcio-2021-eng.pdf (accessed on 18 October 2022).

Miller, P., Kurunmäki, L., & O'Leary, T. (2008). Accounting, hybrids and the management of risk. *Accounting, organizations and society, 33*(7-8), 942-967. https://doi.org/10.1016/j.aos.2007.02.005

Marrone, M., Linnenluecke, M. K., Richardson, G., & Smith, T. (2020). Trends in environmental accounting research within and outside of the accounting discipline. *Accounting, Auditing & Accountability Journal, 33*(8), 2167-2193. https://doi.org/10.1108/AAAJ-03-2020-4457

ПІДЗВІТНІСТЬ ФУТБОЛУ ЯК ФОРМИ СУСПІЛЬНОГО БЛАГА ДЛЯ МІСЦЕВИХ ГРОМАД: ПІЛОТНЕ ДОСЛІДЖЕННЯ

Ґаетано Раіола[1ABE], Франческа Д'Елія[1ABC], Джіованні Еспозіто[1CDE], Ґаетано Алтавілла[2ABC], Тіціана Д'Ізанто[1BDE]

[1]Університет Салерно
[2]Університет Саленто

Авторський вклад: A – дизайн дослідження; B – збір даних; C – статаналіз; D – підготовка рукопису; E – збір коштів

Реферат. Стаття: 8 с., 3 табл., 34 джерел.

Мета дослідження. Футбол є соціальним явищем, особливо через величезне використання ЗМІ та економічні та фінансові наслідки, які випливають із його комплексної спортивної діяльності. Любительські спортивні асоціації є частиною цього явища, оскільки вони представляють соціально-освітні агентства, які переслідують цілі спортивної підготовки шляхом прийняття конкретних освітніх, соціальних та економічних моделей. Окремо вони мають скромні розміри, але в сукупності вони становлять значний вимір суспільства, на який не можна не зважати. Мета дослідження полягає в тому, щоб спробувати зрозуміти уявлення зацікавлених сторін щодо питань дитячого футболу та підзвітності, яку футбол, у розумінні його як суспільного блага, створює в місцевих громадах.

Матеріали та методи. Це дослідження проводили за допомогою опитування, запропонованого вибірці, яку складали президенти та тренери 112 любительських спортивних клубів у провінції Салерно, місті на півдні Італії. Опитування складається з двох тематичних розділів. У першому розділі наведено 6 пунктів, спільних як для президентів, так і для тренерів, про різні соціальні та освітні питання, пов'язані з практикою спорту. У другому розділі наведено 4 пункти, які аналізують внесок, який футбольний клуб США «Салернітана 1919», який вважається «суспільним благом», приносить території з точки зору економічної та соціальної віддачі. Розраховано валідність і надійність. Зібрані дані були проаналізовані за допомогою критерію хі-квадрат (χ^2), щоб перевірити кореляцію між відповідями, наданими зацікавленими сторонами.

Результати. Результати показують узгодженість думок зацікавлених сторін щодо найбільш актуальних освітніх аспектів, пов'язаних із практикою футболу, та основних критичних проблем, пов'язаних із молодіжною академією футбольного клубу США «Салернітана 1919».

Висновки. Ці результати підкреслюють повне усвідомлення зацікавленими сторонами потенційних позитивних соціальних наслідків присутності футбольних любительських спортивних клубів на території, навіть враховуючи обмеження досліджуваної вибірки та територіально обмежену мету дослідження.

Ключові слова: футбол, суспільне благо, місцева громада, зацікавлена сторона.

Information about the authors:

Raiola, Gaetano: graiola@unisa.it; https://orcid.org/0000-0002-7659-1674; Department of Political and Social studies, University of Salerno, Via Giovanni Paolo II, 132, 84084 Fisciano SA, Italy.

D'Elia, Francesca: fdelia@unisa.it; https://orcid.org/0000-0003-1441-8101; Department of Human, Philosophical and Education Sciences, University of Salerno, Via Giovanni Paolo II, 132, 84084 Fisciano SA, Italy.

Esposito, Giovanni: g.esposito198@studenti.unisa.it; https://orcid.org/0000-0002-3659-8943; Department of Human, Philosophical and Education Sciences, University of Salerno, Via Giovanni Paolo II, 132, 84084 Fisciano SA, Italy.

Altavilla, Gaetano: gaetano.altavilla@unisalento.it; https://orcid.org/0000-0001-8436-7819; Department of Biological and Environmental Science and Technologies, University of Salento, Piazza Tancredi, 7, 73100 Lecce LE, Italy.

D'Isanto, Tiziana: tizidisanto@libero.it; https://orcid.org/0000-0001-7151-7486; Department of Human, Philosophical and Education Sciences, University of Salerno, Via Giovanni Paolo II, 132, 84084 Fisciano SA, Italy.

Cite this article as: Raiola, G., D'Elia, F., Esposito, G., Altavilla, G., & D'Isanto, T. (2023). The Accountability of Football as a Form of Public Good on Local Coammunities: A Pilot Study. *Physical Education Theory and Methodology, 23*(2), 263-270. https://doi.org/10.17309/tmfv.2023.2.15

Received: 24.02.2023. Accepted: 18.03.2023. Published: 28.04.2023

Теорія та методика фізичного виховання
Physical Education Theory and Methodology
Teorìâ ta Metodika Fizičnogo Vihovannâ

ISSN 1993-7989 (print)
ISSN 1993-7997 (online)
ISSN-L 1993-7989

ORIGINAL SCIENTIFIC ARTICLE

DIFFERENT EXPLOSIVE STRENGTH AND PHYSIOLOGICAL DEMANDS BETWEEN MALE AND FEMALE BASKETBALL TEAMS

Gaetano Altavilla[1ABC], Tiziana D'Isanto[2BDE], Gaetano Raiola[2ABD] and Francesca D'Elia[2ABC]

[1]University of Salento
[2]University of Salerno

Authors' Contribution: A – Study design; B – Data collection; C – Statistical analysis; D – Manuscript Preparation; E – Funds Collection

Corresponding Author: Gaetano Raiola, E-mail: gaetano.raiola2012@gmail.com
Accepted for Publication: April 3, 2023
Published: April 28, 2023

DOI: 10.17309/tmfv.2023.2.16

Abstract

Background. The several types of running in the team sports such as basketball, soccer and rugby, vary according to physical characteristics and sports. In particular, in the basketball the running is characterized by continuous acceleration and deceleration phases, which entails greater energy expenditure. This study aimed to assess the strength decrease of the lower limbs and energy expenditure at different running conditions (n=4) with/without the ball during Linear running and Shuttle run (180°) in two groups (male: n=15; female: n=15).

Materials and methods. Experimental approach required the following tests/devices: Squat Jump to assess the strength of the lower limbs before/after each test, and a portable Metabolimeter was used to assess the metabolic parameters. The T-test was used for independent samples and Two-way repeated measures ANOVA was used to assess the significant differences for each variable between each running conditions.

Results. Initial hypothesis has been confirmed, showing a significantly different strength decrease in different running conditions (Linear Running and Shuttle run with and without ball) and between the two teams considered (male and female). In addition, different energy expenditure between the two groups increases even more during the running with the ball compared to running without the ball.

Conclusions. The results of this study could be useful for coaches to optimize training with different training load related to gender and to the running conditions (with and without the ball), but also to optimize the work load of young players in relation to the abilities, skills and experiences of players.

Keywords: physical fatigue, strength decrease, training load, performance.

Introduction

The match analysis showed that basketball players perform sprint at different velocities (Ben Abdelkrim et al., 2007), over distances between 10 and 20m, within a limited timeframe of up to 20 sec. (Narazaki et al., 2009), changing direction with and without ball; indeed, basketball is characterized by multiple high-intensity actions and it represents a multi-task sport (Sanchez-Sanchez et al., 2019). All these displacements on field determine considerable and different energy expenditure (Ben Abdelkrim et al., 2010). In addition, in basketball has been considered fundamental (Altavilla et al., 2022) since physiological demands under stress can negatively alter players' performance. Therefore, is important to understand fatigue adaptations, because the players must be able to effectively perform specific tasks under physical fatigue during training and match (Kamandulis et al., 2013). The several types running in the team sports such as basketball, soccer and rugby, vary according to physical characteristics and sports (Esposito et al., 2019). Continuous acceleration and deceleration phases characterized the running in the basketball, which entail a greater energy expenditure. In team sports is essential to optimize the training program through the study and workload analysis. These activity, generally, limited to the overall load and they not assess the different running conditions related at gender and to the positions by players. Researches are not many that concern the physiological load, due to accelerations and decelerations during changes of direction every 15 m. Specifically, we will verify both the decrease in strength of the lower limbs that the energy expenditure in two different running conditions (Linear run and Shuttle run), with and without changes of direction, with and without the ball between two teams of young basketball players (male and

female). The analysis of decrement of the strength and the energy expenditure in different running conditions can be useful to differentiate the training load. It can contribute to the improvement the learning process on a specific motor task and to comprise how the energy expenditure change to the quality of the task performed. The purpose of this study is to assess the level of decrement of the strength and the energy expenditure in different running conditions: Linear running and Shuttle running between two youth basketball teams (male and female). The hypothesis formulated is as follows: the strength of the lower limbs may decrease more in the running with ball and between two groups (male and female); while the energy expenditure should be different in four running conditions with ball compared to running without ball.

Materials and methods

Study participants

The subjects who participated were thirty young basketball players aged 20±1. They represented two teams (male n=15 and female n=15). All players had at least five years of training experience and they participated voluntarily. The variables detected were the following: Jump performance (cm) and mechanical work ($j \cdot (kg \cdot m)^{-1}$). Data collection required the use of the following devices and tests: Lower limb muscle strength assessed with Optojump (Bosco et al., 1983), Yo-Yo endurance test (Bangsbo et al., 2006); Linear running and Shuttle running (Vaquera et al., 2016) assessed with Metabolimeter K4b2. In table 1 showed the anthropometric characteristics of the two groups considered (male and female). The mean age of the male group was 19.8 ± 0.6 years, the body height was 191.4 ± 4.2 cm, the body weight was 82.3 ± 2.9 kg, the body mass index was 22.4 ± 2.7 kg/m² (indicated as normal value). The mean age of the female group was 19.5 ± 0.5 years, their body height was 180.1 ± 3.8 cm, the body weight was 75.2 ± 3.1 kg, the body mass index was 23.2 ± 2.9 kg/m².

Table 1. Anthropometric and physiological characteristics of the two teams

Variables	Male team (n=15)	Female team (n=15)
Age (years)	19.8 ± 0.6	19.5 ± 0.5
Height (cm)	191.4 ± 4.2	180.1 ± 3.8
Weight (kg)	82.3 ± 2.9	75.2 ± 3.1
BMI (kg/m²)	22.4 ± 2.7	23.2 ± 2.9
VO_2max ($ml \cdot kg^{-1} \cdot min^{-1}$)	50.4 ± 2.6	42.6 ± 2.4
Heart rate max (b/min)	181.3 ± 2.4	183.5 ± 2.6

Procedures

At the two teams were provided explanations on the protocol to follow. The study envisaged five testing sessions on seven-day period and with two-day rest in-between. In the first session, the participants did an indirect continuous multistage field test to determine VO_2max (Léger & Boucher,1980) to set the relative intensities of the next experimental sessions. The two teams have performed two sessions of running without ball: in-line continuous running, Shuttle running on 15 meter with directional changes at 180°. The same sessions, were repeated with ball. All players were required to run at an intensity at 80% of VO_2max, this intensity was controlled with a frequency meter; while, beep sounds and track markers were used as spatiotemporal indicators. The tests were carried on a flat 100m course on a synthetic rubber base. All players performed at least 10 minutes of a warm-up before carrying out each test. After one week all tests were repeated to verify the reliability of measurements. The Yo-Yo endurance test has been performed by each participant, as an incremental test (di Prampero et al., 2009) to detect the VO_2max. After wards, the Squat Jump (SJ) has been performed, for each running condition, to assess the muscle strength decrement. Optojump evaluated lower limbs muscle strength before and after each running conditions, with and without ball, from the two teams (male and female). Finally, All participants were tested (on 1000m at 80% of VO_2max) and they were randomly selected. Each group performed randomly and evaluated in the different running conditions with and without the ball (n=4).

Statistical analysis

All data are presented as mean and standard deviation (Mean ± SD). The normality of the data distribution was verified by means of the Shapiro-Wilk test, while the homogeneity of the variances was verified with the Levene test. Intra-class correlation coefficient (Hopkins, 2000) was calculated to assess the reliability of the measures for each running condition. Regarding the energy expenditure, the t-test for independent sample was used to assess the significance of the differences in the different running conditions (with and without the ball). Instead, for lower limbs strength was used the two-way 2×2 between-within ANOVA to assess the main effect of the between-subjects factor Group (male and female), within-subjects factor Treatment (Pre and Post) together with the factorial interaction Group×Treatment. While for the measure of the effect size was used partial eta squared (η^2). The significance level was fixed at $P < 0.05$. All statistical tests were conducted through IBM SPSS Statistics version 23.

Results

The results of the study confirmed the initial hypothesis. The T-test was used for independent samples to verify any significant differences on the energy expenditure for each running condition between the two groups (with the ball and without the ball). Table 2 shows significant differences both two teams analyzed (male and female) depending for each running conditions: LR without the ball with p=0.01; SR without the ball with p=0.01; LR with the ball with p=0.00 and SR with the ball with p=0.00. The homogeneity of the variance was confirmed through the use of Levene's test. The values of Intraclass Correlation Coefficient was verified for the reliability of the measures of the energy expenditure were excellent, showing a range from 0.90 to 0.97. Regarding the men's team these are the outcomes: LR without the ball 0.97; SR without the ball 0.94; LR with the ball 0.95 and SR with the ball 0.92. While the women's team these are the outcomes: LR without the ball 0.96; SR without the ball 0.93; LR with the ball 0.94 and SR with the ball 0.90.

Table 2. T-test for independent samples: Energy expenditure for each running condition (n=4)

Variables	Mean male C_[j·(kg·m)$^{-1}$]	Mean female C_[j·(kg·m)$^{-1}$]	t-value	df	p	Levene's test F(1,df)	p Levene's test
LR without the ball	5.12 ± 0.20	5.28 ± 0.26	-2.81	28	0.01	0.633	0.452
SR without the ball	5.30 ± 0.34	5.50 ± 0.33	-2.77	28	0.01	0.466	0.524
LR with the ball	6.02 ± 0.27	6.40 ± 0.28	-2.43	28	0.00	0.008	0.932
SR with the ball	6.50 ± 0.45	6.96 ± 0.42	-2.90	28	0.00	0.564	0.454

LR – Linear Running; SR – Shuttle Run; p – p value.

Table 3. Two way (between-within) 2×2 ANOVA in four running conditions

Effects	LR without the ball		SR without the ball		LR with the ball		SR with the ball	
	P	Partial eta-squared (η^2)	P	Partial eta-squared (η^2)	P	Partial eta-squared (η^2)	P	Partial eta-squared (η^2)
Groups	0.01	0.16	0.00	0.30	0.00	0.18	0.00	0.36
R1	0.00	0.70	0.00	0.50	0.00	0.82	0.00	0.75
R1* Groups	0.20	0.04	0.14	0.08	0.36	0.03	0.18	0.08

LR - Linear Running; SR – Shuttle Run; p – p value; η^2 – effect size; R1 – Treatment.

The results shown in table 3 demonstrate the effects and interactions between two factors (Treatment-Groups) and the dependent variable (lower limb strength). Significant evidence was detected between the groups (p=0.01; p=0.00; p=0.00; p=0.00) and in treatments "R1" (p=0.00; p=0.00; p=0.00; p=0.00); while the interaction between the groups and treatments (R1*Groups) are not significant (p=0.20; p=0.14; p=0.36; p=0.18). Finally, the size of the partial effect for regarding the groups is small, while in the case of the treatments "R1" they result to be medium-sized.

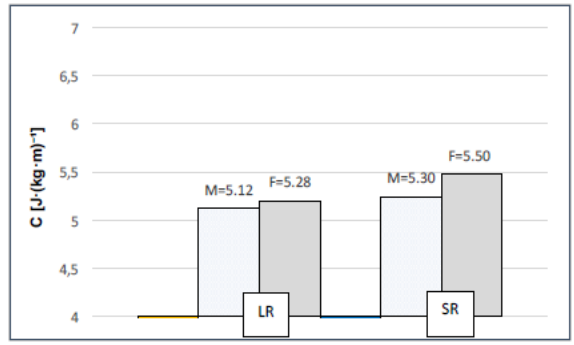


Fig. 1. Energy expenditure of running without ball between two teams (M = Male; F = Female; LR = Linear running; SR = Shuttle run)

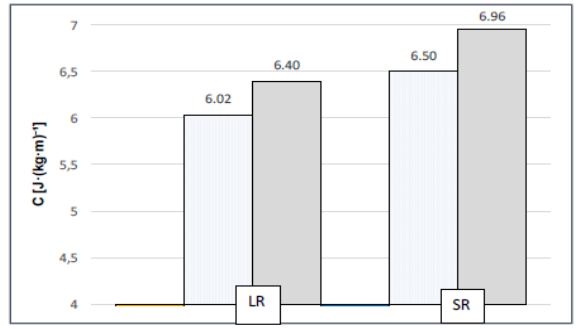


Fig. 2. Energy expenditure of running with ball between two teams (M = Male; F = Female; LR = Linear running; SR = Shuttle run)

Discussion

The strength's decrease and the energy expenditure between the two groups (male and female) in the Shuttle run result more expensive compared to linear running (Bekraoui et al., 2020). In the shuttle run with the ball a significant difference was detected between the two groups, as it required more muscular work due to the deceleration and acceleration action on each change of direction and at more motor control of the ball (table 2, p = 0.00). Male group, in all different running conditions (n=4) showed lower energy expenditure values than female group. In this study, the results obtained offers new information that allows an estimate of the energy expenditure due to acceleration and deceleration. The effects and interactions between the factors "Treatment and Groups" and the dependent variable (lower limbs strength) are shown in table 3. shows the effects and interactions between two factors (Treatment-Groups) and the dependent variable (lower limbs strength). There were significant differences between the two groups (Groups: 0.01; 0.00; 0.00 and 0.00) and in the treatments (R1: 0.00; 0.00; 0.00 and 0.00). For every running conditions (n=4) the result showed a significant difference in the decrease of strength in the comparison between the male and female groups, and so too in the before and after tests in each group. Finally, the interactions between the groups and the treatment did not provide significant outcome in the four running conditions (p: 0.20; 0.14; 0.36; 0.18). In this study, the multiple decelerations and accelerations require greater physiological demands at the players compared to linear running (Buglione & di Prampero, 2013). In addition, the different and significant energy expenditure between the two groups (male and female) increases even more in the running with the ball than that without the ball (Figures 1 and 2). This could be justified by an additional demand necessary both for the motor control of the ball and both due to possession of some quantitative and qualitative skills, result of specific training and also for gender characteristics.

Therefore, the evaluation training and continuous monitoring of the physiological aspects become an important aspect for the control of the performance.

Conclusions

In light of these results, it could be useful to design training loads adapted to the effective energy and physiological needs of the game situations and in relation to the different of position in field, of gender, conditional and coordinating capacities requests. Therefore, it is necessary to differentiate and to customize the training load. For example, intervening on the variables such as exercise duration, distance, intensity and recovery time.

Conflict of Interest

The authors declare that they have no conflict of interest.

References

Ben Abdelkrim, N., El Fazaa, S., & El Ati, J. (2007). Time-motion analysis and physiological data of elite under-19-year-old basketball players during competition. *British Journal of Sports Medicine, 41*(2), 69-75. https://doi.org/10.1136/bjsm.2006.032318

Narazaki, K., Berg, K., Stergiou, N., & Chen, B. (2009). Physiological demands of competitive basketball. *Scandinavian Journal of Medicine & Science in Sports, 19*(3), 425-432. https://doi.org/10.1111/j.1600-0838.2008.00789.x

Sanchez-Sanchez, J., Carretero, M., Ramirez-Campillo, R., Petisco, C., Diego M. Gonzalo-Skok O, Nakamura, FY. (2019). Effects of high-intensity training with one versus three changes of direction on young female basketball player's performance. *Kinesiology, 50*(S1), 117-125. UDC: 796.015.367: 796.323.2 055.25.

Ben Abdelkrim, N., Castagna, C., Jabri, I., Battikh, T., El Fazaa, S., & El Ati, J. (2010). Activity profile and physiological requirements of junior basketball players in relation to aerobic-anaerobic fitness. *Journal of Strength and Conditioning Research,* 24, 2330-2342. https://doi.org/10.1519/JSC.0b013e3181e381c1

Altavilla, G., Raiola, G., D'Elia, F., Jelicic, M. (2022). Energetic cost of running with and without the ball in male basketball players. *Physical Activity Review, 10*(2), 88-96. https://doi.org/10.16926/par.2022.10.24

Kamandulis, S., Venckūnas, T., Masiulis, N., Matulaitis, K., Balčiūnas, M., Peters, D., Skurvydas, A. (2013). Relationship between general and specific coordination in 8-to 17-year-old male basketball players. *Perceptual and Motor Skills, 117*(3), 821-836. https://doi.org/10.2466/25.30.PMS.117x28z7

Esposito, G., Ceruso, R., D'isanto, T. (2019). Evaluation of some quantitative aspects in the young soccer players training process during puberty. *Journal of Physical Education and Sport, 19*(S5), 1777-1783. https://doi.org/10.7752/jpes.2019.s5261

Bosco, C., Luhtanen, P., & Komi, P.V. (1983). A simple method for measurement of mechanical power in jumping. *European Journal of Applied Physiology, 50*(2), 273-82. https://doi.org/10.1007/BF00422166

Bangsbo, J., Mohr, M., Poulsen, A., Perez-Gomez, J., & Krustrup, P. (2006). Training and testing the elite athlete. *Journal of Exercise Science and Fitness, 4*(1), 1-14.

Vaquera, A., Villa, J.G., Morante, J.C., Thomas, G., Renfree, A.J., & Peters, D.M. (2016). Validity and test-retest reliability of the TIVRE-Basket Test for the determination of aerobic power in elite male basketball players. *Journal of Strength and Conditioning Research, 30*(2), 584-587. https://doi.org/10.1519/JSC.0000000000001078

Léger, L.A., & Boucher, R. (1980). An indirect continuous running multistage field test: The University of Montreal track test. *Canadian Journal of Sport Sciences, 6*, 77-84. PMID: 7389053.

di Prampero, P.E., Salvadego, D., Fusi, S., & Grassi, B. (2009). A simple method for assessing the energy cost of the running during incremental test. *Journal of Applied Physiology,* 107, 1068-1075. https://doi.org/10.1152/japplphysiol.00063.2009

Hopkins, W.G. (2000). Measures of reliability in sports medicine and science. *Sports Medicine, 30*(1), 1-15. https://doi.org/10.2165/00007256-200030010-00001

Bekraoui, N., Boussaidi, L., Cazorla, G., & Leger, L. (2020). Oxygen uptake, heart rate, and lactate responses for continuous forward running and stop-and-go running with and without directional changes. *Journal of Strength and Conditioning Research, 34*(3), 699-707. https://doi.org/10.1519/JSC.0000000000002802

Buglione, A., di Prampero, P.E. (2013). The energy cost of shuttle running. *European Journal of Applied Physiology, 113*(6), 1535-1543. https://doi.org/10.1007/s00421-012-2580-9

РІЗНА ВИБУХОВА СИЛА ТА РІЗНІ ФІЗІОЛОГІЧНІ ВИМОГИ МІЖ ЧОЛОВІЧИМИ ТА ЖІНОЧИМИ БАСКЕТБОЛЬНИМИ КОМАНДАМИ

Ґаетано Алтавілла[1ABC], Тіціана Д'Ізанто[2BDE], Ґаетано Раіола[2ABD], Франческа Д'Елія[2ABC]

[1]Університет Саленто
[2]Університет Салерно

Авторський вклад: A – дизайн дослідження; B – збір даних; C – статаналіз; D – підготовка рукопису; E – збір коштів

Реферат. Стаття: 5 с., 3 табл., 2 рис., 15 джерел.

Історія питання. Кілька типів бігу в командних видах спорту, таких як баскетбол, футбол і регбі, відрізняються залежно від фізичних характеристик і видів спорту. Зокрема, у баскетболі біг характеризується безперервними фазами прискорення та уповільнення, що тягне за собою більші витрати енергії. Метою цього дослідження було оцінити зниження сили нижніх кінцівок і витрати енергії за різних умов бігу (n=4) з м'ячем та без м'яча під час прямолінійного бігу та човникового бігу (180°) у двох групах (чоловіки: n=15; жінки: n=15).

Матеріали та методи. Експериментальний підхід вимагав наступних тестів/пристроїв: для оцінки сили нижніх кінцівок до/після кожного тесту використовували стрибки зігнувши ноги, а для оцінки метаболічних параметрів використовували портативний метаболіметр. Для незалежних вибірок використовували t-критерій Стьюдента, а для оцінки статистично значущих відмінностей для кожної змінної між кожними умовами виконання використовували двофакторний дисперсійний аналіз повторних вимірювань.

Результати. Початкова гіпотеза була підтверджена, показуючи статистично значущо різне зниження сили в різних умовах бігу (прямолінійний біг і човниковий біг із м'ячем і без нього) і між двома розглянутими командами (чоловічою та жіночою). Крім того, різниця витрати енергії між двома групами ще більше збільшується під час бігу з м'ячем порівняно з бігом без м'яча.

Висновки. Результати цього дослідження можуть бути корисними для тренерів для оптимізації тренувань із різним тренувальним навантаженням залежно від статі та умов бігу (з м'ячем і без нього), а також для оптимізації робочого навантаження молодих гравців залежно від здібностей, навичок і досвіду гравців.

Ключові слова: фізична втома, зниження сили, тренувальне навантаження, результативність.

Information about the authors:

Altavilla, Gaetano: gaetano.altavilla@unisalento.it; https://orcid.org/0000-0001-8436-7819; Department of Biological and Environmental Science and Technologies, University of Salento, Piazza Tancredi, 7, 73100 Lecce LE, Italy.

D'Isanto, Tiziana: tizidisanto@libero.it; https://orcid.org/0000-0001-7151-7486; Department of Human, Philosophical and Education Sciences, University of Salerno, Via Giovanni Paolo II, 132, 84084 Fisciano SA, Italy.

Raiola, Gaetano: graiola@unisa.it; https://orcid.org/0000-0002-7659-1674; Department of Political and Social studies, University of Salerno, Via Giovanni Paolo II, 132, 84084 Fisciano SA, Italy.

D'Elia, Francesca: fdelia@unisa.it; https://orcid.org/0000-0003-1441-8101; Department of Human, Philosophical and Education Sciences, University of Salerno, Via Giovanni Paolo II, 132, 84084 Fisciano SA, Italy.

Cite this article as: Altavilla, G., D'Isanto, T., Raiola, G., & D'Elia, F. (2023). Different Explosive Strength and Physiological Demands Between Male and Female Basketball Teams. *Physical Education Theory and Methodology, 23*(2), 271-275. https://doi.org/10.17309/tmfv.2023.2.16

Received: 26.02.2023. Accepted: 03.04.2023. Published: 28.04.2023

Теорія та методика фізичного виховання
Physical Education Theory and Methodology
Teorìâ ta Metodika Fìzičnogo Vihovannâ

ISSN 1993-7989 (print)
ISSN 1993-7997 (online)
ISSN-L 1993-7989

ORIGINAL SCIENTIFIC ARTICLE

EVALUATION OF THE CORRELATION BETWEEN STRENGTH AND SPECIAL TRAINING INDICATORS IN MIXED MARTIAL ARTS

Andrii Chernozub[1ABCDE], Oleh Olkhovyi[2ABCD], Alla Aloshyna[1ABCD], Andrii Savenko[1ABCD], Ivan Shtefiuk[3ABD], Ivan Marionda[4BDE], Tetiana Khoma[4BDE] and Victoriya Tulaydan[4BDE]

[1]Lesya Ukrainka Volyn National University
[2]Kharkiv State Academy of Physical Culture
[3]Yuriy Fedkovych Chernivtsi National University
[4]State University "Uzhhorod National University"

Authors' Contribution: A – Study design; B – Data collection; C – Statistical analysis; D – Manuscript Preparation; E – Funds Collection

Corresponding Author: Andrii Chernozub, E-mail: chernozub@gmail.com
Accepted for Publication: April 3, 2023
Published: April 28, 2023

DOI: 10.17309/tmfv.2023.2.17

Abstract

Study purpose. To study the peculiarities of correlation between the maximum strength development and quantity of kicks in MMA using load regimes of different intensity and energy supply.

Materials and methods. 75 athletes aged 19±0.7 practicing MMA for 4±0.8 years were examined and divided into 3 groups. During 12 weeks, group 1 athletes used low-intensity (Ra=0.53) load regime, group 2 – medium-intensity (Ra=0.65) and group 3 – high-intensity (Ra=0.72). The control of attacking kicks (front kick, reverse side kick, roundhouse kick) quantity with maximum force until full muscle fatigue for 20 s allowed to check special training. The level of strength training was evaluated by estimating the maximum strength development (1 RM) indicators. Non-parametric methods of mathematical statistics were used for data processing.

Results. The indicators of special training showed the greatest increase by an average of 13.2% in group 3 athletes during 12 weeks. In the other two groups, the dynamics of the controlled indicator was 3.2 times smaller for a similar period of time. The maximum muscle strength indicator increased by 41.9% in group 3 athletes compared to the initial data. These changes are on average 1.5 times higher than the results recorded in athletes of groups 1 and 2. Despite the revealed growth of strength and special training indicators in MMA athletes, there was no strong correlation between them in any research group.

Conclusions. Using high-intensity load regime in conditions of anaerobic-alactate mode of energy supply allowed achieving the greatest results in strength and special training indicators. However, the study did not show correlation between the increase in maximum strength development and quantitative indicators of attacking kicks. Further research will be focused on searching for more informative markers for assessing the training of athletes in MMA and adaptation processes using biochemical control methods.

Keywords: MMA, load regimes, intensity, muscle strength, special training.

Introduction

Mixed Martial Arts is one of the spectacular professional types of martial arts in the world, which has been developing rapidly in recent years. Being related to "gladiator matches" and creating a bright "show" requires great skill from athletes. The need to master the perfect technique of kicks, punches, and pain techniques together with a powerful level of functional capabilities and physical development requires constant improvement of training (Chernozub et al., 2018; Antoniettô et al., 2023; Bueno et al., 2022). The study of effective mechanisms for optimizing the training system in MMA is one of the debated issues among scientists in spheres of sports, biology and medicine. At the same time, the question of the effectiveness and expediency of using certain ways of solving this problem is quite controversial (James et al., 2020; Kirk et al., 2020; Olkhovyi O. et al., 2020; Chernozub et al., 2022).

Strength training is one of the key factors increasing the adaptive reserves of athletes and enlarging their explosive

ТМФВ
ТОВ ОВС

power (Chernozub et al., 2019; Kirk et al., 2021; Liu et al., 2022). An important aspect of optimizing the training process is the effective combination of energy supply modes of muscle activity and the magnitude of load indicators. Using loads of different volume and intensity allows precisely influencing on the level of functional training of athletes of the striking or wrestling style of fighting in MMA (Chernozub et al., 2018; Pavelka et al., 2022). Power load regimes optimization is impossible without employing a wide range of physiological and biochemical methods for controlling adaptive and compensatory reactions to a stressful stimulus, which is an integral part of improving the training system (Giboin & Gruber, 2022; Tota & Wiecha, 2022).

Scientists have been recently paying close attention to studying the impact of various load regimes on the growth of strength capabilities and indicators of special training (Seniuk et al., 2020; Camarco et al., 2022; Folhes et al., 2022). These studies concern the need to improve the quantity and power of attacking and counter-attacking kicks in MMA due to the growth of maximum muscle strength (1 RM). However, the results of research identifying correlation between these indicators have not been found in the available scientific literature.

Thus, the purpose of this research is to study the peculiarities of correlation between the maximum strength development and quantity of kicks in MMA using load regimes of different intensity and energy supply.

Materials and methods

Study participants

75 athletes aged 19±0.7 who had been practicing MMA for the last 4±0.8 years were examined and divided into 3 groups. The duration of the study was 12 weeks. Athletes of the 1st group used low-intensity load regime (Ra=0.53), which had the following characteristics: anaerobic-glycolytic mode of energy supply of muscle activity; full amplitude of movement with fixation at the peak point; the duration of a repetition is 4 seconds; 12 repetitions in a set; the maximum duration of work in a set is 48-55 seconds; rest between sets lasts 60 seconds; the projectile working mass is 53-55% of 1RM. Group 2 representatives used a medium-intensity (Ra=0.65) load regime characterized by the following features: anaerobic-glycolytic mode of energy supply of muscle activity; full amplitude of movement without fixation at the peak point; the duration of each repetition is 5-6 seconds; 8 repetitions in a set; the maximum duration of work in a set is 40-43 seconds; rest between sets lasts 60 seconds; the projectile working mass is 65-67% of 1RM. The third group athletes used a high-intensity (Ra=0.72) load regime based on anaerobic-alactate mode of energy supply of muscle activity and including partial (90%) range of motion; the duration of each repetition is 8-9 seconds; 4 repetitions in a set; the maximum duration of work in a set is 32-35 seconds; rest between sets lasts 45 seconds; the projectile working mass is 72-75% of 1RM.

Study organization

The level of strength training in study participants was assessed with the help of the maximum strength indicators (1 RM) using the control testing method. Control over 1 RM development of certain muscle groups was carried out using training exercises: bench press on the Smith simulator, block thrust behind the head, and lying leg press.

The level of special training in MMA was determined using the method of control testing of the training level of athletes. The proposed method is based on monitoring the dynamics of quantitative indicators of attacking kicks (reverse side kick, roundhouse kick) performed with maximum force until full muscle fatigue for 20 seconds. Measurements were taken at the beginning of the study and every 4 weeks.

The research algorithm consisted of three stages. At the first stage, load regimes were developed using the integral method of quantitative estimation of load capacity in power fitness depending on the conditions of muscular activity and level of training (Chernozub et al., 2018). At the second stage, the dynamics of strength and special training indicators were studied. At the third stage, we studied the peculiarities of correlation between the maximum strength development and the quantity of kicks in MMA using load regimes of different intensity and energy supply.

Statistical analysis

Statistical analysis of the research results was performed using the IBM *SPSS*Statistics 26 program package (StatSoftInc., USA). Median, lower and upper quartiles, interquartile range (IQR) were determined. Kruskal-Wallis H test was used for testing whether samples originate from the same distribution. Friedman's two-way analysis of variance by ranks was used to compare indicators of the same sample of subjects during the control period. Kendall's W (the Kendall's coefficient of concordance) is an effect size index for Friedman test. The G-Power 3.1.96 program was used to calculate statistical power (determining the smallest sample size for the study). The relationship between certain variables and individual-typological characteristics of the subjects was established using Spearman's rank correlation coefficients.

Results

Table 1 presents the results of changes in the maximum muscle strength (1 RM) in athletes of all groups using the proposed load regimes during 12 weeks of the study.

The obtained results showed that initial indicators of the maximum muscle strength development did not differ in the athletes of all three groups. During 12 weeks of research, the maximum muscle strength indicators increased by 41.9% on average ($p<0.05$) in group 3 athletes. In the representatives of the other two groups, the studied strength indicators also grew, but with a smaller progression (on average by 3.2 times) over a similar period of time.

Thus, it is the high-intensity load in conditions of anaerobic-alactate mode of energy supply that contributes to the accelerated growth of the maximum muscle strength development in MMA athletes.

The results presented in Figure 1 demonstrate the peculiarities of changes in the quantitative indicators of kicks (front kick, reverse side kick, roundhouse kick) performed with maximum force until complete fatigue for 20 seconds. Control of the studied indicators in athletes of all three groups took place during 12 weeks of using load regimes that differ in terms of energy supply and intensity.

Table 1. The results of the maximum muscle strength (1RM) development in study participants during 12 weeks, (median, interquartile range (IQR), n=75

Exercises	Group	Term of observation, weeks				χ^2, p df=3
		Initial data	4 weeks	8 weeks	12 weeks	
Bench press on the Smith simulator	1	65.00 (11.50) H=1.24 p=0.53	72.50 (8.75) 11.5%1*	80.00 (10.00) 10.3%1*	82.00 (10,00) 2.5%1* 26.1%2***	χ^2=74.19*** W=0.98***
	2	65.00 (10.00) H=1.24 p=0.53	75.00 (8.75) 15.4%1*	85.00 (9.00) 13.3%1*	87.00 (6.00) 2.4%1* 33.8%2***	χ^2=71.93*** W=0.96***
	3	60.00 (12.50) H=1.24 p=0.53	75.00 (17.75) 25.0%1*	85.00 (15.00) 13.3%1*	86.00 (13.50) 1.2%1* 43.3%2***	χ^2=73.20*** W=0.97***
Block thrust behind the head	1	65.00 (10.00) H=7.50 p=0.07	70.00 (10.00) 7.7%1*	75.00 (8.50) 7.1%1*	77.00 (7.00) 2.7%1* 18.4%2***	χ^2=73.62*** W=0.98***
	2	65.00 (10.00) H=7.50 p=0.07	75.00 (5.00) 15.4%1*	80.00 (7.00) 6.7%1*	80.00 (5.00) 0.0%1 23.0%2***	χ^2=72.61*** W=0.96***
	3	60.00 (50.0) H=7.50 p=0.07	72.00 (10.00) 20.0%1*	77.50 (11.50) 7.6%1*	82.00 (6.50) 5.8%1* 36.6%2***	χ^2=73.40*** W=0.97***
Lying leg press	1	120.00 (22.50) H=3.22 p=0.20	138.00 (13.50) 15.0%1*	152.00 (16.00) 10.1%1*	155.00 (16.50) 2.0%1* 29.1%2***	χ^2=69.58*** W=0.92***
	2	125.00 (25.50) H=3.22 p=0.20	135.50 (25.50) 8.4%1*	155.00 (30.00) 14.4%1*	165.00 (26.50) 6.4%1* 32.0%2***	χ^2=73.20*** W=0.97***
	3	120.00 (20.00) H=3.22 p=0.20	148.00 (21.00) 23.3%1*	170.00 (20.00) 14.9%1*	175.00 (18.50) 2.9%1* 45.8%2***	χ^2=73.97*** W=0.98***

Notes: 1 – difference (%) compared to previous results; 2 – difference (%) in comparison with the initial data; df is the number of degrees of freedom; H – Kruskel Wallis criterion; χ^2 – Friedman test; W is the Kendall coefficient; *– p<0.05; *** – p<0.001

At the beginning of the study the controlled indicators had no significant differences among the athletes of the examined groups. This fact allowed determining the level of influence of the proposed load regimes on the quantitative indicators of the studied types of kicks in the given conditions.

The quantitative indicators of kicks controlled during the study increased on average by 13.2% (p<0.05) in group 3 athletes compared to the initial data. The studied indicators showed a positive tendency in group 1 athletes, but 3.7 times lower compared to the 3rd group results. In group 2 athletes,

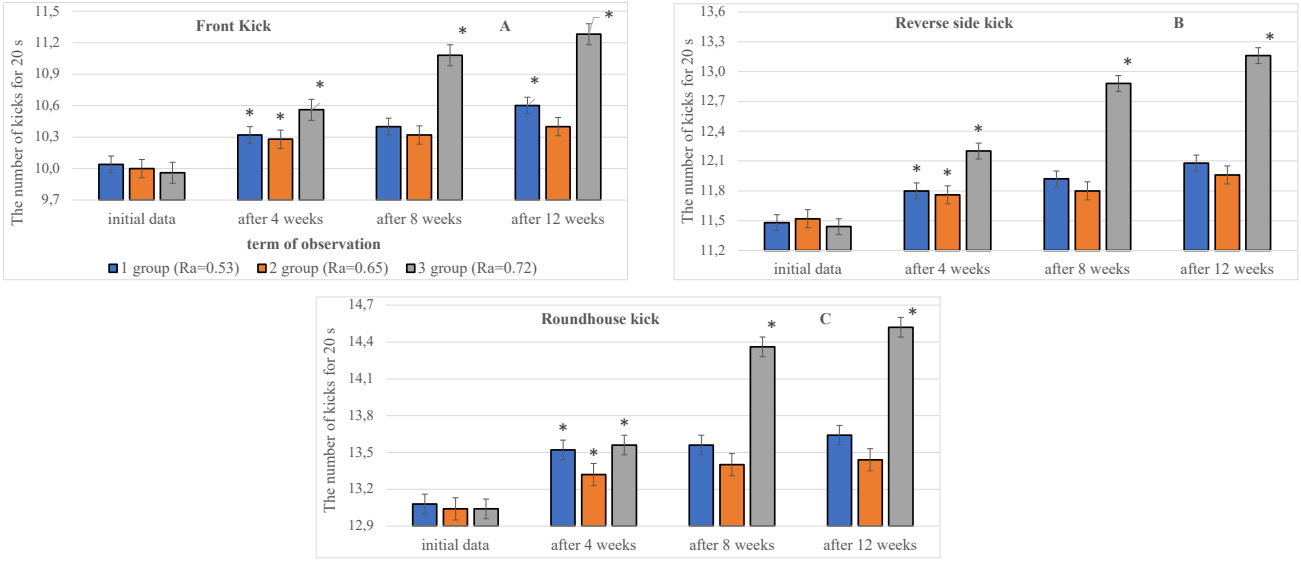


Fig. 1. Results of changes in quantitative indicators of "Front kick" (A), "Reverse side kick" (B), "Roundhouse kick" (C) for 20 s in athletes of the examined groups during the study, n=75. Note: * (p<0.05) – compared with the previous results

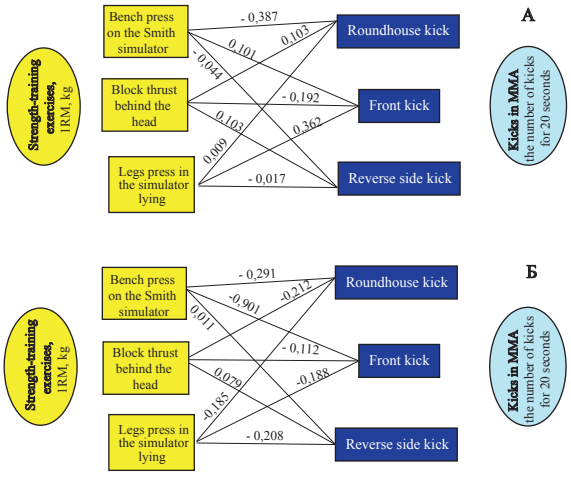


Fig. 2. The results of the correlation analysis between the maximum strength development (1PM) and the number of kicks performed for 20 s at the beginning (A) and at the end (B) of the study in group 1athletes

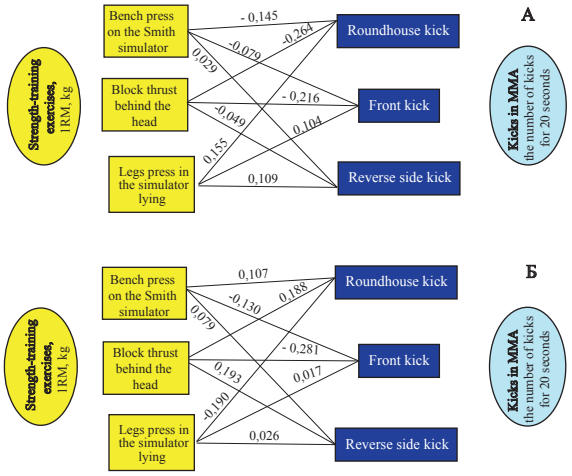


Fig. 3. The results of the correlation analysis between the maximum strength development (1PM) and the change in the number of kicks performed for 20 s at the beginning (A) and at the end (B) of the study in athletes of the 2nd group

who used medium intensity (Ra=0.65) load regime, the studied indicators increased by 5.0%. during the study.

Thus, the changes in the quantitative indicators of kicks (front kick, reverse side kick, roundhouse kick) indicated the advantage of using high-intensity load regime in the anaerobic-alactate mode of energy supply in MMA athletes. This statement is confirmed by the results of monitoring the dynamics of the maximum muscle strength development in the study participants. These changes mainly occur due to the activation of a significant number of moving units in muscles and the additional involvement of synergist muscles while performing control exercises.

Figures 2-4 graphically present the results of correlation between the maximum strength development (1PM) and the number of kicks performed by the athletes of the examined groups for 20 seconds during the study.

The results of group 1 athletes showed no strong correlation between the maximum strength indicators and

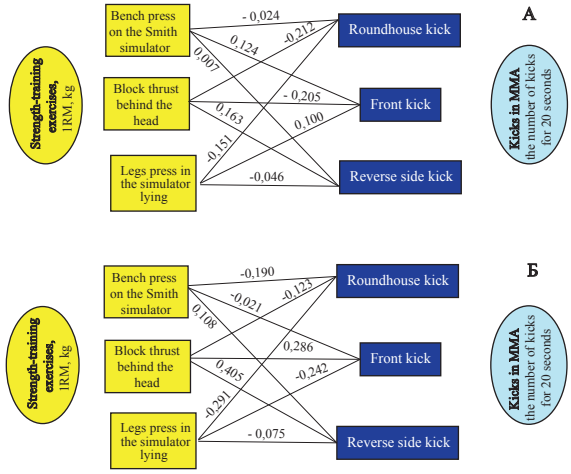


Fig. 4. The results of the correlation analysis between the development of the maximum strength indicators (1PM) and the change in the number of kicks performed for 20 s at the beginning (A) and at the end (B) of the study in the 3rd group athletes

the level of special training (the number of kicks performed for 20 seconds). The lack of correlation between the controlled indicators is observed both at the beginning and at the end of the study, despite the significant growth of their parameters in all exercises.

Analysis of the results presented in figure 3 shows that there is no correlation between the controlled indicators at all stages of the study in group 2 athletes.

The study analysis demonstrated that there was no correlation between the level of the 1 RM indicator and the number of kicks during the control exercises (Fig. 4) in group 3 athletes at all stages of the study.

Thus, the results of the correlation analysis between the level of the maximum strength development and the number of kicks performed for 20 s during control exercises indicated the need for additional research. It is possible that the use of physiological and biochemical methods of studying the processes of adaptation in the given conditions of muscle activity will allow to substantiate the obtained results of the correlation analysis.

Discussion

This study describes the peculiarities of the influence produced by load regimes different in intensity and energy supply on the level of changes in strength and special training indicators in MMA athletes. We studied the correlation between the level of the maximum muscle strength (1RM) development and the change in the number of kicks during control exercises, depending on the features of the applied load regimes. The study results showed that using high-intensity load (Ra=0.72) regime gave the greatest increase in strength and special training indicators. Despite the significant growth of strength capabilities and quantitative indicators of kicks during control exercises, the correlation analysis demonstrated no strong correlation between the compared indicators at all stages of the study. The results of this study will allow developing a mechanism for correcting loads for athletes taking into account the individual duration of attacking or counter-attacking actions of MMA athletes.

The lack of clear understanding which mechanisms for training optimization allow to maximize the power of attacking punches is one of the unresolved problems of modern training in MMA. Using a great variety of power load regimes from various types of martial arts, powerlifting, bodybuilding is not always a scientifically based mechanism for improving the training of athletes (Chernozub et al., 2018; Antoniettô et al., 2023; Olkhovyi O. et al., 2020). Determining the effective parameters of load indicators, taking into account the individual capabilities of athletes, the style of conducting matches, the adaptive body reserves formation will open one of the ways to solve this scientific problem. In the process of strength training, most researchers suggested using principles, methods and load correction mechanisms that are most often used in boxing and wrestling (Camarco et al., 2022; Folhes et al., 2022).

Leading experts in MMA paid little attention to the problem of compliance of the training regime to certain conditions of energy supply, and period of duration and power of counter-attacking actions in a fight. The problem of researching adaptation and compensatory reactions in similar conditions of training and competitive activity was solved in the same way (Chernozub et al., 2019; Kirk et al., 2021; Liu et al., 2022). The highest level of strength and special training indicators while using high-intensity (Ra=0.72) load regime indicated pronounced body adaptation processes in MMA athletes. These adaptive changes are associated with increasing the recruitment of mobile units of fast-twitch muscle fibers, growing creatine phosphate reserves in muscles, and strengthening of the creatine phosphokinase ATP resynthesis mechanism (Tota & Wiecha, 2022).

The results of correlation analysis between the level of maximum strength development and the number of kicks performed for 20 seconds during control exercises demonstrated no strong correlation. At the same time, the results of studied indicators do not depend on the load regimes used by the athletes or the type of energy supply of muscle activity. It can be assumed that such changes occur due to the use of different sources of energy supply of muscle activity during strength and special training control exercises. The duration of performing the control exercise to determine the 1 RM indicator lasts 1-2 s and requires significant activation of intra-muscular and inter-muscular coordination. Energy supply occurs at the expense of ATP reserves. While performing a series of kicks with maximum force for 20 seconds before complete muscle fatigue, energy supply occurs mainly due to the reserves of creatine phosphate and muscle glycogen. The level of strength abilities in these conditions will mainly depend on the activation of intermuscular coordination.

Conclusions

Using high-intensity load regime in conditions of anaerobic-alactate mode of energy supply allowed to achieve the most pronounced results in indicators of strength and special training in MMA athletes. However, no strong correlation between the increase in maximal strength and quantitative indicators of attacking kicks with maximal strength to full muscle fatigue for 20 s was found. It is possible that such changes can occur while using different sources of energy supply of muscle activity during control exercises of strength and special training. It is necessary to conduct further search for more informative markers for evaluating the training of athletes and adaptation processes using biochemical control methods.

Conflicts of interest

The authors declare that they have no competing interests.

References

Chernozub, A., Korobeynikov, G., Mytskan, B., Korobeinikova, L., & Cynarski, W.J. (2018). Modelling mixed martial arts power training needs depending on the predominance of the strike or Wrestling fighting style. *Journal of Martial Arts Anthropology, 18*(3), 28-36. https://doi.org/10.14589/ido.18.3.5

Antoniettô, N. R., Bello, F. D., Carrenho Queiroz, A. C., Berbert De Carvalho, P. H., Brito, C. J., Amtmann, J., & Miarka, B. (2023). Suggestions for Professional Mixed Martial Arts Training With Pacing Strategy and Technical-Tactical Actions by Rounds. *Journal of Strength and Conditioning Research, Publish Ahead of Print.* https://doi.org/10.1519/JSC.0000000000003018

Bueno, J., Faro, H., Lenetsky, S., Gonçalves, A., Dias, S., Ribeiro, A., Silva, B., Filho, C., Vasconcelos, B., Serrão, J., Andrade, A., Souza-Junior, T., & Claudino, J. (2022). Exploratory Systematic Review of Mixed Martial Arts: An Overview of Performance of Importance Factors with over 20,000 Athletes. *Sports (Basel), 10*(6), 80. https://doi.org/10.3390/sports10060080

James, L., Connick, M., Haff, G., Kelly, V., & Beckman, E. (2020). The Countermovement Jump Mechanics of Mixed Martial Arts Competitors. J*ournal of Strength and Conditioning Research, 34*(4), 982-987. https://doi.org/10.1519/JSC.0000000000003508

Kirk, C., Clark, D., Langan-Evans, C., & Morton, J. (2020). The physical demands of mixed martial arts: A narrative review using the ARMSS model to provide a hierarchy of evidence. *Journal of Sports Sciences, 38*(24), 2819-2841. https://doi.org/10.1080/02640414.2020.1802093

Olkhovyi, O., Chernozub, A., Danylchenko, S., Korchagin M., Romanchuk, S., Oderov, A., Klymovych, V., & Zhembrovskyi, S. (2020). Experience of determining the priority of complex process or system (on the example of physical education and sport). *Journal of Physical Education and Sport, 20*(S6), Art 451, pp. 3330-3335. https://doi.org/10.7752/jpes.2020.s6451

Chernozub, A., Manolachi, V., Korobeynikov, G., Potop, V., Sherstiuk, L., Manolachi, V., & Mihaila, I. (2022). Criteria for assessing the adaptive changes in mixed martial arts (MMA) athletes of strike fighting style in different training load regimes. *PeerJ,* 10, e13827. https://doi.org/10.7717/peerj.13827

Chernozub, A., Danylchenko, S., Imas, Y., Kochina, M., Ieremenko, N., Korobeynikov, G., Korobeynikova, L., Potop, V., Cynarski, W.J., & Gorashchenco, A. (2019). Peculiarities of correcting load parameters in power training of mixed martial arts athletes. *Journal of Physical Education and Sport, 19*(2), 481-488. https://doi.org/10.7752/jpes.2019.s2070

Kirk, C., Langan-Evans, C., Clark, D., & Morton, J. (2021). Quantification of training load distribution in mixed martial arts athletes: A lack of periodisation and load management. *PLoS One, 16*(5), e0251266. https://doi.org/10.1371/journal.pone.0251266

Liu, Y., Evans, J, Wąsik, J, Zhang, X., & Shan, G. (2022). Performance Alteration Induced by Weight Cutting in Mixed Martial Arts-A Biomechanical Pilot Investigation. *International Journal of Environmental Research and Public Health, 19*(4), 2015. https://doi.org/10.3390/ijerph19042015

Pavelka, R., Třebický, V., Fialová, J., Zdobinský, A., Coufalová, K., Havlíček, J., & Tufano, J. (2020). Acute fatigue affects reaction times and reaction consistency in Mixed Martial Arts fighters. *PLoS One, 15*(1), e0227675. https://doi.org/10.1371/journal.pone.0227675

Giboin, L., & Gruber, M. (2022). Neuromuscular Fatigue Induced by a Mixed Martial Art Training Protocol. *Journal of Strength and Conditioning Research, 36*(2), 469-477. https://doi.org/10.1519/JSC.0000000000003468

Tota, Ł.M., & Wiecha, S.S. (2022). Biochemical profile in mixed martial arts athletes. *PeerJ,* 10, e12708. https://doi/10.7717/peerj.12708

Seniuk, H., Vu, J., & Nosik, M. (2020). Application of the matching law to Mixed Martial Arts. *Journal of Applied Behavior Analysis, 53*(2), 846-856. https://doi.org/10.1002/jaba.653

Camarco, N., Neto, I., Ribeiro Jr, E., & Andrade, A. (2022). Anthropometrics, Performance, and Psychological Outcomes in Mixed Martial Arts Athletes. *Biology (Basel), 11*(8), 1147. https://doi.org/10.3390/biology11081147

Folhes, O., Reis, V., Marques, D., Neiva, H., & Marques, M. (2022). Maximum Isometric and Dynamic Strength of Mixed Martial Arts Athletes According to Weight Class and Competitive Level. *International Journal of Environmental Research and Public Health, 19*(14), 8741. https://doi.org/10.3390/ijerph19148741

ОЦІНКА ВЗАЄМОЗВ'ЯЗКУ МІЖ ЗМІНОЮ ПОКАЗНИКІВ СИЛОВОЇ ТА СПЕЦІАЛЬНОЇ ПІДГОТОВКИ СПОРТСМЕНІВ ЗМІШАНИХ ЄДИНОБОРСТВ

Андрій Чернозуб[1ABCDE], Олег Ольховий[2ABCDE], Алла Альошина[1ABCD], Андрій Савенко[1ABCDE], Іван Штефюк[3ABD], Іван Маріонда[4BDE], Тетяна Хома[4BDE], Вікторія Тулайдан[4BDE]

[1]Волинський національний університет імені Лесі Українки

[2]Харківська державна академія фізичної культури

[3]Чернівецький національний університет імені Юрія Федьковича

[4]Державний вищий навчальний заклад «Ужгородський національний університет»

Авторський вклад: A – дизайн дослідження; B – збір даних; C – статаналіз; D – підготовка рукопису; E – збір коштів

Реферат. Стаття: 7 с., 1 табл., 4 рис., 18 джерел.

Мета дослідження. Вивчити особливості взаємозв'язку між динамікою максимальної сили та ударами ногами в ММА в процесі використання різних за енергозабезпеченням та інтенсивністю режимів навантаження.

Матеріали та методи. Обстежено 75 спортсменів віком 19±0,7 років, які займаються ММА протягом останніх 4±0,8 років. Учасники були рівномірно розділені на 3 групи. Протягом 12 тижнів спортсмени 1 групи використовували навантаження низької інтенсивності (Ra=0,53), а представники 2 групи – навантаження середньої інтенсивності (Ra=0,65). Режим навантажень високої інтенсивності (Ra=0,72) використовували спортсмени 3 групи. Контроль кількісних показників атакуючих ударів ногами (front kick, reverse side kick, roundhouse kick) з максимальною силою до повного м'язового стомлення за 20 с дозволяв оцінити спеціальну підготовку. Рівень зміни силової підготовки оцінювали за рахунок розвитку показників максимальної сили (1 RM). Для обробки даних використовували непараметричні методи математичної статистики.

Результати. Встановлено, що показники спеціальної підготовки демонструють найбільшу динаміку за 12 тижнів дослідження в середньому на 13,2 % у спортсменів 3 групи. В інших двох групах, динаміка контрольованого показника в 3,2 рази менша за аналогічний проміжок часу. Виявлено, що у спортсменів 3 групи показник максимальної м'язової сили за період дослідження зростає на 41,9% порівняно з вихідними даними. Відповідні зміни розвитку показника 1 RM в середньому в 1,5 рази перевищують результати фіксовані у спортсменів інших двох груп. Однак, незважаючи на виявлену позитивну динаміку зростання показників силової та спеціальної підготовки в ММА, кореляційного взаємозв'язку між ними не виявлено в жодній із дослідних груп.

Висновки. Використання режиму навантажень високої інтенсивності в умовах анаеробно-алактатного типу енергозабезпечення дозволяє досягти найбільшої результатів в динаміці показників силової та спеціальної підготовки. Однак, достовірний взаємозв'язок між зростання максимальної сили та кількісними показниками атакуючих ударів ногами не виявлений. Для поглибленого дослідження , необхідний пошук більш інформативних маркерів оцінки тренованості спортсменів в ММА та процесів адаптації з використання біохімічних методів контролю.

Ключові слова: ММА, режими навантаження, інтенсивність, м'язова сила, спеціальна підготовка.

Information about the authors:

Chernozub, Andrii: chernozub@gmail.com; https://orcid.org/0000-0001-6293-84222; Department of Sports Theory and Physical Culture, Lesya Ukrainka Volyn National University, Vinnichenka St, 30, Lutsk, 43025, Ukraine.

Olkhovyi, Oleh: olkhovoleh@gmail.com; https://orcid.org/0000-0002-5223-5229; Kharkiv State Academy of Physical Culture, Klochkivska St, 99, Kharkiv, 61022, Ukraine.

Aloshyna, Alla: Aloshina.Alla@vnu.edu.ua; https://orcid.org/0000-0001-6517-1984; Department of Sports Theory and Physical Culture, Lesya Ukrainka Volyn National University, Vinnichenka St, 30, Lutsk, 43025, Ukraine.

Savenko, Andrii: galkinalora2015@ukr.net; https://orcid.org/0000-0002-3124-26733; Lesya Ukrainka Volyn National University, Vinnichenka St, 30, Lutsk, 43025, Ukraine.

Shtefiuk, Ivan: i.shtefyuk@chnu.edu.ua; https://orcid.org/0000-0003-0390-5422; Yuriy Fedkovych Chernivtsi National University, Kotsjubynskyi St, 2, Chernivtsi, 58012, Ukraine.

Marionda, Ivan: ivan.marionda@uzhnu.edu.ua; https://orcid.org/0000-0002-3950-8202; Department of Physical Education, State University "Uzhhorod National University", Narodna sq, 3, Uzhhorod, 88000, Ukraine.

Khoma, Tetiana: tetiana.khoma@uzhnu.edu.ua; https://orcid.org/0000-0002-9458-4056; Department of Physical Education, State University "Uzhhorod National University", Narodna sq, 3, Uzhhorod, 88000, Ukraine.

Tulaydan, Victoriya: victoria.tulaydan@uzhnu.edu.ua; https://orcid.org/0000-0002-2110-8171; Department of Physical Education, State University "Uzhhorod National University", Narodna sq, 3, Uzhhorod, 88000, Ukraine.

Cite this article as: Chernozub, A., Olkhovyi, O., Aloshyna, A., Savenko, A., Shtefiuk, I., Marionda, I., Khoma, T., & Tulaydan, V. (2023). Evaluation of the Correlation Between Strength and Special Training Indicators in Mixed Martial Arts. *Physical Education Theory and Methodology, 23*(2), 276-282. https://doi.org/10.17309/tmfv.2023.2.17

Received: 02.03.2023. Accepted: 03.04.2023. Published: 28.04.2023

Теорія та методика фізичного виховання
Physical Education Theory and Methodology
Teorìâ ta Metodika Fizičnogo Vihovannâ

ISSN 1993-7989 (print)
ISSN 1993-7997 (online)
ISSN-L 1993-7989

ORIGINAL SCIENTIFIC ARTICLE

PHYSICAL (IN)ACTIVITY GENDER GAP OF SLOVAK NON-ATHLETE ADOLESCENTS

Štefan Adamčák[1ABCE], Michal Marko[2ABDE] and Pavol Bartík[1ACE]

[1]Matej Bel University in Banská Bystrica
[2]Academy of Arts in Banská Bystrica

Authors' Contribution: A – Study design; B – Data collection; C – Statistical analysis; D – Manuscript Preparation; E – Funds Collection

Corresponding Author: Pavol Bartík, E-mail: pavol.bartik@umb.sk
Accepted for Publication: April 3, 2023
Published: April 28, 2023

DOI: 10.17309/tmfv.2023.2.18

Abstract

Study purpose. Declining levels of physical activity in adolescence are of increasing concern, with data showing the difference of ≥ 8% by gender in favor of adolescent boys; therefore, the present study aims at determining physical (in)activity gender gap of non-athlete adolescent boys and girls in Slovakia.

Materials and methods. Standardized measure to estimate the habitual practice of physical activity (IPAQ-SF) was carried out six months (January – June, 2022), through the intentional sampling of 1 517 Slovak non-athlete adolescent boys (40.54%, n = 615) and girls (59.46%, n = 902), aged 18 – 19 years (18.50 ± 0.50 years), attending the secondary schools. Descriptive statistics (e.g., measures of frequency, central tendency), two-sample t-test and chi-square test (χ^2) were used to analyze and compare the data.

Results. When considering the physical activity (seven-day week) in adolescence, the Slovak non-athlete adolescent boys and girls reported: (i) high levels of physical activity – 51.73% (n = 785); (ii) moderate levels of physical activity – 25.92% (n = 393); (iii) low levels of physical activity – 22.35% (n = 339) ($p < 0.01$). When considering the gender gap in physical activity in adolescence, total physical activity (seven-day week), expressed in MET-minutes/week, was lower (statistically, $p < 0.01$; difference of 712 MET-minutes/week) among the Slovak non-athlete adolescent girls (1 898 MET-minutes/week), compared to boys (2 610 MET-minutes/week). And when considering the gender gap and sitting time (sedentary behavior), the Slovak non-athlete adolescent girls were more sedentary, compared to boys ($p > 0.05$) (360 vs. 330 minutes/week).

Conclusions. Constant low levels of physical activity in adolescence constitute the public health emergency of international concern; therefore, the urgent policy action to increase the physical activity is necessary; in particular, in promoting and retaining the adolescent girls' participation in physical activity.

Keywords: adolescent boys and girls, gender gap, non-athlete population, physical activity.

Introduction

Physical activity participation declines during the lifespan; in particular, in adolescence (Guthold et al., 2020; Mikaelsson et al., 2020; Ahmad et al., 2021). As age increases, physical activity declines and sedentary time increases (Jago et al., 2020; Aira et al., 2021; Parker et al., 2021). As a result, adolescent boys and girls worldwide, aged 5-17 years, are not achieving the recommended levels of physical activity (population); in particular, ≥ 60 minutes (1 hour) of moderate- to-vigorous intensity physical activity; incorporating vigorous aerobic activity, and activity that strengthen muscle and bone, at least three days/week (Guthold et al., 2018); however, physical activity guidelines for adolescent boys and girls was updated (2020), resulting in doing at least "an average of 60 minutes/day of moderate-to-vigorous intensity physical activity" (Guthold et al., 2020).

Physical activity should become a routine part of adolescent' lives as eating and sleeping; however, insufficient physical activity becomes the global problem and pandemic (since 2012) (Kohl et al., 2012), which requires the global action of implementing modern programs in increasing insufficient physical activity in adolescent boys and girls, because ≥ 80% of adolescent boys and girls, aged 11-17 years, worldwide remain inactive (Guthold et al., 2020; Marques et al., 2020; Ma et al., 2020); with existing gender discrepancy (gender gap) in prevalence of insufficient physical activity

(Guthold et al., 2022); in particular, in 78.84% of adolescent boys and 84.4% of girls (Sallis et al., 2016). Gender gap in physical activity in adolescence, i.e., adolescent boys are more active than girls, becomes the persistent finding in literature (Cowley et al., 2021; Beck et al., 2022; Gracia et al., 2022; Ljungman et al., 2022). Age and status (socioeconomic) are important correlates of physical activity (Ricardo et al., 2022); however, large portions of physical activity inequality are because of gender gap, increasing over time (Guthold et al., 2020). Gender gap in physical activity is caused by many barriers (e.g., personal, practical, cultural), which play an important role in adolescent boys' and girls' attitudes (behavior) (Manić et al., 2021; Mata et al., 2022). Adolescence is an important stage of life for improving attitudes toward physical activity; therefore, adolescent health becomes the strong predictor of adult health (Bartík et al., 2022). Besides that, 1.2 billion (bn) of the world's population (28%) remains inactive, putting their current and future health at risk (±25% increased risk of all-cause mortality) (Guthold et al., 2018). When considering the current trends, the 15% relative reduction in physical inactivity will not be possible by 2023 (Guthold et al., 2020; Mayo et al., 2020).

Physical inactivity becomes the leading (4th) risk factor, accounting for 6% of deaths worldwide, following hypertension (13%), smoking (9%), and diabetes (6%) (Joseph et al., 2022), causing the economic cost of healthcare system around $53.8 bn in direct cost (healthcare expenditure) and $13.7 bn in indirect cost (loss in productivity) in 2013, of which $31.2 bn was paid by public sectors, $12.9 bn by private sectors, and $9.7 bn by households (Ding et al., 2016). Slovakia was footing the bill of $63 216 ($6 250 – $238 384) of which $46 187 was direct cost and $17 029 was indirect cost. Athlete (active) population, on average, spent 38% more days in hospital, compared to non-athlete (inactive), using more resources of healthcare; in particular, using ≥ 5.5% of family physician visits, 12% of nurse visits, and 13% of specialist services (Sari, 2009). Because many gaps remain in literature, in terms of Slovak scale, the present study aims at determining physical (in)activity gender gap of non-athlete adolescent boys and girls in Slovakia.

Materials and methods

Study participants

In terms of study aim, the target population consisted of 1 517 Slovak non-athlete adolescent boys (40.54%, n = 615) and girls (59.46%, n = 902), aged 18-19 years (18.50 ± 0.50 years), attending the secondary schools. Adolescent boys and girls (n = 1 517) consisted of convenience sample – non-athlete and Slovak (citizenship), recruited through the complete school system – EduPage (Bartlett et al., 2017; Garavan et al., 2018). Subjective self-report measure (questionnaire) to estimate the habitual practice of physical activity (seven-day week) was carried out six months (January – June, 2022), aiming for intentional sampling, regarding age, gender, and year of study. Data interpretation process (authentic) consisted of 2 375 debriefing forms; however, 36.12% (n = 858) were excluded. Reasons for not meeting the inclusion criteria were as follows: (i) not sick (ill) (seven-day week) (18.42%, n = 158); (ii) non-participation in organized team- and individual sports (81.58%, n = 700). The present study was carried out in accordance with the ethical standards as laid down in the 1964 Declaration of Helsinki and its later amendments and/or comparable ethical standards. All subjects provided written informed consent.

Study organization

Subjective self-report single-measure comparative study (descriptive) was carried out six months (January – June, 2022), in order to determine (analyze and compare) the physical (in)activity gender gap of non-athlete adolescent boys and girls in Slovakia. Available research instrument ("International Physical Activity Questionnaire – Short Form") (IPAQ-SF) was online (unlimited time), collecting the data of non-athlete adolescent boys (40.54%, n = 615) and girls (59.46%, n = 902) in Slovakia. Available feedback (online) did not indicate any problems (e.g., comparative design/ grammar and vocabulary). Questionnaire incentive was not given (voluntary participation); however, non-athlete adolescent boys and girls (n = 1 517) (i.e., "study group") received the reports with their personal results afterwards. Self-report measure (IPAQ-SF) was not identifying any information about the identity, was chosen because of being inexpensive, easy to use in large scale, and time saving (Microsoft Forms, Office 365, Microsoft Corp., Redmond, WA, USA).

Available research instrument (IPAQ-SF) assesses the types (intensity) of physical activity and sitting time (seven-day week), which the target population (15 years of age + more) do as a part of their lives and estimate the total physical activity in Metabolic equivalent of task (MET-minutes/ week) and/or time sitting (Masala et al., 2018; Tran et al., 2018). Metabolic equivalent of task (MET; unit) estimates the energy expenditure as reflected by oxygen consumption (metabolic cost) of physical activity – resting metabolic rate (Lavelle et al., 2020; Meh et al., 2022). Available data of study group (n = 1 517) were converted from MET-min/ week and multiplied the number of exercise min/ day by number of exercise days/ week by exercise intensity coefficient – MET: (i) vigorous physical activity – 8 MET; (ii) moderate physical activity – 4 MET; (iii) walking – 3.3 MET. 1 MET is equal to 3.5 ml oxygen kg - 1 body weight/ min – 1 (Ács et al., 2020). Available research instrument (IPAQ-SF) was scored in accordance with scoring system as recommended at website – www.ipaq.ki.se ("Guidelines for Data Processing and Analysis of International Physical Activity Questionnaire"), consisting of three groups: (i) high physical activity – energy expenditure exceeds 1 500 MET-min/ week, 3 or more days of vigorous intensity physical activity of ±30 min/ day, or almost every day of 30 min of moderate intensity physical activity and walking (≥3 000 MET-min/ week); (ii) moderate physical activity – energy expenditure ranges, 600 – 1 500 MET-min/ week, 3 or more days of intense physical activity of ±20 min, 5 and more days of moderate intensity physical activity of ±30 min or combination of vigorous and moderate intensity physical activity and walking (≥600 MET-min/ week); (iii) low physical activity – energy expenditure does not reach 600 MET-min/week.

Subjective self-report measure (questionnaire, IPAQ-SF) provides the cost-effective method of accessing (capturing) physical activity (intensity levels) into four generic dimensions: (i) vigorous physical activity (e.g., running, aer-

obics); (ii) moderate physical activity (e.g., leisure cycling); (iii) walking; (iiii) sitting (Ahmad et al., 2021). Available research instrument (IPAQ-SF) consisted of two sections: (i) basic demographic information (e.g., age, gender, year of study, type of school); (ii) open-ended questions surrounding the seven-day week physical activity of study group (n = 1 517), concerning physical activity associated with occupation performed and/or at school (ii-i), physical activity at home and around house (ii-ii), and moving to different places and mobility during leisure time (ii-iii) (Adamčák et al., 2022).

Statistical analysis

Available data, collected through the debriefing forms, were tabulated and figured in database designed precisely for self-report (subjective) single-measure comparative study (descriptive). Incidence of responses; each item of study group (n = 1 517) was evaluated (e.g., analyze, compare) by using the program of Tap3 – Gamo (Banská Bystrica, Slovakia). After cleaning available data of study group (n = 1 517), descriptive statistics (e.g., measures of frequency, central tendency) were used to analyze and compare the data. Differences (statistical) between the study group (n = 1 517) (boys vs. girls) were evaluated by using the methods of inductive statistics; in particular, chi-square test (χ^2) and two-sample t-test with unequal variances, of which the significance level (α) was 0.01 and 0.05. When evaluating the physical activity (e.g., high, moderate, low) of study group (n = 1 517), the chi-square test (χ^2) was used ($p < 0.01, 0.05$) and when evaluating the physical activity (e.g., vigorous, moderate, walking, sitting) and median values of study group (n = 1 517), the two-sample t-test with unequal variances was used ($p < 0.01, 0.05$).

Results

According to study aim, Figure 1 illustrates the physical activity levels of Slovak non-athlete adolescent boys and girls (n = 1 517) (MET-min/week; %). When considering the physical activity levels in adolescence (seven-day week), the Slovak non-athlete adolescent boys and girls (n = 1 517) reported (self): (i) high levels of physical activity – 51.73% (n = 785) (55.55%, n = 342 – boys vs. 47.90%, n = 432); (ii) moderate levels of physical activity – 25.92% (n = 393) (27.45%, n = 168 – boys vs. 24.40%, n = 220 – girls); (iii) low levels of physical activity – 22.35% (n = 339) (17.00%, n = 105 – boys vs. 27.70%, n = 250 – girls). Differences in % (statistical) of physical activity levels between the Slovak non-athlete adolescent boys and girls (n = 1 517) were significant (statistically) ($p < 0.01$) ($\chi^2(2) = 23.90$; $p = 6.58$ E-10).

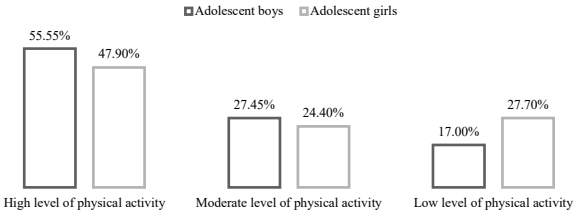


Fig. 1. Physical activity levels of Slovak non-athlete adolescent boys and girls (n = 1 517) (%) ($\chi^2(2) = 23.90$; $p = 6.58$ E-10**)

Table 1. Slovak non-athlete adolescent boys and girls (n = 1 517) and vigorous-, moderate-intensity activity and walking

Vigorous-intensity activity		Minutes/day	Days/week	MET-minutes/week
Adolescent boys	Mean	54.08	2.06	1118
	Median	45	2	720
Adolescent girls	Mean	37.76	1.86	778
	Median	30	2	480
Adolescent boys and girls	Mean	45.92	1.96	948
	Median	30	2	480
	P-value	6.92 E-12**	0.015*	1.98 E-07**
Moderate-intensity activity		**Minutes/day**	**Days/week**	**MET-minutes/week**
Adolescent boys	Mean	55.10	2.20	566
	Median	60	2	480
Adolescent girls	Mean	40.40	1.84	422
	Median	30	2	240
Adolescent boys and girls	Mean	47.75	2.02	494
	Median	30	2	300
	P-value	8.06 E-10**	1.23 E-05**	4.05 E-06**
Walking		**Minutes/day**	**Days/week**	**MET-minutes/week**
Adolescent boys	Mean	66.92	3.92	926
	Median	60	4	628
Adolescent girls	Mean	57.40	3.64	698
	Median	45	3	462
Adolescent boys and girls	Mean	62.16	3.78	812
	Median	50	3	594
	P-value	0.0001**	0.0042**	4.86 E-08**

MET = Metabolic equivalent of task; ** = $p < 0.01$; * = $p < 0.05$.

Physical activity levels of Slovak non-athlete adolescent boys and girls (n = 1 517) (MET-min/week) illustrates Figure 2. When considering the gender gap in physical activity (total) in adolescence (seven-day week), physical activity was lower (statistically, $p < 0.01$; ±712 MET-min/week) ($p = 1.90$ E-12) among the Slovak non-athlete adolescent girls (1 898 MET-min/week), compared to boys 2 610 MET-min/week). Arithmetic mean (e.g., x – measure of central tendency) of gender gap in physical activity; in particular, intensity levels, was as follows: (i) vigorous-intensity activity – 1 118 MET-min/week, boys vs. 778 MET-min/week, girls (x, 948 MET-min/week, ±340 MET-min/ week, $p = 1.98$ E-07); (ii) moderate-intensity activity – 566 MET-min/week, boys vs. 422 MET-min/week, girls (x, 494 MET-min/week, ±144 MET-min/week, $p = 4.05$ E-06); (iii) walking – 926 MET-min/week, boys vs. 698 MET-min/ week, girls (x, 812 MET-min/week, ±228 MET-min/week, $p = 4.86$ E-12) (Table 1).

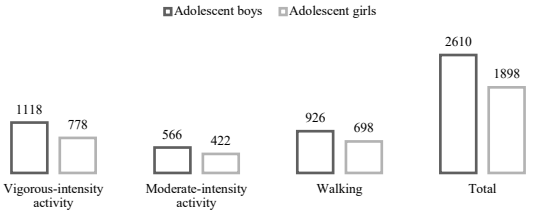


Fig. 2. Physical activity levels of Slovak non-athlete adolescent boys and girls (n = 1 517) (MET-min/week) (p = 1.90 E-12**)

Specific time (e.g., minutes/day, days/week) spent in physical activity; in particular, intensity levels, of Slovak non-athlete adolescent boys and girls (n = 1 517) (e.g., arithmetic mean, median) illustrates Table 1. When considering the gender gap in physical activity (intensity levels) of Slovak non-athlete adolescent boys ang girls (n = 1 517), arithmetic mean and/or median of vigorous-, moderate -intensity activity and walking was lower (statistically, $p < 0.01$, 0.05) among the Slovak non-athlete adolescent girls, compared to boys. Differences in arithmetic mean and/or median (statistical) spent in physical activity; in particular, intensity levels, between the Slovak non-athlete adolescent boys and girls (n = 1 517), were as follows: (i) vigorous-intensity activity – 45 min/day (2 days/week), boys vs. 30 min/day (2 days/week), girls (min/day, $p = 6.92$ E-12; days/week, $p = 0.15$); (ii) moderate-intensity activity – 60 min/day (2 days/week), boys vs. 30 min/day (2 days/week), girls (min/day, $p = 8.06$ E-10; days/week, $p = 1.23$ E-05); (iii) walking – 60 min/day (4 days/week), boys vs. 45 min/ day (3 days/week), girls (min/day, $p = 0.0001$; days/week, $p = 0.0042$) (Table 1).

Table 2. Slovak non-athlete adolescent boys and girls (n = 1 517) and sitting

Sitting		Minutes/ day	Days/ week
Adolescent boys	Mean	360.40	6.02
	Median	330	5.5
Adolescent girls	Mean	358.60	5.96
	Median	360	6
Adolescent boys and girls	Mean	359.50	5.99
	Median	360	6
	P-value	0.75	–

Sedentary behavior, i.e., sitting time (minutes/day, days/week) of Slovak non-athlete adolescent boys and girls (n = 1 517) (e.g., arithmetic mean, median) illustrates Table 2. When considering the gender gap and sitting time, the Slovak non-athlete adolescent girls were more sedentary, compared to boys ($p > 0.05$) (360 vs. 330 min/day, $p = 0,75$; 6 vs. 5.5 days/week) (Table 2).

Discussion

When it comes to determining the differences (gender) in physical activity (e.g., intensity, volume) between the adolescent boys and girls (aged 5-17 years) worldwide, the incidence rate is strong, with increasing numbers of carried out studies (see Introduction); however, to our knowledge, important knowledge gaps remain in literature, in terms of Slovak scale; therefore, the present study aims at determining physical (in)activity gender gap of non-athlete adolescent boys and girls in Slovakia. When considering the physical activity levels (seven-day week) in adolescence, the Slovak non-athlete adolescent boys and girls reported: (i) low levels of physical activity – 22.35% (n = 338) (±5.35%, n = 82, difference in favor adolescent girls); (ii) moderate levels of physical activity – 25.92% (n = 393) (± 1.53%, n = 23, difference in favor of adolescent boys); (iii) high levels of physical activity – 51.73% (n = 785) (±3.82%, n = 58, difference in favor of adolescent boys) ($p < 0.01$) ($\chi^2(2) = 23.90$; $p = 6.58$ E-10). Existing evidence of Polish data (5 086 adolescent boys and girls, attending the secondary schools) shows that 39. 59% of Polish adolescents (48.77% of boys and 31.35% of girls) participated in high levels of physical activity (Bergier et al., 2012). After two years, 71.98% of Polish adolescents (76.18% of boys and 67.77% of girls) were characterized by high levels of physical activity (Bergier et al., 2014). Only 18.9% (n = 76 out of 401, 100%) of Serbian adolescents (191 boys and 210 girls, aged 15-17 years) were characterized by high level levels of physical activity (Nikolić et al., 2020). Another existing evidence of Bosnian data (813 adolescent boys and girls) shows that 55.70% of Bosnian adolescents (58.90% of boys and 53.70% of girls) were characterized by high levels of physical activity (Ćosić Mulahasanović et al., 2018).

When considering the gender gap in physical activity (total) in adolescence (seven-day week), physical activity was lower (statistically, $p < 0.01$; ±712 MET-min/week) ($p = 1.90$ E-12) among the Slovak non-athlete adolescent girls (1 898 MET-min/week), compared to boys 2 610 MET-min/ week). Comparable study carried out in Lithuania shows different levels of general (total) physical activity, which was lower (±491.34 MET-min/week) among the Lithuanian adolescent girls (4 404.12 MET-min/week; n = 57 out of 101), compared to boys (4 895.46 MET-min/ week; n = 44/101) (Bergier et al., 2012). Another existing evidence of Ukrainian data (2 125 adolescent boys and girls) shows that physical activity (total) was lower (±498 MET-min/week) among the Ukrainian adolescent girls (3 365 MET-min/week; n = 1 291, 60.80%), compared to boys (3 863 MET-min/week; n = 834,

39.20%) ($p < 0.01$) (Bergier et al., 2014). Interesting study carried out in Poland/ Turkey shows that physical activity (total) was lower (±2 858.06 MET-min/week) among the Turkish adolescents (3 095.45 MET-min/week; 14 boys and 36 girls, aged 18-20 years), compared to Polish adolescents (5 953.51 MET-min/week; 25 boys and 25 girls) (Bednarek et al., 2016). In term of Slovak data, physical activity (total) (MET-min/week) of 2375 Slovak adolescents (54.56% of them adolescent girls, aged 17-19 years) was lower (statistically, $p < 0.01$, ±875 MET-min/week) among the adolescent girls (1795 MET-min/week), compared to boys (2670 MET-min/week) ($p = 2.8$ E-32) (Adamčák et al., 2022).

In accordance with study aim, physical activity gender gap of Slovak non-athlete adolescent boys and girls (n = 1 517, 100%) prevails ($p < 0.01$), which is in accordance with increasing numbers of carried out studies (see Introduction + Discussion). Besides that, the Slovak adolescent girls (59.46%, n = 902) dominate physical activity related with walking (926 MET-min/week), while among the boys (40.54%, n = 615) vigorous-intensity activity dominated (1 118 (MET-min/week). For more complete insight into physical activity patterns, we consider it necessary to separately analyze each domain of physical activity (Nikolić et al., 2020).

Conclusions

Current proportion of adolescent boys and girls meeting the global physical activity recommendation of ≥ 60 minutes (1 hour)/ day of moderate-to-vigorous intensity physical activity remains low (see Introduction). When considering the gender gap in physical activity (total) in adolescence, physical activity was lower (statistically, $p < 0.01$; ±712 MET-min/week) ($p = 1.90$ E-12) among the Slovak non-athlete adolescent girls (1 898 MET-min/week), compared to boys (2 610 MET-min/week). Persistent inequality (gender) remains and worsens with age; therefore, monitoring declining levels of physical activity in adolescence allows the identification of specific needs and inequalities within and between countries/regions. Measuring (monitoring) health indicators are important in providing the foundation for measuring inequality and guide decision (evidence-based) making in public health. Improvements in indicators of population health are acquired by increasing levels of physical activity of non-athlete population of adolescent boys and girls, instead of involving athlete population of adolescent boys and girls in more activity. Urgent policy action to increase physical activity in adolescence is necessary; in particular, in promoting and retaining adolescent girls' participation in physical activity.

Acknowledgment

This work was supported by the Matej Bel University in Banská Bystrica; in particular, the Faculty of Arts, as employer of the author(s) – Š. Adamčák and P. Bartík (50%); and the Academy of Arts in Banská Bystrica; in particular, the Faculty of Performing Arts, as employer of the author – M. Marko (50%).

Conflict of interest

The author(s) declare that the research was conducted in the absence of any commercial and/ or financial relationships that could be construed as a potential conflict of interest.

References

Guthold, R., Stevens, G. A., Riley, L. M., & Bull, F. C. (2020). Global trends in insufficient physical activity among adolescents: a pooled analysis of 298 population-based surveys with 1.6 million participant. *The Lancet, Child & Adolescent Health, 4*(1), 23-35. https://doi.org/10.1016/S2352-4642(19)30323-2

Mikaelsson, K., Rutberg, S., Lindqvist, A., & Michaelson, P. (2020). Physically inactive adolescents' experiences of engaging in physical activity. *European Journal of Physiotherapy, 22*(2), 191-196. https://doi.org/10.1080/21679169.2019.1567808

Ahmad, N., Asim, H. H., Juatan, N., Hipni, N. E., Ithnain, N., Ahmad Sanusi, N. H., Harun, S. N. F., Zakaria, M. R., Jaafar, N., Mohamed, M. H., Suraji, S. H., & Krishnan, M. (2021). Contributing factors to decline in physical activity among adolescents: a scoping review. *Malasian Journal of Social Sciences and Humanities, 6*(9), 447-463. https://doi.org/10.47405/mjssh.v6i9.998

Jago, R., Salway, R., Emm-Collison, L., Sebire, S. J., Thompson, J. L., & Lawlor, D. A. (2020). Association of Bmi category with change in children's physical activity between ages 6 and 11 years: a longitudinal study. *International Journal of Obesity, 44*(1), 104-113. https://doi.org/10.1038/s41366-019-0459-0

Aira, T., Vasankari, T., Heinonen, O. J., Korpelainen, R., Kotkajuuri, J., Parkkari, J., Savonen, K., Uusitalo, A., Valtonen, M., Villberg, J., Vähä-Ypyä, H., & Kokko, S. P. (2021). Physical activity from adolescence to young adulthood: patterns of change, and their associations with activity domains and sedentary time. *International Journal of Behavioral Nutrition and Physical Activity, 18*(1), 85. https://doi.org/10.1186/s12966-021-01130-x

Parker, K., Timperio, A., Salmon, J., Villanueva, K., Brown, H., Esteban-Cornejo, I., Cabanas-Sánchez, V., Castro-Piñero, J., Sánchez-Oliva, D., & Veiga, O. L. (2021). Activity-related typologies and longitudinal change in physical activity and sedentary time in children and adolescencts: the -up&down study. *Journal of Sport and Health Science, 10*(4), 447-453. https://doi.org/10.1016/j.jshs.2020.02.004

Guthold, R., Stevens, G. A., Riley, L. M., & Bull, F. C. (2018). Worldwide trends in insufficient physical activity from 2001 to 2016: a pooled analysis of 358 population-based surveys with 1.9 million participants. *The Lancet, Global Health, 6*(10), 1077-1086. https://doi.org/10.1016/S2214-109X(18)30357-7

Guthold, R., Willumsen, J., & Bull, F. C. (2022). What is driving gender inequalities in physical activity among adolescents? *Journal of Sport and Health Science, 11*(4), 424-426. https://doi.org/10.1016/j.jshs.2022.02.003

Kohl, H. W., Craig, C. L., Lambert, E. V., Inoue, S., Alkandari, J. R., Leetongin, G., & Kahlmeier, S. (2012). The pandemic of physical inactivity: global action for public health. *The Lancet, 380*(9838), 394-305. https://doi.org/10.1016/S0140-6736(12)60898-8

Marques, A., Henriques-Neto, D., Peralta, M., Martins, J., Demetriou, Y., Schönbach, D. M. I., & Gaspar de Matos, M. (2020). Prevalence of physical activity among adolescents from 105 low, middle, and high-income countries. *International Journal of Environmental Research and Public Health, 17*(9), 3145. https://doi.org/10.3390/ijerph17093145

Ma, C., Zhang, Y., Zhao, M., Bovet, P., & Xi, B. (2020). Physical activity and sedentary behavior among young adolescents in 68 Lmics, and their relationships with national economic development. *Internationa Journal of Environmental Research and Public Health, 17*(21), 7752. https://doi.org/10.3390/ijerph17217752

Sallis, J. F., Bull, F. C., Guthold, R., Heath, G. W., Inoue, S., Kelly, P., Oyeyemi, A. L., Perez, L. G., Richards, J., & Hallal, P. C. (2016). Progress in physical activity over the olympic quadrennium. *The Lancet, 388*(10051), 1325-1336. https://doi.org/10.1016/S0140-6736(16)30581-5

Mayo, X., Lugue-Casado, A., Jimenez, A., & del Villar, F. (2020). Physical activity levels for girls and young adult women versus boys and young adult men in Spain: a gender gap analysis. *Sustainability, 12*(15), 6265. https://doi.org/10.3390/su12156265

Cowley, E. S., Watson, P. M., Foweather, L., Belton, S., Thompson, A., Thijssen, D., & Wagenmakers, A. J. M. (2021). "Girls aren't meant to exercise": perceived influences on physical activity among adolescent girls – the herizon project. *Children, 8*(1), 31. https://doi.org/10.3390/children8010031

Beck, F., Dettweiler, U., Sturm, D. J., Demetriou, Y., & Reimers, A. K. (2022). Compensation of overall physical activity in (pre)adolescent girls – the creactivity project. *Archives of Public Health, 80*(1), 244. https://doi.org/10.1186/s13690-022-01002-1

Gracia, P., Garcia-Roman, J., Oinas, T., & Anttila, T. (2022). Gender differences in child and adolescent daily activities: a cross-national time use study. *Acta Sociologica, 65*(1), 41-65. https://doi.org/10.1177/00016993211008500

Ljungmann, C. K., Christensen, J. H., Klinker, C. D., Pawlowski, C. S., & Johnsen, H. R. (2022). Barriers to sports participation among adolescent girls from deprived neighbourhoods. *European Journal of Public Health, 32*(2), ckac095.050. https://doi.org/10.1093/eurpub/ckac095.050

Ricardo, L. I. C., Wendt, A., Costa, C. D. S., Mielke, G. I., Brazo-Sayavera, J., Khan, A., Kolbe-Alexander, T. L., & Crochemore-Silva, I. (2022). Gender inequalities in physical activity among adolescents from 64 Global South countries. *Journal of Sport and Health Science, 11*(4), 509-520. https://doi.org/10.1016/j.jshs.2022.01.007

Manić, M., Zelenović, M., Stamenković, A., Čaprić, I., & Božić, D. (2021). Barriers to physical activity in adolescents: a systematic review. *Turkish Journal of Kinesiology, 7*(1), 22-30. https://doi.org/10.31459/turkjkin.840536

Mata, C., Onofre, M., & Martins, J. (2022). Adolescents' perceived barriers to physical activity during the Covid-19 pandemic. *Children, 9*(11), 1726. https://doi.org/10.3390/children9111726

Bartík, P., Adamčák, Š., & Marko, M. (2022). Leisure time analysis and comparison of secondary school male students in terms of selected regions of Slovakia: a cross-sectional study. *Trends in Sport Sciences, 29*(4), 161-169. https://doi.org/10.23829/TSS.2022.29.4-3

Joseph, J. J., Deedwania, P., Acharya, T., Aguilar, D., Bhatt, D. L., Chyun, D. A., Di Palo K. E., Golden, S. H., & Sperling, L. S. (2022). Comprehensive management of cardiovascular risk factors for adults with type 2 diabetes: a scientific statement from the American Heart Association. *Circulation, 145*(9), 722-759. https://doi.org/10.1161/CIR.0000000000001040

Ding, D., Lawson, K. D., Kolbe-Alexander, T. L., Finkelstein, E. A., Katzmarzyk, P. T., van Mechelen, W., & Pratt, M. (2016). The economic burden of physical inactivity: a global analysis of major non-communicable diseases. *The Lancet, 388*(10051), 1311-1324. https://doi.org/10.1016/S0140-6736(16)30383-X

Sari, N. (2009). Physical inactivity and its impact on healthcare utilization. *Health Economics, 18*(8), 885-901. https://doi.org/10.1002/hec.1408

Bartlett, R., Wright, T., Olarinde, T., Holmes, T., Beamon, E. R., & Wallace, D. (2017). Schools as sites for recruiting participants and implementing research. *Journal of Community Health Nursing, 34*(2), 80-88. https://doi.org/10.1080/07370016.2017.1304146

Garavan, H., Bartsch, H., Conway, K., Decastro, A., Goldstein, R. Z., Heeringa, S., Jernigan, T., Potter, A., Thompson, W., & Zahs, D. (2018). Recruiting the abcd sample: design considerations and procedures. *Developmental Cognitive Neuroscience, 32*(1), 16-22. https://doi.org/10.1016/j.dcn.2018.04.004

Masala, D., Mannocci, A., Mei, D., Tribuzio, A. M., Villari, P., & La Torre, G. (2018). International Physical Activity Questionnaire for adolescents (IPAQ-A): reliability of an Italian version. *Minerva Pediatrics, 73*(5), 383-390. https://doi.org/10.23736/s2724-5276.16.04727-7

Tran, V., DO, V., Pham, N., Nguyen, C., Tuyet Xuong, N., Jancey, J., & Lee, A. (2018). Validity of the International Physical Activity Questionnaire – Short Form for application in Asian countries: a study in Vietnam. *Evaluation and the Health Professions, 43*(2), 105-109. https://doi.org/10.1177/0163278718819708

Lavelle, G., Noorkoiv, M., Theis, N., Korff, T., Kilbride, C., Baltzopoulos, V., Shorland, A., Levin, W., & Ryan, J. M. (2018). Validity of the International Physical Activity Questionnaire Short Form (IPAQ-SF) as a measure of physical activity (pa) in young people with cerebral palsy: a cross-sectional study. *Physiotherapy, 107*(10), 209-215. https://doi.org/10.1016/j.physio.2019.08.013

Meh, K., Sember, V., Đurić, S., Vähä-Ypyä, H., Rocha, P., & Jurak, G. (2022). Reliability and validity of Slovenian versions of IPAQ-SF, GPAQ and EHIS-PAQ for assessing physical activity and sedentarism of adults. *International Journal of Environmental Research and Public Health, 19*(1), 430. https://doi.org/10.3390/ijerph19010430

Ács, P., Betlehem, J., Oláh, A., Bergier, J., Melczer, C., Prémusz, V., & Makai, A. (2020). Measurement of public health benefits of physical activity: validity and reliability study of the international physical activity questionnaire in Hungary. *BMC Public Health, 20*(S1), 1198.

Adamčák, Š., Bartík, P., & Marko, M. (2022). Physical activity of Slovak adolescents during the "second wave" of Covid-19 pandemic: a cross-sectional study. *European Journal of Contemporary Education, 11*(4), 1066-1078. https://doi.org/10.13187/ejced.2022.4.1066

Bergier, J., Kapka-Skrzypczak, L., Biliński, P., Paprzycki, P, & Wojtyła, A. (2012). Physical activity of Polish adolescents and young adults according to IPAQ: a population-based study. *Annals of Agricultural and Environmental Medicine, 19*(1), 109-115.

Bergier, B., Tsos, A., & Bergier, J. (2014). Factors determining physical activity of Ukrainian students. *Annals of Agricultural and Environmental Medicine, 21*(3), 613-616. https://doi.org/10.5604/12321966.1120612

Nikolić, M., Jovanović, R., & Stanković, A. (2020). Characteristics of physical activity among healthy Serbian

adolescents. *Revista Brasileira de Medicina do Esporte, 26*(1), 30-33. https://doi.org/10.1590/1517-869220202601187598

Ćosić Mulahasanović, I., Nožinović Mujanović, A., Mujanović, E., & Atiković, A. (2018). Level of physical activity of the students at the University of Tuzla according to IPAQ. *Central European Journal of Sport Sciences and Medicine, 1*(21), 23-30. https://doi.org/10.18276/cej.2018.1-03

Bergier, B., Bergier, J., & Wojtyła A. (2012) Various aspects of physical activity among Lithuanian adolescents. *Annals of Agricultural and Environmental Medicine, 19*(4), 775-779.

Bednarek, J., Pomykała, S., Bigosińska, M., & Szyguła, Z. (2016). Physical activity of Polish and Turkish university students as assessed by IPAQ. *Central European Journal of Sport Sciences and Medicine, 16*(4), 13-22. https://doi.org/10.18276/cej.2016.4-02

ГЕНДЕРНИЙ РОЗРИВ У ФІЗИЧНІЙ (НЕ)АКТИВНОСТІ СЛОВАЦЬКИХ ПІДЛІТКІВ, ЯКІ НЕ ЗАЙМАЮТЬСЯ СПОРТОМ

Штефан Адамчак[1ABCE], Міхал Марко[2ABDE], Павол Бартік[1ACE]

[1]Університет Матея Беля
[2]Академія мистецтв у Банській Бистриці

Авторський вклад: A – дизайн дослідження; B – збір даних; C – статаналіз; D – підготовка рукопису; E – збір коштів

Реферат. Стаття: 7 с., 2 табл., 2 рис., 40 джерел.

Мета дослідження. Зниження рівнів фізичної активності в підлітковому віці викликає дедалі більше занепокоєння, при цьому дані показують різницю ≥ 8% за параметром статі на користь хлопчиків-підлітків; тому це дослідження спрямоване на визначення гендерного розриву у фізичній (не)активності словацьких хлопців і дівчат підліткового віку, які не займаються спортом.

Матеріали та методи. Стандартизоване вимірювання для оцінки звичної практики фізичної активності (Міжнародний опитувальник із фізичної активності – Коротка форма – IPAQ-SF) проводилося протягом шести місяців (січень – червень 2022 р.) шляхом цілеспрямованої вибірки 1 517 словацьких підлітків-хлопців (40,54%, n = 615) та дівчат (59,46%, n = 902), які не замаються спортом, віком 18–19 років (18,50 ± 0,50 років), і які навчаються у загальноосвітніх школах. Для аналізу та порівняння даних використовували описову статистику (наприклад, вимірювання частоти, середнє значення розподілу), t-критерій Стьюдента на основі подвійної вибірки та критерій хі-квадрат (χ^2).

Результати. Розглядаючи фізичну активність (семиденний тиждень) у підлітковому віці, словацькі хлопці та дівчата підліткового віку, які не займаються спортом, повідомили: (i) високі рівні фізичної активності – 51,73% (n = 785); (ii) помірні рівні фізичної активності – 25,92% (n = 393); (iii) низькі рівні фізичної активності – 22,35% (n = 339) (p < 0,01). Розглядаючи гендерний розрив у фізичній активності в підлітковому віці, загальна фізична активність (семиденний тиждень), виражена в метаболічному еквіваленті навантаження MET-хвилинах/тиждень, була нижчою (статистично, p < 0,01; різниця 712 MET-хвилин/тиждень) серед словацьких дівчат підліткового віку, які не займаються спортом (1 898 MET-хвилин/тиждень), порівняно з хлопцями (2 610 MET-хвилин/тиждень). А якщо розглядати гендерний розрив і час сидіння (пасивний спосіб життя), словацькі дівчата підліткового віку, які не займаються спортом, вели більш пасивний спосіб життя порівняно з хлопцями (p > 0,05) (360 проти 330 хвилин на тиждень).

Висновки. Постійно низькі рівні фізичної активності в підлітковому віці становлять надзвичайну ситуацію в галузі охорони здоров'я, що викликає міжнародне занепокоєння; отже, необхідні термінові політичні дії з метою підвищення фізичної активності; зокрема, які сприяють участі та підтримують участь дівчат підліткового віку у фізичній активності.

Ключові слова: хлопці та дівчата підліткового віку, гендерний розрив, населення, яке не займається спортом, фізична активність.

Information about the authors:

Adamčák, Štefan: stefan.adamcak@umb.sk; https://orcid.org/0000-0002-8002-6010; Department of Physical Education and Sports, Faculty of Arts, Matej Bel University, Tajovského 40, 97401 Banská Bystrica, Slovakia.

Marko, Michal: michal.marko@aku.sk; https://orcid.org/0000-0003-0054-0667; Department of Music-Theoretical and Academic Subjects, Faculty of Performing Arts, Academy of Arts in Banská Bystrica, Jána Kollára 22, 974 01 Banská Bystrica, Slovakia.

Bartík, Pavol: pavol.bartik@umb.sk; https://orcid.org/0000-0002-2087-7876; Department of Physical Education and Sports, Matej Bel University, Tajovského 40, 97401 Banská Bystrica, Slovakia.

Cite this article as: Adamčák, Š., Marko, M., & Bartík, P. (2023). Physical (In)Activity Gender Gap of Slovak Non-athlete Adolescents. *Physical Education Theory and Methodology, 23*(2), 283-289. https://doi.org/10.17309/tmfv.2023.2.18

Received: 06.03.2023. Accepted: 03.04.2023. Published: 28.04.2023

Теорія та методика фізичного виховання
Physical Education Theory and Methodology
Teorìâ ta Metodika Fìzičnogo Vihovannâ

ISSN 1993-7989 (print)
ISSN 1993-7997 (online)
ISSN-L 1993-7989

ORIGINAL SCIENTIFIC ARTICLE

SCHOOL PHYSICAL EDUCATION PROGRAM IMPACT ON PSYCHOLOGICAL WELL-BEING AND COGNITIVE ABILITY OF PRIMARY SCHOOL CHILDREN

Irina Kliziene[1ABCD], Arunas Emeljanovas[2ABCD] and Mindaugas Dubosas[1ABCD]

[1]Kaunas University of Technology
[2]Lithuanian Sports University

Authors' Contribution: A – Study design; B – Data collection; C – Statistical analysis; D – Manuscript Preparation; E – Funds Collection

Corresponding Author: Irina Kliziene, E-mail: irina.kliziene@ktu.lt
Accepted for Publication: April 3, 2023
Published: April 28, 2023

DOI: 10.17309/tmfv.2023.2.19

Abstract

Study purpose. This study aimed to determine the impact of school Physical Education programs on well-being and cognitive ability (CA), as measured by mathematics achievements, in primary school children.

Materials and methods. The study participants selected from three schools were 100 girls and 102 boys aged 9–10 years. According to Kliziene et al. (2022), the CA diagnostic test for mathematics in Grade 4 is grounded in Feuerstein and Lewin-Benham's (2012) dynamic cognitive modality assessment theory, as well as the General Curriculum for Primary Education approved by the Minister of Education and Science of Lithuania (ISAK-2433, 2008). This test designed for learners in Grade 4 encompasses mathematics. The study aimed to assess the level of enthusiastic well-being by examining three primary dimensions: somatic anxiety, personal anxiety, and social anxiety. To measure anxiety, the Revised Children's Manifest Anxiety Scale (RCMAS) was used, which consists of 37 items, with 28 of them assessing anxiety and the other 9 measuring the child's defensiveness. In this study, a pre-/post-test experimental methodology was used to avoid any interruption of educational activities, due to the random selection of children in each group. The methodology depended on dynamic exercise, intense repetition of motor skills, differentiation, seating and parking reduction and physical activity distribution in the classroom model.

Results. The CA diagnostic test was analyzed in terms of the learners' levels of achievement (satisfactory, basic, advanced) and cognitive functions. The systematic exploration function was used to achieve systematic, non-impulsive, planned behavior when collecting data or checking information. There was a strong difference between students at the satisfactory and advanced levels in the ability to orient themselves in space and follow directions (score for boys, Post-test 2.53 (0.25) points; for girls, Post-test 2.91 (0.32) points out of a maximum 4 points; $p<0.05$). After the school PE program, the personality anxiety results decreased for both boys (2.68 ± 0.98 points) and girls (3.41 ± 0.55 points) ($F = 4.98$, $p < 0.05$, $P = 0.729$).

Conclusions. Overall, the physical education program implemented in this study was found to have a positive effect on the psychological well-being of 9–10-year-old children, specifically in reducing somatic anxiety, personality anxiety, and social anxiety. Additionally, it was observed that the program led to statistically significant improvements in the children's cognitive abilities across nine functions, including spatial orientation, sequencing, recognition of relationships and patterns, and information processing.

Keywords: school physical education program, well-being, cognitive ability, primary education.

Introduction

Despite being distinct skill sets in early school age, both motor competence and physical fitness may be important for children's overall physical well-being and academic achievement (Haapala, 2013; Robinson et al., 2015). Although physical education (PE) has been a curricular component in schools for many years, attention to the important role that schools play for physical activity and physical fitness surveillance has recently increased due to concern about childhood obesity and well-being. There are a number of psychological benefits for physical activity, including psychological well-being and improvements to self-confidence and self-esteem and reduced levels of stress, anxiety and depression (Lubans et al., 2016). Larsen et al. (2021) established that school-based 'health education

through sport', using the '11 for Health' model, was enjoyable for girls and boys aged 10–12 years old and improved health knowledge related to physical activity and well-being. It has been established that physical activity breaks with integrated mathematics content were effective in improving children's on-task behaviour and learning scores (Mavilidi et al., 2018).

Emerging research has also demonstrated the benefits of physical activity for children's cognition, meta-cognition, student engagement and academic performance (Alvarez-Bueno et al., 2017). According to the definition of Myers (2007), 'cognition is the mental activity of thinking, knowing, remembering and communicating'. Ashcraft (1989) defined the cognitive abilities used to acquire cognition as the ability to use the cognitive functions of attention, memory, logical and spatial reasoning, and well as concentration performance, memory, problem solving and decision-making (Lubans et al., 2016). Attention and concentration performance are key contributors to successful academic performance, adaptive behaviours and daily life functioning in youth and children (Janssen et al., 2014). These abilities are closely related to the learner's academic achievement (Gagne, 2005). In a conceptual model, Lubans et al. (2016) proposed that cognitive function provides the core foundation for developing and establishing psychological well-being. Cognitive function and psychological well-being are two variables related to mental health, and several studies have shown that these variables are sensitive to acute physical exercise, but it is not known what doses of exercise are the most adaptive. Including physical exercise prior to performing tasks that require high cognitive inhibition may be a useful strategy for improving cognitive performance (Pastor et al., 2021). Jäger et al. (2014) investigated the effects of an acute 20-min physical activity intervention on executive function in a sample of 52 young elementary school children, aged 6–8 years, compared to another 52 children assigned to a resting control condition. They found statistically significant cognitive effects induced by acute sports intervention.

This study sought to determine the impact of school PE programmes on well-being and cognitive ability (CA), as measured by mathematics achievements, in primary school.

Hypothesis 0: school PE programmes affect well-being and CA (as measured by mathematics achievements) in school students.

Hypothesis 1: school PE programmes do not affect well-being and CA (as measured by mathematics achievements) in school students.

Materials and methods

Study participants

In this study, primary schools in Lithuania were selected randomly, with three schools chosen from different regions that represented the state education system. This system follows the primary, basic, and secondary education programmes approved by the Lithuanian Minister of Education and Science in 2015.

The study was conducted with the agreement of parents and school administration regarding the time and location. The research ethics committee of Kaunas University of Technology's Institute of Social Science and Humanity approved the study, identified by protocol no. V19-1253-03.

The participants selected from the three schools were 100 girls and 102 boys aged 9–10 years (fourth grade).

Rationale for the CA diagnostic test

According to Kliziene et al. (2022), the CA diagnostic test for mathematics in Grade 4 is grounded in Feuerstein and Lewin-Benham's (2012) dynamic cognitive modality assessment theory, as well as the General Curriculum for Primary Education approved by the Minister of Education and Science of Lithuania (ISAK-2433, 2008). This test designed for learners in Grade 4 encompasses mathematics. The assessment criteria in the test are specific and individualized, making it an objective tool for determining learners' strengths and weaknesses to plan appropriate teaching and learning methods. Kliziene et al. (2022) opine that the primary objective of the test is to measure changes in learners' knowledge, understanding, application of knowledge, and higher-order thinking skills. The test comprises tasks that reflect nine cognitive functions.

The CA test was aimed at testing and measuring alterations in the knowledge, understanding, and higher-order skills of learners. In the test, the tasks were distributed based on nine cognitive functions:

1. *Systematic exploration:* To achieve planned and systematic behaviour in data collection, learners use the function of systematic exploration, creating a sequential system (as a case in point, left to right, top to bottom) to complete tasks in a non-impulsive manner;
2. *Spatial orientation:* this refers to the ability to perceive and follow directions in words or signs to navigate a given path;
3. *Sequencing:* the function entails creating a rule for arranging objects in a specific order;
4. *Image recognition:* this involves evaluating changes in visual objects after an action has taken place.
5. *Recognising and understanding relationships:* recognizing and understanding relationships involves identifying associations between elements by observing periodic changes;
6. *Collecting and processing information:* the ability to collect complete, clear, and accurate information.
7. *Algorithm development:* this involves designing a logical rule tailored to solve a particular problem, regardless of the amount of data involved;
8. *Data management (classification):* the grouping of objects and events based on defined criteria.
9. *Construction of combinations:* this entails establishing sets according to given or self-created rules while recognizing the number of possibilities and variations in each combination.

The CA test categorizes tasks based on levels of achievement and cognitive abilities (CAs). This, in turn, paves the way for the evaluation of student achievement. The test aligns with the Grade 4 mathematics curriculum, and performance thresholds were established to ensure fair evaluation of students' CAs. The advanced level of achievement is a score of 22-29 points, basic is 15-21 points, satisfactory is 7-14 points, and low is 0-6 points. The CA clusters were used to identify levels of knowledge, understanding, application, and higher-order thinking skills. The assessment results

were used to evaluate how students organize and implement their learning process. The impact of the learning methods on students' CAs was analysed and interpreted based on the assessment of their achievement levels.

A level of achievement that is considered unsatisfactory indicates that the student does not exhibit the knowledge, comprehension, and abilities that are evaluated within the CA group of the CA test.

On the other hand, a satisfactory level of achievement indicates that the student can reproduce some knowledge, but lacks the ability to apply it in novel situations, resulting in errors in basic mathematical procedures. The student demonstrates an insufficient understanding of mathematical concepts and symbols and struggles to identify patterns and relationships. They can recognize familiar contexts and solve simple problems, typically with only one step involved, but their chosen problem-solving strategies are not always rational. While their reasoning may support their conclusions, they often fail to detect any errors in their reasoning, resulting in incorrect conclusions. They are unable to provide reasoning to support their answers.

A basic level of achievement suggests that the student can apply their existing knowledge to new and relatively simple situations in the CA test, and can perform standard mathematical procedures without making significant errors. Despite their ability to accurately read and comprehend the problem, they may lack consistency and precision in problem-solving. They can think productively in common or familiar situations and can identify basic features, relationships, or patterns of objects. Furthermore, they can solve problems correctly, but may not interpret the final answer in the context of the original condition.

Meanwhile, an advanced level of achievement is indicative of the fact that the student possesses a thorough understanding of the terms used in various problems, has learned and comprehends mathematical concepts, can perform standard mathematical procedures and can solve mathematical and practical problems in various contexts. The learner demonstrates creative thinking skills, can identify common and subordinate features of objects and their relationships, observes patterns, selects appropriate strategies to solve problems, and can test them effectively. The student can draw detailed and precise conclusions.

The Revised Children's Manifest Anxiety Scale

The study aimed to assess the level of enthusiastic well-being by examining three primary dimensions: somatic anxiety, personality anxiety, and social anxiety. To measure anxiety, the Revised Children's Manifest Anxiety Scale (RCMAS) was used, which consists of 37 items, with 28 of them assessing anxiety and the other 9 measuring the child's defensiveness. Only 28 items related to anxiety were used in the factor analysis. The RCMAS yielded three factors: (a) somatic anxiety, comprising 12 items; (b) personality anxiety, comprising 8 items; and (c) social anxiety, comprising 8 items (Dewaraja et al., 2006). The results were interpreted based on the following criteria: (a) somatic anxiety, with scores of ≥6.0 points indicating high somatic anxiety, scores of 5.9-4.5 points indicating typical somatic anxiety, and scores of 4.4-1.0 points indicating low somatic anxiety; (b) personality anxiety, with scores of 2.0-2.5 points indicating low personality anxiety, scores of 2.6-3.5 points indicating typical personality anxiety, and scores of 3.6-4.5 points indicating high personality anxiety; and (c) social anxiety, with scores of ≥5.5 points indicating high social anxiety, scores of 5.4-4.5 points indicating typical social anxiety, and scores of 4.4-3.3 points indicating low social anxiety. The Cronbach's alpha coefficient for the subscales ranged from 0.72 to 0.73.

Procedure

The study employed a pre-/post-test experimental methodology to avoid disrupting educational activities. Children were randomly selected for each group, and the Grade 4 experimental group underwent an eight-month trial. A technique for the school PE programme was developed and a model of educational factors that encourage physical activity for children was created. Methodical material for the PE programme was also prepared based on the work of Coder et al. (2009) and Kliziene et al. (2020). As outlined in Kliziene et al. (2020) and Powell et al. (2016), the methodology involved dynamic exercise, intense repetition of motor skills, differentiation, reduction of sitting and parking time, and distribution of physical activity throughout the classroom.

The objective of the school's physical education programme was to promote physical activity, enhance skill development, and be enjoyable for the students. The recommended frequency for physical education classes was three times per week, with each Grade 4 session lasting 45 minutes and consisting of three sections: health fitness activities (20 minutes), skill fitness activities (20 minutes), and relaxation, focus, and reflection (5 minutes). The programme included activities that varied in intensity, duration, and complexity, with an emphasis on improving cardiovascular endurance. Short activities were also included to improve core strength and movement skills. To encourage motivation, students self-assessed and recorded their fitness levels monthly. The programme included four units of sports and games that developed skill-related fitness: basketball, football, gymnastics, and athletics. Information about healthy lifestyles and unconventional physical activities was also introduced. These sports and games had the potential to promote cardiovascular fitness and engagement in the community, while the relaxation, focus, and reflection activities promoted regular exercises and valuable meditation and relaxation techniques, such as children's yoga, concentration exercises, and conflict resolution (Table 1).

The study utilized physical schooling to teach school PE activities, with the aid of a textbook that had two parts: 1) the textbook itself; and 2) children's notes. The textbook included practical tasks, self-evaluation exercises, and activities that focused on spatial perception and self-improvement. Methodological devices were also provided to aid in using the textbook strategies. The PE programme aimed to integrate "natural" learning and dynamic learning to promote healthy lifestyles and awareness of nature. An advanced version of the programme was available to help teachers with planning and implementation. The material also incorporated intercultural mindfulness and sensitivity, with balanced gender representation. The intervention procedures were mixed, and a new methodology was used, which greatly impacted the participants, as found

Table 1. School Physical Education Programme (4 Grade)

Month	Lesson topic	Lesson areas of activity
Month 1	Working with textbook and notes	What helps you stay active throughout the day? What do you choose for your daily diet? Why is it important to exercise not only in the morning?
	Cohesive communication, communication to avoid conflict	Healthy lifestyle
	Throwing the small ball	Sport units (Athletics)
	Long jump test to test explosive power of children's leg muscles Activity games	Sport units (Athletics) Movement skills
Month 2	Working with textbook and notes	What exercises should you do in preparation for a long run? How can one overcome long distances? What are the square rules? How do you orient yourself in nature without a compass? Healthy lifestyle
	Lithuanian folk mobile games, dexterity training in special games	Movement skills
	Long-distance running	Sport units (Athletics)
	The square Orientation by maps Children's yoga Frisbee	Sport units (Football) Tourism, orienteering Unconventional physical activity
Month 3	Working with textbook and notes	What is important when you are doing the 5×10 m shuttle run test? How do you pass and kick the ball when playing mini football? How do you jump a long jump?
	Shuttle run: 5×10 m High jump Mini football game Orientation in nature Long jump-rope	Sport units (Athletics) Sport units (Athletics) Sport units (Football) Tourism, orienteering Sport units (Gymnastics)
Month 4	Working with textbook and notes	How do you exercise your eyes? How do you sit properly at the computer? What games do we play with a ball? What fun exercises improve coordination?
	Eye exercises Playing with balls	Unconventional physical activity
	Exercises to develop coordination, muscle stretching, maintaining balance Exercises to help calm down and concentrate	Movement skills Healthy lifestyle
Month 5	Working with textbook and notes	What foods are suitable for snacks? How do you throw a ball at a target? How do you pass and throw the ball?
	Food suitable for snacking	Healthy lifestyle
	Throwing the ball at target balls Basketball and passing after a two-step Gymnastics with hoop Project "Snow Castle"	Sport units (Basketball) Sport units (Gymnastics) Unconventional physical activity
Month 6	Working with textbook and notes	How do you get around an obstacle when sledding down a hill? Which mobile games develop aiming skills? How do you perform a correct handstand on the shoulder blades?
	Basics of gymnastics means, tools, correct posture; handstand on the shoulder blades Winter team game	Sport units (Gymnastics) Unconventional physical activity
	Sport games in pairs	Movement skills
	Mobile games to improve agility Time management	Sport units (Football) Healthy lifestyle
Month 7	Working with a textbook and notes	How does teamwork and a common goal help in relay races? What skills do you develop when you play mobile games? How can you learn to concentrate?
	Mobile relay races	Sport units (Athletics)
	Exercises for endurance and strength training	Movement skills
	Exercises to improve concentration	Healthy lifestyle

Table 1 (continued). School Physical Education Programme (4 Grade)

Month 8	Working with a textbook and notes	How do you overcome easy obstacles on a run? What are the important rules to follow when playing mini football? Why do you need to do stretching exercises?
	Ways to overcome easy obstacles on a run	Sport units (Athletics)
	Mini football game	Sport units (Football)
	Muscle stretching exercises, European physical fitness test (Eurofit): sit-and-reach	Healthy lifestyle
Month 9	Working with a textbook and notes	What are the important rules to follow when playing mini basketball? How do you protect yourself from the effects of the sun? How do you choose a safe swimming place?
	Eurofit in the following test order: Flamingo balance, standing broad jump, sit-ups, 10×5 m speed shuttle run	Sport units (Athletics)
	Mini basketball game	Sport units (Basketball)
	Mini golf game	Unconventional physical activity
	Project: Sport event	Healthy lifestyle

by Vaquero-Solís et al. (2020). The standard methodology was applied once a month, during which the material in the textbook was reviewed and tasks for the month were presented.

Statistical analysis. Descriptive statistics were reported for all measured variables as mean ±SD. The effect size of the Mann–Whitney U test was calculated using the equation $r = Z/\sqrt{N}$, in which Z is the z-score and N is the total number of the sample (small: 0.1; medium: 0.3; large: 0.5). Statistical significance was defined as $p \leq 0.05$ for all analyses. Analyses were conducted using SPSS 23 software (SPSS inc., Chicago, IL, USA).

Results

Cognitive functions by level of achievement (Grade 4)

The CA diagnostic test was analysed in terms of the learners' levels of achievement (satisfactory, basic, advanced) and cognitive functions. The systematic exploration function was used to achieve systematic, non-impulsive, planned behaviour when collecting data or checking information. It should be noted that almost all of the primary school students, both boys and girls, at the advanced level (scores for boys, Post-test 3.81 (0.42); for girls, Post-test 3.95 (0.50) points out of a maximum pf 4 points; $p<0.05$) were able to use this cognitive function. There was a strong difference between students at the satisfactory and advanced levels in the ability to orient themselves in space and follow directions (score for boys, Post-test 2.53 (0.25) points; for girls, Post-test 2.91 (0.32) points out of a maximum 4 points; $p<0.05$). The distribution of scores for the item sequencing rule and finding missing items or extending the sequences was consistent with the achievement levels (satisfactory: boys, Post-test 3.38 (1.61) points, girls, 3.51 (1.67) points; basic: boys, Post-test 4.38 (1.56) points, girls, 4.50 (1.12) points; advanced: boys, Post-test 5.51 (0.92) points, girls, 5.59 (0.94) points out of a maximum 7 points; $p<0.05$ for all). There was very little difference in the scores for the collection and processing of information (advanced: boys, Post-test 1.93 (0.10) points, girls, 1.99 (0.15) points; satisfactory: boys, Post-test 1.71 (0.53) points, girls, 1.80 (0.67) points; basic: boys, Post-test 1.89 (0.25) points, girls, 1.95 (0.19) points; $p<0.05$ for all; see Table 2).

Anxiety of 9–10-year-old children (Grade 4)

The study performed at the beginning of the experiment showed that, in the pre-test, the levels of somatic anxiety among primary school children were average for both boys (4.97 ± 1.05 points) and girls (4.98 ± 1.13 points). When exploring the results for somatic anxiety, we established that, after the school PE programme, somatic anxiety fell, but remained average for both boys (4.63 ± 1.00 points) and girls (4.92 ± 1.00 points). These scores demonstrate lower levels of depression, seclusion, somatic complaints, aggression and delinquent behaviour ($F = 5.76$, $p < 0.05$, $P = 0.638$; Figure 1a).

When looking at the results for personality anxiety, we established that the levels of personality anxiety among primary school children were average for both boys (3.49 ± 1.15 points) and girls (3.71± 0.85 points). After the school PE programme, the personality anxiety results decreased for both boys (2.68 ± 0.98 points) and girls (3.41 ± 0.55 points) ($F = 4.98$, $p < 0.05$, $P = 0.729$; Figure 1b)

In the pre-test, the levels of social anxiety were high for both boys (6.28 ± 1.08 points) and girls (6.03 ± 1.32 points). The post-test results were statistically significantly lower, with boys reaching low levels of social anxiety (4.26 ± 1.41 points, $F = 5.61$, $p<0.05$, $P = 0.684$) and girls reaching normal levels (5.30± 1.25 points, $F = 5.27$, $p<0.05$, $P = 0.724$). When analysing the levels of the social anxiety, the pre-test and post-test results decreased after the school PE programme (Figure 1c).

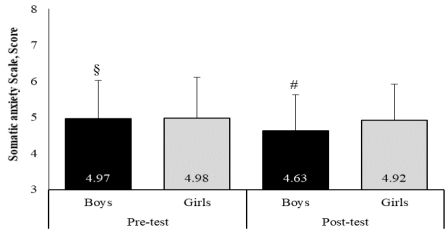
Discussion

Physical education is an essential component of school-based interventions aimed at promoting physical activity among children. PE has been shown to have positive effects on children's health, including improving their physical fitness, reducing the risk of chronic diseases, and enhancing mental health (Andermo et al., 2020; Kliziene et al., 2020).

Table 2. Distribution of cognitive functions by level of achievement (Pre-test and Post-test)

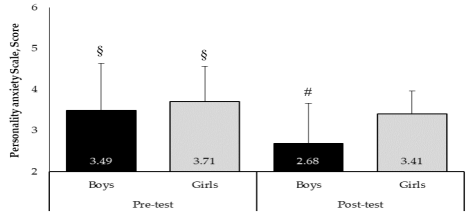
Cognitive functions	Achievement level					
	Satisfactory		Basic		Advanced	
	boys	girls	boys	girls	boys	girls
			Pre-test			
Systematic exploration	2.11 (1.12)	2.19 (1.53)	2.81 (1.02)	2.89 (1.20)	3.31 (0.98)	3.42 (0.91)
Spatial orientation	0.41 (0.92)	0.42 (0.98)	1.24 (0.95)	1.28 (0.93)	1.95 (0.38)	2.01 (0.36)
Sequencing	2.93 (1.50)	2.91 (1.49)	3.75 (1.60)	3.76 (1.41)	4.91 (0.93)	4.93 (0.89)
Image recognition	1.01 (0.91)	1.08 (0.83)	1.29 (0.48)	1.27 (0.46)	1.53 (0.72)	1.50 (0.69)
Recognising and understanding relationships	0.47 (0.20)	0.48 (0.18)	0.55 (0.14)	0.54 (0.18)	0.83 (0.10)	0.85 (0.08)
Collection and processing information	1.15 (0.84)	1.21 (0.86)	1.43 (0.51)	1.41 (0.52)	1.62 (0.31)	1.71 (0.38)
Algorithm development	0.51 (1.08)	0.51 (0.99)	1.83 (1.52)	1.89 (1.67)	2.49 (1.10)	2.50 (1.15)
Data management (classification)	0.21 (0.98)	0.19 (0.92)	0.75 (1.02)	0.78 (1.13)	1.50 (1.41)	1.49 (1.39)
Construction of combinations	0.32 (1.24)	0.68 (1.65)	1.15 (1.50)	1.21 (1.49)	1.98 (0.98)	2.07 (0.83)
			Post-test			
Systematic exploration	2.62* (1.51)	2.71* (1.42)	3.36 (0.72)	3.51* (0.51)	3.81 (0.42)	3.95 (0.50)
Spatial orientation	0.83* (0.94)	0.79* (0.99)	1.85* (0.92)	1.88* (0.95)	2.53* (0.25)	2.91* (0.32)
Sequencing	3.38 (1.61)	3.51 (1.67)	4.38 (1.56)	4.50 (1.12)	5.61 (0.92)	5.59 (0.94)
Image recognition	1.42* (0.80)	1.43* (0.65)	1.81* (0.25)	1.79* (0.73)	1.95* (0.53)	1.96* (0.61)
Recognising and understanding relationships	0.87* (0.15)	0.86* (0.13)	0.91* (0.10)	0.95* (0.09)	0.97 (0.08)	1.00 (0.00)
Collection and processing information	1.71* (0.53)	1.80* (0.67)	1.89* (0.25)	1.95* (0.19)	1.93 (0.10)	1.99 (0.15)
Algorithm development	0.85* (0.79)	0.72* (1.08)	2.38* (0.99)	2.31* (0.89)	2.95 (1.12)	2.89 (1.26)
Data management (classification)	0.25 (0.99)	0.28* (0.85)	1.15* (0.86)	1.23* (0.95)	1.92* (1.25)	1.98* (1.40)
Construction of combinations	0.45* (1.00)	0.85* (0.99)	1.92* (1.05)	2.01* (0.98)	2.57* (0.75)	2.86* (0.69)

* – p<0.05



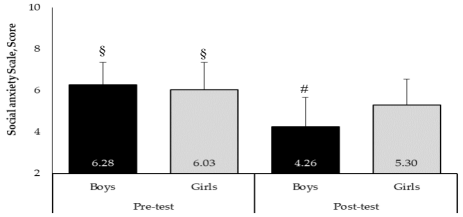
a

– p<0.05 between boys and girls; § – p<0.05 between pre-test and post-test



b

– p<0.05 between boys and girls; § – p<0.05 between pre-test and post-test



c

– p<0.05 between boys and girls; § – p<0.05 between pre-test and post-test

Fig. 1. The level of primary school children somatic anxiety (a), personality anxiety (b) and social anxiety (c) at pre-test and post-test

However, the effectiveness of PE programmes in reducing anxiety in children has received little attention.

Anxiety is a common problem among children, and it can affect their academic achievement, social development, and overall well-being (Ginsburg & Schlossberg, 2002). Anxiety can manifest in various forms, including somatic anxiety, personality anxiety, and social anxiety. Somatic anxiety is characterized by physical symptoms such as sweating, trembling, and rapid heartbeat, while personality anxiety refers to feelings of inadequacy and incompetence. Social anxiety is a fear of negative evaluation or judgment from others.

Given the importance of promoting physical activity and reducing anxiety among school children, this study aimed to identify a recommended approach for a school PE programme that could reduce anxiety in children aged 9-10 years in Lithuania.

According to the findings of this study, the recommended approach for a school PE programme had an impact on three key dimensions – a) somatic anxiety, b) personality anxiety, and c) social anxiety – in children aged 9-10 years. The approach involved dynamic exercise, repetition of motor skills, differentiation, reducing seating and parking, and spreading physical activity in the classroom. The study found a decrease in anxiety in children after nine months of implementing this school PE programme. Therefore, schools seem to be feasible in terms of promoting physical activity among children.

Our hypothesis 0, which proposed that a school PE programme would positively impact student well-being and cognitive achievement, was supported by the results of this study. These findings align with previous research indicating that physical activity interventions in schools can reduce anxiety, increase resilience, and improve overall mental health in children and adolescents (Andermo et al., 2020; Kliziene et al., 2020). Furthermore, the positive effects of physical activity on general health lend further credence to school-based initiatives aimed at increasing physical activity (Andermo et al., 2020).

Research by Larun et al. (2006) suggests that exercise can have a significant effect on depression in children and young people, but not on anxiety. Hermoso et al. (2020) also reported that physical activity is related to positive feelings, life satisfaction, and lower anxiety in children. Meanwhile, according to Chen et al. (2022), cardiorespiratory fitness, concentration performance, attention span, and attention accuracy are all significant predictors of psychological well-being in children. They also found that Grade 4 students with higher levels of psychological well-being had better cardiorespiratory fitness compared to those with lower levels of psychological well-being.

Given the increase in psychological well-being issues among children and youth, which may be partially caused by increased school stress, there is a growing need for evidence-based initiatives to counteract this trend. The results of this study are encouraging, as they suggest that schools can implement initiatives to increase physical activity during the school day and potentially reverse this negative trend.

According to Diamond and Lee (2011), cognitive control is essential for academic achievement, physical health, and mental health. The present study showed a significant improvement in school children's cognitive functions, including systematic exploration, orientation in space, sequencing, image recognition, recognizing and understanding relationships, collection and processing of information, algorithm development, data processing (classification), and construction of combinations. Pastor et al. (2020) suggested that including physical exercise before performing tasks that require high cognitive inhibition could be an effective strategy for enhancing cognitive performance. Similarly, Schmidt et al. (2016) found positive effects of acute ten-minute physical activity breaks on children's cognitive functions. Chen et al. (2022) identified three cognitive functions, namely concentration performance, attention span, and attention accuracy, as significant collective predictors of children's psychological well-being. Attention accuracy, in particular, was found to be a significant individual predictor of psychological well-being.

Attention accuracy is a crucial component of cognitive control, which enables individuals to selectively focus on relevant information and ignore distractions. It has been associated with various aspects of cognitive and socio-emotional development in children, including academic achievement, social competence, and emotional regulation (Posner & Rothbart, 2016). As such, attention accuracy is a key factor in promoting positive psychological well-being in children.

In addition, research has shown that physical activity can enhance attention accuracy and cognitive control in children. A study by Hillman et al. (2014) found that acute physical activity was associated with improved cognitive performance, including attention accuracy, in preadolescent children. Similarly, a study by Kao et al. (2018) found that physical activity was positively associated with cognitive control in preschool children. These findings suggest that physical activity can be a promising strategy for promoting attention accuracy and cognitive control, which, in turn, can improve psychological well-being in children.

Moreover, attention accuracy and cognitive control have been shown to play a critical role in academic achievement, particularly in early childhood. For example, a longitudinal study by Blair and Razza (2007) found that children who exhibited better cognitive control in preschool had higher academic achievement in early elementary school. Similarly, a study by McClelland et al. (2007) found that children who exhibited better attention control and working memory in kindergarten had higher academic achievement in second grade.

Furthermore, Grade 4 students with better psychological well-being exhibited better concentration performance and attention accuracy, indicating their ability to focus on relevant stimuli while ignoring irrelevant ones. Conversely, children with lower psychological well-being had lower concentration performance and attention accuracy.

Conclusion

Overall, the physical education programme implemented in this study was found to have a positive effect on the psychological well-being of 9-10-year-old children, specifically in reducing somatic anxiety, personality anxiety, and social anxiety. Additionally, it was observed that the programme led to statistically significant improvements in the children's cognitive abilities across nine functions, including spatial orientation, sequencing, recognition of relationships and patterns, and information processing.

Conflict of interest

If the authors have any conflicts of interest to declare.

References

Haapala, E. A. (2013). Cardiorespiratory fitness and motor skills in relation to cognition and academic performance in children: A Review. *Journal of Human Kinetics, 36*(1), 55-68. https://doi.org/10.2478/hukin-2013-0006

Robinson, L. E., Stodden, D. F., Barnett, L. M., Lopes, V. P., Logan,S. W., Rodrigues, L. P., & D'Hondt, P. (2015). Motor competence and its effect on positive developmental trajectories of health. *Sports Medicine, 45*(9), 1273-1284. https://doi.org/10.1007/s40279-015-0351-6

Lubans, D. R., Richards, J., Hillman, C. H., Faulkner, G., Beauchamp, M.R., Nilsson, M., et al. (2016). Physical activity for cognitive and mental health in youth: a systematic review of mechanisms. *Pediatrics, 138*(3), e20161642. https://doi.org/10.1542/peds.2016-1642

Larsen, M. N., Elbe, A. M., Madsen, M., Madsen, E. E., Ørntoft, C., Ryom, K., Dvorak, J., & Krustrup, P. (2022). An 11-week school-based 'health education through football programme' improves health knowledge related to hygiene, nutrition, physical activity and well-being—and it's fun! A scaled-up, cluster-RCT with over 3000 Danish school children aged 10–12 years old. *British Journal of sport medicine, 55*(16), 906-911. http://doi.org/10.1136/bjsports-2020-103097

Mavilidi, M. F., Drew, R., Morgan, P. J., Lubans, D. R., Schmidt, M., & Riley, N. (2019). Effects of different types of classroom physical activity breaks on children's on-task behaviour, academic achievement and cognition. *Acta Pediatrica,* 158-165. https://doi.org/10.1111/apa.14892

Alvarez-Bueno, C., Pesce, C., Cavero-Redondo, I., Sanchez-Lopez, M., Martınez-Hortelano, J. A., & Martınez-Vizcaino, V. (2017). The effect of physical activity interventions on children's cognition and metacognition: a systematic review and meta-analysis. *J Am Acad of Child Adolesc Psychiatry,* 56, 729-738. https://doi.org/10.1016/j.jaac.2017.06.012

Myers, D. D. (2007). *Psichologija.* Worth Publishers, ISBN 0-7167-2831-1.

Ashcraft, M. (1989). *Human Memory and Cognition.* Glenview, IL, Scott, Foresman, ISBN13: 9780673467898.

Janssen, M.; Toussaint, H. M.; van Mechelen, W.; & Verhagen, E. A. (2014). Effects of acute bouts of physical activity on children's attention: A systematic review of the literature. *SpringerPlus, 3*(410), 2-10.

Gagne, F. (2005). *From gifts to Talents: the DMGT as a Development Model: gifedness and talent*, Cambridge university press, 93-112, ISBN: 9780521547307.

Pastor, D., Cervelló, E., Peruyero, F., Biddle, S., & Montero, C. (2021). Acute physical exercise intensity, cognitive inhibition and psychological well-being in adolescent physical education students. *Current Psychology, 40*(10), 5030–5039. https://doi.org/10.1007/s12144-019-00454-z

Jäger, K., Schmidt, M., Conzelmann, A., & Roebers, C. M. (2014). Cognitive and physiological effects of an acute physical activity intervention in elementary school children. *Frontiers in Psychology, 1473*(5), 1-11. https://doi.org/10.3389/fpsyg.2014.01473

Kliziene, I., Paskovske, A., Čižauskas, G., Augustiniene, A., Simonaitiene, B., & Kubiliunas, R. (2022). The impact of achievements in mathematics on cognitive ability in primary school. *Brain sciences, 12*(6), 736, 1-17. https://doi.org/10.3390/brainsci12060736

Feuerstein, R. & Lewin-Benham, A. (2012). *What Learning Looks Like: Mediated Learning in Theory and Practice, K-6*. Teachers College Press: New York, NY, USA.

General Curricullum for Primary Education (approved by order no. ISAK-2433 of the Minister of Education and Science of the Republic of Lithuania, 26 August 2008. Official Gazette, 2008, Nr. 99-3848.

Dewaraja, R., Hideyuki, S., & Ogawa, T. (2006). Anxiety in tsunami-affected children in Sri Lanka measured by revised children's manifest anxiety scale and synthetic house-tree-person test. *International Congress Series,* 1287, 74–78. https://doi.org/10.1016/j.ics.2005.12.035

Corder, K., van Sluijs, E. M., Wright, A., Whincup, P., Wareham, N. J., & Ekelund, U. (2009). Is it possible to assess free-living physical activity and energy expenditure in young people by self-report? *American journal of clinical nutrition, 89*(3), 862-870. https://doi.org/10.3945/ajcn.2008.26739

Kliziene, I., Cizauskas, G., Augustiniene, A., Sipaviciene, S., & Aleksandraviciene, R. (2020). The relationship between school age children's ˙ academic performance and innovative physical education programs. *Sustainability, 12*(12), 4922, 1-13. https://doi.org/10.3390/su12124922

Powell, E., Woodfield, L. A., & Nevill, A. M. (2016). Increasing physical activity levels in primary school physical education: The SHARP Principles Model. *Preventive medicine reports,* 3, 7-13. https://doi.org/10.1016/j.pmedr.2015.11.007

Vaquero-Solís, M., Amado Alonso, D., Sánchez-Oliva, D., Sánchez-Migue, P.A., & Iglesias-Gallego, D. (2020). Emotional intelligence in adolescence: Motivation and physical activity. *Revista Internacional de Medicina y Ciencias de la Actividad Fisica y del Deporte, 77*(20), 119–131. https://doi.org/10.15366/rimcafd2020.77.008

Andermo, S., Hallgren,, M., Nguyen, T.T.D., Jonsson, S., Petersen, S., Friberg, M., Romqvist, A., Stubbs, B., & Elinder, L.S. (2020). School-related physical activity interventions and mental health among children: a systematic review and meta-analysis. *Sports Medicine – Open,* 2-27. https://doi.org/10.1186/s40798-020-00254-x

Ginsburg, G. S., & Schlossberg, M. C. (2002). Family-based treatment of childhood anxiety disorders. *International Review of Psychiatry, 14*(2), 143-154.

Larun, L., Nordheim, L.V., Ekeland, E., Hagen, K.B., & Heian, F. (2006). Exercise in prevention and treatment of anxiety and depression among children and young people. *Cochrane Database of Systematic Reviews,* 3, Cd004691. https://doi.org/10.1002/14651858.CD004691.pub2.

Hermoso, A.G., Aguayo, I.H., Vergara, O.F., Olivares, P.R., & Granado, X.O. (2020). Physical activity, screen time and subjective well-being among children. *International Journal of Clinical and Health Psychology,* 20, 126-134. https://doi.org/10.1016/j.ijchp.2020.03.001

Chen, W., Gu, X., Chen, J., & Wang, X. (2022). Association of cardiorespiratory fitness and cognitive function with psychological well-being in school-aged children. *International Journal of Environmental Research and Public Health,* 19, 1434. https://doi.org/10.3390/ijerph19031434

Diamond, A., & Lee, K. (2011). Interventions shown to aid executive function development in children 4 to 12 years old. *Science, 333*(6045), 959-964.

Schmidt, M., Benzing, V., & Kamer, M. (2016). Classroom-based physical activity breaks and children's attention: cognitive engagement works! *Frontiers Psychology,* 7, 1474, 1-13. https://doi.org/10.3389/fpsyg.2016.01474

ВПЛИВ ШКІЛЬНИХ ПРОГРАМ ІЗ ФІЗИЧНОГО ВИХОВАННЯ НА ГАРНЕ ПСИХОЛОГІЧНЕ САМОПОЧУТТЯ ТА КОГНІТИВНУ ЗДІБНІСТЬ ДІТЕЙ МОЛОДШОГО ШКІЛЬНОГО ВІКУ

Клізене Іріна[1ABCD], Емельяновас Арунас[2ABCD], Міндаугас Дубозас[1ABCD]

[1]Каунаський технологічний університет
[2]Литовський спортивний університет

Авторський вклад: A – дизайн дослідження; B – збір даних; C – статаналіз; D – підготовка рукопису; E – збір коштів

Реферат. Стаття: 9 с., 2 табл., 1 рис., 27 джерел.

Мета дослідження. Метою цього дослідження було визначення впливу шкільних програм із фізичного виховання на гарне самопочуття та когнітивну здібність (КЗ) дітей молодшого шкільного віку за рівнем їхньої успішності з математики.

Матеріали та методи. Учасниками дослідження, відібраними з трьох шкіл, стали 100 дівчат і 102 хлопчики віком 9–10 років. Згідно з даними дослідження Kliziene et al. (2022), діагностичний тест КЗ для математики в 4 класі ґрунтується на теорії динамічної оцінки когнітивної модальності Фойєрштайна та Левін-Бенхам, а також Загальній програмі початкової освіти, затвердженій міністром освіти та науки Литви (ISAK-2433, 2008). Цей тест, призначений для учнів 4-го класу, охоплює математику. Метою дослідження була оцінка рівня піднесеного гарного самопочуття шляхом вивчення трьох первинних аспектів: соматичної тривожності, особистісної тривожності та соціальної тривожності. Для вимірювання тривожності використовували Перероблену шкалу явної тривожності для дітей (RCMAS), яка складається з 37 пунктів, із яких 28 оцінюють тривожність, а решта 9 вимірюють захисну поведінку дитини. У цьому дослідженні використовували методологію експерименту з попереднім і підсумковим тестуванням, щоб уникнути перерви в освітній діяльності, з огляду на випадковий відбір дітей у кожній групі. Ця методологія ґрунтувалася на динамічних вправах, інтенсивному повторенні рухових навичок, диференціації, скороченні часу сидіння та стояння в очікуванні та розподілі фізичної активності в моделі шкільного класу.

Результати. Діагностичний тест КЗ аналізували за рівнями успішності (задовільний, середній, високий) та когнітивних функцій учнів. Функцію систематичного дослідження використовували для забезпечення систематичної, неімпульсивної, запланованої поведінки під час збору даних або перевірки інформації. Між учнями задовільного та середнього рівня спостерігалася сильна різниця у здатності орієнтуватися в просторі та рухатися в заданих напрямках (оцінка у хлопчиків: підсумкове тестування – 2,53 (0,25) бала; оцінка в дівчат: підсумкове тестування – 2,91 (0,32) бала з максимум 4 балів; $p<0,05$). Після проходження шкільної програми з ФВ результати особистісної тривожності знизилися і в хлопчиків (2,68 ± 0,98 бала), і в дівчат (3,41 ± 0,55 бала) ($F = 4,98$, $p < 0,05$, $P = 0,729$).

Висновки. Загалом було встановлено, що програма з фізичного виховання, реалізована в цьому дослідженні, позитивно впливає на гарне психологічне самопочуття дітей віком 9–10 років, зокрема на зниження соматичної тривожності, особистісної тривожності та соціальної тривожності. Крім того, за результатами спостережень, ця програма забезпечила статистично значущі покращення когнітивних здібностей дітей у дев'яти функціях, включаючи орієнтацію в просторі, упорядкування, розпізнавання взаємозв'язків та образів, а також обробку інформації.

Ключові слова: шкільна програма з фізичного виховання, гарне самопочуття, когнітивна здібність, початкова освіта.

Information about the authors:

Kliziene, Irina: irina.kliziene@ktu.lt; https://orcid.org/0000-0003-1914-7355; Educational Research Group, Institute of Social Science and Humanity, Kaunas University of Technology, K. Donelaičio g. 73, 44249 Kaunas, Lithuania.

Emeljanovas, Arunas: arunas.emeljanovas@lsu.lt; https://orcid.org/0000-0001-7762-0660; Department of Physical and Social Education, Lithuanian Sports University, Sporto g. 6, 44221 Kaunas, Lithuania.

Dubosas, Mindaugas: mindaugas.dubosas@ktu.lt; https://orcid.org/0009-0002-1164-6045; Educational Research Group, Institute of Social Science and Humanity, Kaunas University of Technology, Kaunas 44249 Lithuania.

Cite this article as: Kliziene, I., Emeljanovas, A., & Dubosas, M. (2023). School Physical Education Program Impact on Psychological Well-Being and Cognitive Ability of Primary School Children. *Physical Education Theory and Methodology, 23*(2), 290-298. https://doi.org/10.17309/tmfv.2023.2.19

Received: 06.03.2023. Accepted: 03.04.2023. Published: 28.04.2023

Теорія та методика фізичного виховання
Physical Education Theory and Methodology
Teorìâ ta Metodika Fizičnogo Vihovannâ

ISSN 1993-7989 (print)
ISSN 1993-7997 (online)
ISSN-L 1993-7989

ORIGINAL SCIENTIFIC ARTICLE

MYOFASCIAL RELEASE AS A MEANS OF INJURY PREVENTION AND MOVEMENT AMPLITUDE RECOVERY IN QUALIFIED FOOTBALL PLAYERS

Eduard Doroshenko[1ABCD], Svitlana Kokareva[2BCE], Borys Kokarev[3BCE], Ruslana Sushko[4ABE], Oleksiy Nikanorov[5ABE] and Lyudmyla Sushchenko[6ACE]

[1]Zaporizhzhia State Medical and Pharmaceutical University
[2]National University "Zaporizhzhia Polytechnic"
[3]Zaporizhzhia National University
[4]Borys Grinchenko Kyiv University
[5]National University of Ukraine on Physical Education and Sports
[6]Dragomanov Ukrainian State University

Authors' Contribution: A – Study design; B – Data collection; C – Statistical analysis; D – Manuscript Preparation; E – Funds Collection

Corresponding Author: Eduard Doroshenko, E-mail: doroe@ukr.net
Accepted for Publication: April 20, 2023
Published: April 28, 2023

DOI: 10.17309/tmfv.2023.2.20

Abstract

The purpose of the study was to determine the effectiveness of MFR tools used in the training process of qualified football players.

Materials and methods. The study participants were 28 football specialists of the Ukrainian Premier League football teams and 36 football players of FC "Zorya" (Luhansk). Methods used in the study included analysis, generalization and systematization of data from scientific and methodical literature and Internet, questionnaire survey, pedagogical observations, pedagogical testing of flexibility indicators, pedagogical experiment, methods of mathematical statistics.

Results. The results of using MFR manual techniques in the training process of qualified football players are as follows: relaxation of chronically tense muscles, recovery of mobility and normal amplitude of motion in the joints, improvement of the elastic properties of the muscular and ligamentous structures of the musculoskeletal system of football players, optimization of hemodynamics and lymphodynamics at the microcirculatory level, optimization of general and local metabolic processes in the body, functional recovery of the musculoskeletal system of football players after excessive physical exertion and injuries, improvement of proprioception and neuromuscular control, optimization of the psychoemotional state.

Conclusions. The analysis of the results of testing the flexibility of football players of FC "Zorya" (Luhansk) at the end of the first and second preparatory periods of the 2019-2020 sports season allows us to state the presence of higher indicators compared to the results of preliminary testing in the 2018-2019 sports season. According to the results of the monitoring performed by the specialists of the complex scientific group, there has been recorded an 11.11% decrease in the number of injuries related to damage to the muscular-ligamentous structures of the lower limbs and trunk of football players in FC "Zorya" (Luhansk).

Keywords: MFR tools, prevention, injuries, amplitude of motion, football.

Introduction

In the vast majority of modern professional sports, coaches quite often encounter complaints from athletes about pain in the muscles, which is a sign of physical discomfort and prevents athletes from fully training and competing. However, in the majority of cases, medical professionals do not diagnose problems related to the functioning of the musculoskeletal system of athletes (Bethers et al., 2021; Al Attar et al., 2021; Al Attar, 2021). On the other hand, the coach visually records certain movement defects when performing football techniques and sportsmen's posture, which leads to a decrease in the effectiveness of the training process of

qualified football players. This situation leads to the loss of a significant amount of competitive and training time due to the need for restorative treatment and rehabilitation (Riepenhof et al., 2018; Al Attar et al., 2022).

The probable cause of such problems is negative changes in the myofascial structures of the locomotor apparatus in qualified football players, which are characterized by the donozological or pre-morbid conditions of their bodies. The development of pre-pathological conditions is a complex consequence of maximal and submaximal physical exertion, injuries of the musculoskeletal system, and the effects of permanent stress factors. As a result, the myofascial structures of the body in qualified football players partially lose elasticity. As a result of the cumulative effect of the mentioned factors, microtraumas, and minor damage to the muscle-ligamentous structures, there is a limitation of the amplitude of movements in the joints, and the development of the adhesion process with subsequent pathological and pathomorphic phenomena based on the formation of scars of the muscle-fascial structures (Barbero et al., 2019; Baeumler et al., 2023).

In connection with the above, attention should be paid to the use of the term "trigger point" in modern research by authorship of Janet G. Travell (Barbero et al., 2019). The concept of myofascial pain syndrome was initiated in her works. According to her definition, given in the study (Shah et al., 2015), myofascial pain syndrome is pain and (or) autonomic symptoms (the focus of muscle hyperexcitability) that are reflected from active myofascial trigger points with a certain manifestation of dysfunction (Fig. 1).

In addition, the symptom complex of stress agents affects the hyperreactive nervous structure of the myofascial trigger point, which leads to increased activity (A-B), and transfer of sensations (pain, paresthesia, increased sympathetic activity) to the location (C-D). Other stimuli reach the spinal cord from distant trigger points and additional dysfunctional locations (E-F) (Musculoskeletal Key).

According to the authors of the research, the trigger point is defined as a location of tissue hyperreactivity with a diameter of several millimeters, which is painful when squeezed. These points, which feel like peas in the muscle tissue, shorten the muscle fibers of which they are a part (Riepenhof et al., 2018; Ricci et al., 2023).

Researchers note that indicators of microcirculatory hemodynamics in the area adjacent to the trigger point significantly decrease. This leads to oxygen deficiency and the accumulation of metabolic products, which further irritate the trigger point and provoke the appearance of pain signals (Kisilewicz et al., 2018). Meanwhile, due to the mechanical compression of one segment of the muscle fiber, its other segments are in a state of stretching. As a result, the muscle fiber partially loses its elastic properties, which negatively affects the amplitude of motor activity. Irritated trigger points prevent muscles from relaxing, as a result, there is increased fatigue, a decrease in the functions of intermuscular coordination, and an increased recovery time (Das & Jhajharia, 2022). In the absence of correction, myofascial trigger points deprive the muscle tissue of elasticity so that the normal physiological tone of the fascial chains changes – this is extrapolated to other muscles, which significantly limits the mobility of adjacent joints (Das et al., 2022).

In order to solve this problematic situation, it is necessary to find the most effective means and methods that allow to restore the lost functions of muscle and ligament structures in the shortest possible time (Cao et al., 2021). This is relevant both for sports in general (Sofyan et al., 2022), and for football in particular. One of these methods is MFR, which researchers define as a simultaneous manual effect on muscle and connective tissue aimed at relaxing myofascial structures (Baeumler et al., 2023). The effect is achieved due to compression and passive stretching of irritated musculofascial structures, which require restorative therapy and rehabilitation (Manzi et al., 2020; Bethers et al., 2021).

It is believed that MFR tools in combination with stretching are effective exercises for accelerating recovery processes after significant physical exertion, reducing pain sensations and muscle hypertonicity, increasing the flexibility of the joints, and reducing the probability of injury of the athletes (Doroshenko, 2015; Doroshenko et al., 2019).

Most often, a special cylinder (Foam roller) is used to affect the stressed area. It is made of different materials with different elastic properties: foam plastic, polypropylene foam, polyurethane, wood, etc. Cylinders differ in the composition of the material, which determines their hardness, and in

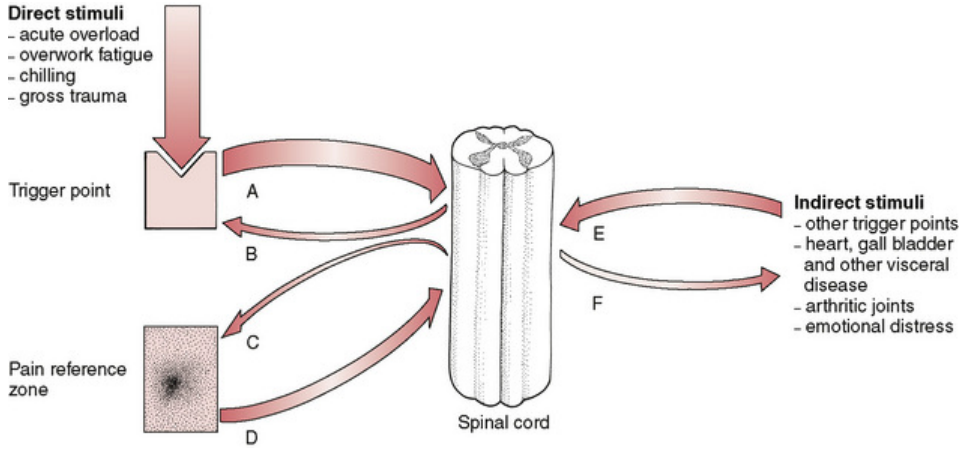


Fig. 1 Mechanism of action of myofascial trigger points and other reflex phenomena (Musculoskeletal Key)

diameter, which provides a larger or smaller area of contact with the body. These differences make it possible to vary the degree of pressure on problem locations of the athlete's body. For a more targeted impact, balls of different diameters and stiffness are also used (for example, a tennis ball).

Also significant is the factor that competitive and training activities of qualified football players are quite traumatic due to their specific nature: constant changes in speed and direction of movements, high coordination complexity of game techniques, variability of offensive and defensive technical and tactical actions, and their combinations, fight for position and the ball (Kostiukevich et al., 2017; Lisenchuk et al., 2022). The complex impact of the above factors leads to injuries of the musculoskeletal system in qualified football players: damage to muscles, ligaments and tendons is a fairly common phenomenon in the competitive and training practice of athletes (Hammami et al., 2016; Taberner & Cohen, 2018; Kadir, & Osman, 2021). Such a situation actualizes the direction of scientific research, which is related to the study of the effectiveness of targeted influence on the musculoskeletal system in qualified football players through the use of special exercises – myofascial release and stretching. Modern scientific researchers testify that the existing complexes of special exercises (stretching tools) are not effective enough, in the context of their systematic use in the training process and competitive activities of qualified football players to prevent injuries and restore the amplitude of movements in the joints (Mohammadtaghi et al., 2016; Evangelos et al., 2017).

Hypothesis. The use of special MFR exercises in the training process and competitive activities of qualified football players will contribute to reducing their injury rates and restoring the amplitude of motion in the joints.

The purpose of the work: to determine the effectiveness of the use of MFR tools used in the training process of qualified football players.

Material and methods

Participants

In order to clarify the opinion regarding the possible use of modern methods of functional training in the process of physical training of qualified football players, a survey of football specialists was conducted at the first stage of the research. Coaches and sports managers of football teams who hold official positions in professional football clubs of the Ukrainian Premier League took part in it: head coaches, assistant head coaches, physical training coaches, sports directors, sports doctors, rehabilitators, experts of complex scientific groups. In total, 28 specialists took part in the survey, who take care of planning and organizing the process of physical training of qualified football players. Table 1 presents the structure of the focus group of specialists who participated in the survey.

All respondents are men, aged from 21 to 70 years. The average age of respondents was 45.5 ± 10.6 years. Specialists who took part in the survey have specialized higher education, coaching (or medical) licenses of the appropriate categories for work with football teams of the Ukrainian Premier League. According to the terms of the contracts, they worked with the teams on a permanent or temporary basis.

Table 1. The structure of the focus group of football specialists who participated in the survey, n=28

Work experience in a football club	Respondents, n	Ratio, %
≤ 5 years	5	17,86
5 – 10 years	6	21,43
10 – 15 years	7	25,00
≥ 15 years	10	35,71
of them, full-time coaches	9	32,14

In the experimental part of the study, 36 highly qualified football players aged 18-30 participated, who during two sports seasons (2018-2019 and 2019-2020) were included in the application letters "A" and "B" of FC "Zorya" (Luhansk) as professional football players and participated in official competitions of the Ukrainian Premier League.

Organization of research

The survey was conducted with the technical support of representatives of the press service of FC "Zorya" (Luhansk). The participants of the survey were given instructions containing a form of consent for the use of the personal data of respondents and experiment participants, an information sheet, and a questionnaire. The information letter explained the aim and objectives of the study, definitions of key terms used in the questionnaire, and contact details of the research team members. The consent form contained personal data identifying the participants of the survey, but it was explained to the participants that filling in this part of the questionnaire was not mandatory.

The ascertainment and formative stages of the pedagogical experiment were carried out within the first and second preparatory periods of the training macrocycle of FC "Zorya" (Luhansk) – sports seasons 2018-2019 and 2019-2020. To determine the impact of the MFR technique on the indicators of injury prevention and restoration of the amplitude of movements in the joints, it is proposed to use exercises with special cylinders "Foam Roller" manufactured by "Everlast" and "Black Roll". MFR exercises were used in the preparatory and final parts of the training sessions of qualified football players. At the beginning and at the end of the first and second preparatory periods, in each part of the class, flexibility testing was conducted before using MFR tools (determinative stage) and after the proposed changes in the training program (formative stage).

The research was conducted on the basis of the football team of the Ukrainian Premier League – FC "Zorya" (Luhansk), the Department of physical culture and Sports of the Zaporizhzhia National University and the Department of physical rehabilitation, sports medicine, physical education and health of the Zaporizhzhia State Medical University in the period of 2018-2020.

At the first stage of the experiment (2018-2019 sports season), the scientific and methodological literature on the topic of the study was analyzed and summarized, its relevance,

theoretical and practical significance were substantiated, and a program for conducting ascertainment and formative experiments was developed. During the official games and training sessions, the experts of the Ukrainian Premier League teams were interviewed, and the results were analyzed and processed. In the ascertainment experiment, the peculiarities of the dynamics of the flexibility indicators in qualified football players within the annual macrocycle under the influence of the traditional training program were studied.

At the second stage of the experiment (sports season 2019-2020), in the formative experiment, the nature of the changes of the specified indicators under the influence of MFR tools was checked, the effectiveness of the experimental program was evaluated, conclusions and practical recommendations were formulated regarding the use of MFR tools in the training process of qualified football players. During the experimental studies, the participants gave informed consent to the processing of personal data in accordance with the requirements of the Declaration of Helsinki of the World Medical Association "Ethical principles of medical research with the participation of a person as an object of research".

Methods of research

Analysis, generalization, and systematization of data from scientific and methodical literature and the global information network "Internet"; questionnaire survey; pedagogical observations; pedagogical testing of flexibility indicators according to tests: "Inclination from a standing position, cm", "Full bridge from the starting position lying on the back, cm", "Front splits, cm", "Side splits on the left or right leg, cm"; a pedagogical experiment with the stages of ascertaining and formative orientation. A qualitative assessment of the development of the "flexibility" quality in qualified football players was carried out according to the recommendations of scientists and experts (Gomez-Piqueras et al., 2018).

Statistical analysis

The obtained experimental materials were processed by the package of application programs "IBM SPSS Statistics" for Windows and "MS Office Excel" with the calculation of the following indicators: arithmetic mean ($\bar{x}$); arithmetic mean error (S); σ – mean square deviation; Student's t-test, which is a test of the reliability of the normal distribution for equal and unequal samples with (n-1) degrees of freedom. Statistically reliable differences are accepted as significant at a 5% significance level of $p<0.05$, which is recognized as a reliable indicator in pedagogical research (processing of experimental data at significance levels of $p<0.01$; $p<0.001$ was also used)

Results

As a result of the analysis of the survey data, it was found that football specialists hold, in general, positive beliefs about the possibilities of using modern technologies of functional training using MFR and stretching tools in the training process of qualified football players (Table 3)

The results of the survey show that 92.85% of football experts believe that muscle elasticity and flexibility are important for the successful competitive performance of qualified football players. A certain conservatism of the opinions of football experts can be seen in the fact that 39.29% believe that the time spent on MFR and stretching in the training process of qualified football players can be used more effectively. 71.44% of the surveyed football specialists believe that MFR tools complement stretching in the training process, which indicates promising opportunities for further differentiation in the use of MFR and stretching as separate methods in various structural formations of the macrocycle. Still, 64.28% of the experts surveyed believe that the use of stretching is more effective than MFR tools in the training process of qualified football players. A rather significant indicator – 46.44% of football specialists do not agree or strongly disagree that MFR tools contribute to the development of flexibility, the restoration of the amplitude of motion in the joints and the reduction of sports injuries. This shows that there is a certain lack of research that convincingly confirms the effectiveness of using these tools in the training process of qualified football players. Another 39.29% of the interviewed specialists strongly disagree or disagree with the statement that the methods that exist and are used today are outdated and require significant modification for use in the training process. 78.57% of specialists believe that the specified innovative methods of functional training increase the effectiveness of the technical and tactical actions of qualified football players, at the same time, 100% consider MFR and stretching as necessary components of the sports training of football players, which indicates the need for widespread use of these methods of functional training in sports training.

35.72% of specialists emphasize that there is a shortage of specialists who are able to integrate new methods of MFR and stretching into the training process of qualified football players at a high professional level, 64.28% – emphasize that, in practice, there is no scientific justification for the use of modern methods of MFR and stretching in sports training of qualified football players.

Table 2. The scale of qualitative assessment of the level of physical preparedness in qualified football players based on flexibility indicators (Kostiukevych et al., 2019)

	low	below average	average	above average	high
Inclination from a standing position, cm	-10 – -5,1	-5,0 – -0,1	0 – 4,9	5 – 9,9	10 ≥
Full bridge from the starting position lying on the back, cm	75,0 ≥	74,9 – 70,0	69,9 – 65,0	64,9 – 60,0	59,9 ≤
Front splits, cm	65,0 ≥	55,0 – 64,99	45,0 – 54,99	35,0 – 44,99	34,99 ≤
Side splits on the left (right) leg, cm	45,0 ≥	40,0 – 44,99	35,0 – 39,99	30,0 – 34,99	29,99 ≤

Table 3. The results of a survey of football specialists regarding the use of MFR and stretching in the training process of qualified football players, %

Categories of questions	Categories of answers				
	strongly disagree	disagree	difficult to answer	generally agree	completely agree
Muscle elasticity and flexibility are important for football players	0	0	7.15	60.71	32.14
the time spent on MFR and stretching can be used more efficiently	14.28	39.28	7.15	32.14	7.15
MFR complements stretching in the training process	0	14.28	14.28	64.29	7.15
The use of stretching is more efficient than MFR	3.57	14.28	17.87	57.13	7.15
MFR helps develop flexibility, restore amplitude of motion, and reduce injuries	21.44	25.00	28.56	25.00	0
the methods that exist are outdated and need to be modified for use in the training process	7.15	32.14	25.00	25.00	10.71
innovative methods of functional training (MFR, stretching) increase the effectiveness of the technical and tactical actions of football players	0	7.15	14.28	50.00	28.57
MFR and stretching are necessary components of the training process	0	0	0	57.15	42.85
there is a shortage of specialists who are able to integrate new MFR and stretching techniques into the training process	7.15	14.28	42.85	35.72	0
there is no scientific justification for the use of modern methods of MFR and stretching in the training process	3.57	7.15	25.00	50.00	14.28

In addition, on the basis of the generalization and extrapolation of data from a questionnaire survey of football specialists of Ukrainian Premier League teams, including physical training coaches and specialists of complex scientific groups, an approximate distribution of types of sports training by volume and percentage ratio was made in the structure of the preparatory period of the annual macrocycle of training professional football teams (Table 4).

Analysis of the data given in Table 4 allows us to state that, according to the interviewed experts, up to 54.58% of the volume of training loads in the preparatory period of the training of qualified football players falls on the development (improvement) of the physical and functional readiness of the players as the basis of a high level of physical performance during a long competitive period. This is significant in the context of the axiomatic statement that, precisely, a high level of physical work capacity based on the development of special motor abilities is a necessary prerequisite for the effective implementation of the existing technical and tactical potential in qualified football players in the competitive process during the macrocycle of training. In this context, the ratio seems logical – up to 35.42% of the number of training loads in the preparatory period of training of qualified football players has a technical and tactical or integral focus. As a result, the two main types of training: 1) with a primary focus on the development (improvement) of physical and functional readiness and 2) with a primary focus on the development of technical and tactical skills and integral preparedness of football players, account for about 90% of the total amount of training and competition loads.

Table 4. Approximate distribution of types of training load during the basic microcycle in the preparatory period of the annual macrocycle according to the results of a survey of UPL football coaches, n=28

Orientation of preparation	Amount (hours per week) $\bar{X} \pm S$	Ratio, %
Technical and tactical training	4.35 ± 0.12	24.17
General and special endurance	4.20 ± 0.19	23.33
Strength training (with resistance)	2.92 ± 0.17	16.25
Speed training	2.70 ± 0.12	15.00
Flexibility (active and passive)	1.80 ± 0.11	10.00
Integrated training	2.03 ± 0.11	11.25
Total	18.0	100

Flexibility development tools, including MFR and stretching, account for about 10% of the total volume of loads in the preparatory period of training of qualified football players (Fig. 2).

During the approbation of the specified means and methods of their implementation in the training process of FC "Zorya" (Luhansk), the following results were obtained (Table 5).

As a result of the pedagogical testing of the flexibility indicators of football players of FC "Zorya" (Luhansk), at the end of the first preparatory period, the following results were obtained: statistically significant differences were recorded

Table 5. Flexibility indicators of football players of FC "Zorya" (Luhansk) in the basic microcycles of the preparatory period of the 2018-2019 and 2019-2020 seasons, ($\bar{x}$±S), (n=36)

The indicators under study	At the end of the 1st PP		Δ1%	At the end of the 2nd PP		Δ2%
	2018/19 pp.	2019/20 pp.		2018/19 pp.	2019/20 pp.	
Inclination from a standing position, cm	-4.93±0.05 average	-4.10±0.05*** below average	16.8	-4.55±0.15 below average	-3.25±0.15*** below average	28.6
Full bridge from the starting position lying on the back, cm	64.85±2.05 average	60.50±1.05* average	6.71	68.50±1.05 average	64.50±1.05* above average	5.84
Front splits, cm	49.50±1.50 average	49.03±0.14 average	0.95	50.0±1.01 average	45.50±1.50** average	9.0
Side splits on the left (right) leg, cm	34.50±1.55 above average	32.40±1.20* above average	6.09	36.50±1.50 average	33.33±1.30** above average	8.68

Notes: *– p<0.05; **– p<0.01; ***– p<0.001 – compared to the results of the previous sports season

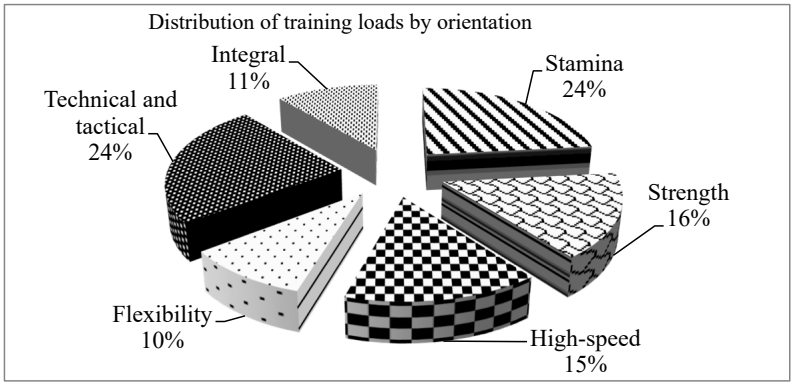


Fig. 2. Approximate distribution of training loads (by predominant orientation) in the basic microcycle of the preparatory period of training of qualified football players

according to the results of the tests "Full bridge from the starting position lying on the back" and 60.50±1.05 cm, respectively); "Side splits on the left (right) leg" (34.50±1.55 cm and 32.40±1.20 cm, respectively), p<0.05. A more significant difference was recorded in the result of the test: "Inclination from a standing position" (result of the previous season -4.93±0.05 cm and -4.10±0.05 cm in the 2019/20 season, p<0.001), which corresponds to the "above average" level of development. Two indicators corresponded to the "average" level: the tests "Full bridge from the starting position lying on the back" and "Front splits", according to the indicators of the test "Side splits on the left (right) leg"), the indicators were recorded at the level of "below average" (Table 2).

The indicators of the comparative analysis of the results of testing the flexibility of FC "Zorya" (Luhansk) football players during the second preparatory period of the 2018-2019 and 2019-2020 sports seasons indicate that it was possible to achieve a higher level of flexibility of the football players of FC "Zorya" (Luhansk) in comparison with the results of the previous season. Statistically reliable differences (p<0.001) of 28.6% were recorded according to the indicators of the flexibility test in the lumbar spine "Inclination from a standing position". Also, statistically reliable differences in indicators were recorded according to the results of the "Front splits" and "Side splits on the left (right) leg" tests (p<0.01), which characterizes the manifestations of flexibility in the hip joints; according to the test "Full bridge from the starting position lying on the back" (p<0.05).

The analysis of the results of the flexibility testing of football players of FC "Zorya" (Luhansk) at the end of the first and second preparatory periods of the 2019-2020 sports season allows us to state that there are higher flexibility indicators compared to the results of the preliminary testing in the 2018-2019 sports season (statistically reliable differences at the levels: p<0.05; p<0.01; p<0.001). Also, in the 2019-2020 sports season, according to the results of monitoring by specialists of the complex scientific group of FC "Zorya" (Luhansk), a decrease in the number of sports injuries related to damage to the muscle and ligament structures of the lower limbs and trunk of football players was recorded – by 11.11%.

Also, in the process of experimental research, the following options for the practical use of MFR tools were determined by the methods of pedagogical observation, generalization, and systematization of the obtained data in accordance with the purpose, tasks, and orientation of specific training sessions:

1) in the preparatory part – in order to increase the amplitude of movements in the joints and prevent injuries in the main part; to reduce the risk of injury of football players during further high-amplitude motor actions and high-intensity training;

2) in the final part – with the aim of accelerating metabolic processes in the muscular-ligamentous structures of the musculoskeletal system of football players and reducing the manifestations of muscle pain after significant physical exertion;

3) as an independent training tool – for the purpose of rehabilitative effects on painful areas of the musculoskeletal structures of the musculoskeletal system of football players to reduce muscle tone and develop flexibility.

The results of using manual MFR techniques are:

- relaxation of chronically tense muscles;
- restoration of mobility and normal (physiologically determined) amplitude of motion in the joints;
- improving the elastic properties of the muscular and ligamentous structures of the musculoskeletal system of football players;
- optimization of hemodynamics and lymphodynamics at the microcirculatory level;
- optimization of general and local metabolic processes in the body;
- restoration of the functions of the musculoskeletal system of football players after excessive physical exertion and injuries;
- improvement of proprioception and neuromuscular control;
- optimization of the psycho-emotional state.

Discussion

In the course of the experimental research, a scientific problem with elements of scientific novelty was raised: the effectiveness of the program of using MFR tools for the prevention of injuries and restoring the amplitude of motion in qualified football players was experimentally substantiated and proven. In addition, the data related to the determination of options for the practical application of MFR tools in accordance with the purpose, tasks, and focus of specific training sessions for qualified football players were summarized and systematized: in the preparatory part; in the final part; as an independent training tool. Added data on the improvement of the system of long-term sports training in football in the context of the use of means of injury prevention, correction of physical condition and recovery of athletes' bodies after significant physical exertion (Kostiukevich et al., 2017; Lisenchuk et al., 2022). Data on the effectiveness of the integrated use of MFR, stretching and therapeutic exercises in the rehabilitation therapy in qualified football players after injuries and disorders of the musculoskeletal system have gained further development (Kisilewicz et al., 2018; Doroshenko et al., 2019).

The results of the experimental studies presented in the paper allow us to state that the modern system of multi-year sports training requires the search for innovative methodological approaches to improving the training process of qualified athletes (Mitova, 2020; Komotska & Sushko, 2022), including qualified football players (Kokareva et al., 2018; Selmi et al., 2018). A long competitive period in modern football – 8-10 months of a calendar year, high physical loads in terms of volume and intensity, highly variable competitive activity with the cumulative effect of stress agents of a socio-psychological nature actualizes problematic issues (Lisenchuk et al., 2019), related to the search and implementation of effective methods of restoring the physical condition in qualified football players, means of their rehabilitation and prevention of sports injuries (Dalla Rosa Nogales & Nogales Zafra, 2019; Morris et al., 2019; Ramirez-Campillo et al., 2019).

One of these tools is manual MFR techniques (Das et al., 2022), which are recommended to be used as a means of preventing sports injuries and restoring amplitude of motion in qualified football players after injuries, damage, and significant physical exertion (Doroshenko, 2015; Doroshenko et al., 2019) in combination with stretching exercises and other therapeutic exercises to enhance the overall effect.

An additional significant factor in solving this problem is the global injury prevention program "FIFA 11+", which was developed by the FIFA Medical Assessment and Research Center (F-MARC), tested and implemented in the activities of many national football associations with the aim of reducing sports injuries among football players of different ages and genders, qualifications (Sadigursky et al., 2017; Patti et al., 2022; Vlachas & Paraskevopoulos, 2022). Currently, the global injury prevention program "FIFA 11+" is also used in other sports, for example, in basketball (Longo et al., 2012). It is shown that the exercises used in the "FIFA 11+" program contain separate elements of MFR, and stretching, which significantly reduces heavy injuries. In particular, these are running exercises at a slow speed in combination with MFR and stretching exercises; functional training for the trunk and limbs, balance exercises, agility, and plyometric exercises; running exercises at a moderate or high speed, integrated with a change in the direction and speed of movement.

Overall statistics vary significantly in the amplitude of a 30%-70% reduction in sports injuries when using the global program "FIFA 11+" ("FIFA 11+ Program: Soccer Injury Prevention").

Also significant is the analysis of the opinion of practical football specialists who work in professional football clubs regarding the use of MFR tools in the training process of qualified football players. The vast majority of interviewed experts consider MFR tools effective in the functional training system (78.57%) and the integrated use of MFR tools and stretching in the sports training of qualified football players is necessary (100%). Meanwhile, 64.28% of the interviewed specialists emphasize that, as of today, there is practically no scientific justification for the effectiveness of modern MFR and stretching methods in the sports training of qualified football players. This indicates the presence of a finally unsolved problem related to the effective integrated use of MFR and stretching in the training process of qualified football players, which requires further detailed research and confirms the conclusions of scientists (Manzi et al., 2020; Das & Jhajharia, 2022).

On the basis of the above, we consider it necessary to focus attention on the following problematic issues, which relate to the raised issue. Firstly, the need to correct the modern system of long-term sports training, in the context

of a wider use of means of prevention of sports injuries and restoration of functional capabilities in qualified football players (Kostiukevych et al., 2019; Lisenchuk et al., 2019). Secondly, the details of scientific research aimed at determining the effectiveness of the integrated use of MFR, stretching, and therapeutic exercises in the training process of football players of different ages, genders, and qualifications (Doroshenko, 2015; Evangelos et al., 2017).

Prospects for further research are based on the expansion of additional means of prevention of sports injuries and recovery of the body in qualified football players after significant loads, rehabilitation after injuries, and damage to the musculoskeletal system. In particular, this applies to the use of neuromuscular training exercises, which are designed to restore normal combinations of individual locomotor acts at the first stages of motor activity recovery, to ensure control and coordination of muscle activation. Increasing the effectiveness of neuromuscular training exercises at the first stages of rehabilitation therapy after complex injuries of the musculoskeletal system can significantly accelerate the rehabilitation in qualified football players.

Conclusions

Analysis of data from scientific literature and the global information network "Internet" allows us to state that the practice of using MFR tools in the training process of qualified football players is not systematic.

A questionnaire survey of football specialists working in clubs of the Ukrainian Premier League shows their understanding of the need to introduce MFR tools into the training process of qualified football players – 78.57% of experts believe that the use of innovative methods of functional training increases the effectiveness of technical and tactical actions of qualified players football players; 100% – consider the integrated use of MFR and stretching in the sports training of qualified football players to be necessary.

The analysis of the results of testing the flexibility of football players of FC Zorya (Luhansk) at the end of the first and second preparatory periods of the 2019-2020 sports season allows us to state the presence of higher indicators compared to the results of the preliminary testing in the 2018-2019 sports season (statistically significant differences in levels: $p<0.05$; $p<0.01$; $p<0.001$). Also, in the 2019-2020 sports season, according to the results of monitoring by specialists of the complex scientific group of FC "Zorya" (Luhansk), a decrease in the number of sports injuries related to damage to the muscle and ligament structures of the lower limbs and trunk of football players was recorded – by 11.11%.

Variants of practical application of MFR tools have been determined in accordance with the purpose, tasks and focus of specific training sessions: in the preparatory part; in the final part; as an independent training tool.

Disclosure statement

No author has any financial interest or received any financial benefit from this research.

Conflict of interest

The authors state no conflict of interest.

References

Bethers, A.H., Swanson, D.C., Sponbeck, J.K., Mitchell, U.H., Draper, D.O., Feland, J.B., & Johnson, A.W. (2021). Positional Release Therapy and Therapeutic Massage Reduce Muscle Trigger and Tender Points. *Journal of Bodywork and Movement Therapies,* 28, 264-270. https://doi.org/10.1016/j.jbmt.2021.07.005

Al Attar, W. S. A., Alarifi, S., Ghulam, H., Yamani, S., Alharbi, E., Aljabri, M., & Sanders, R. H. (2021). Awareness and Use of Current Sports Injury Prevention Programs among Physiotherapists Worldwide. *Physical Education Theory and Methodology, 21*(4), 365-374. https://doi.org/10.17309/tmfv.2021.4.12

Al Attar, W. S. A. (2021). The Current Implementation of an Evidence-Based Hamstring Injury Prevention Exercise (Nordic Hamstring Exercise) among Athletes Globally. *Physical Education Theory and Methodology, 21*(3), 273-280. https://doi.org/10.17309/tmfv.2021.3.11

Riepenhof, H., Del Vescovo, R., Droste, J., McAleer, S., & Pietsch, A. (2018). Muscle Injuries in Professional Football: Treatment and Rehabilitation. Der Unfallchirurg, 121 (6): 441-449. https://doi.org/10.1007/s00113-018-0501-z

Al Attar, W. S. A., Yamani, S., Ghulam, H., Alharbi, E., & Sanders, R. H. (2022). Limited Implementation of the FIFA 11+ Shoulder Injury Prevention Program (FIFA 11+ S) Among Professional Soccer Goalkeepers Globally. *Physical Education Theory and Methodology, 22*(1), 36-42. https://doi.org/10.17309/tmfv.2022.1.05

Barbero, M., Schneebeli, A., Koetsier, E., & Maino, P. (2019). Myofascial Pain Syndrome and Trigger Points: Evaluation and Treatment in Patients with Musculoskeletal Pain. *Current Opinion in Supportive & Palliative Care, 13*(3), 270-276. https://doi.org/10.1097/SPC.0000000000000445

Baeumler, P., Hupe, K., & Irnich, D. (2023). Proposal of a Diagnostic Algorithm for Myofascial Trigger Points Based on a Multiple Correspondence Analysis of Cross-Sectional Data. *BMC Musculoskeletal Disorders,* 24, 1. https://doi.org/10.1186/s12891-023-06129-y

Shah J., Thaker N., Heimur J., Aredo J., Sikdar S., & Gerber L. (2015). Myofascial Trigger Points Then and Now: a Historical and Scientific Perspective. *PMR, 7*(7), 746-761. https://doi.org/10.1016/j.pmrj.2015.01.024

Musculoskeletal Key. *Fastest Musculoskeletal Insight Engine*. Electronic resource: https://musculoskeletalkey.com/myofascial-trigger-points-and-other-reflex-phenomena/

Ricci, V., Mezian, K., Ke-Vin Chang, K-V., Tarantino, D., Güvener, O., Gervasoni, F., Naňka, O., & Özçakar L. (2023). Ultrasound Imaging and Guidance for Cervical Myofascial Pain: A Narrative Review. *Int. J. Environ. Res. Public Health, 20*(5), 3838. https://doi.org/10.3390/ijerph20053838

Kisilewicz, A., Janusiak, M., Szafraniec, R., Smoter, M., Ciszek, B., Madeleine, P., Fernández-de-Las-Peñas, C., & Kawczyński, A. (2018). Changes in Muscle Stiffness of the Trapezius Muscle after Application of Ischemic Compression into Myofascial Trigger Points in Professional Basketball Players. *Journal of Human Kinetics, 64*(1), 35-45. https://doi.org/10.2478/hukin-2018-0043

Das, R., & Jhajharia, B. (2022). Correlation Between Latent Myofascial Trigger Point and Peak Torque Production of

Lower Limb Muscles on Sports Person. *Journal of Physical Education and Sport, 22*(9), 2224-2230. https://doi.org/10.7752/jpes.2022.09283

Das, R., Jhajharia, B., Ciocan, V.C., Sharma, A., & Majumdar, I. (2022). Myofascial Trigger Points and its Influence on Athletic Performance – a Review. *NeuroQuantology, 20*(19), 467-483. https://doi.org/10.48047/nq.2022.20.19.NQ99043

Cao, Q.-W., Peng, B.-G., Wang, L., Huang, Y.-Q., Jia, D.-L., Jiang, H., Lv, Y., Liu, X.-G., Liu, R.-G., Li, Y., Song, T., Shen, W., Yu, L.-Z., Zheng, Y.-J., Liu, Y.-Q., & Huang, D. (2021). Expert Consensus on the Diagnosis and Treatment of Myofascial Pain Syndrome. *World Journal of Clinical Cases, 9*(9), 2077-2089. https://doi.org/10.12998/wjcc.v9.i9.2077

Sofyan, D., Saputra, Y.M., Nurihsan, J., Kusmaedi, N., & Abdullah, K.H. (2022). Stance of Sports and Fitness: A Scientometric Review. *Physical Education Theory and Methodology, 22*(4), 596-607. https://doi.org/10.17309/tmfv.2022.4.20

Manzi V.D., V., Iellamo, F., Alashram, A.R., & Annino, G. (2020). Effects of Three Different Stretching Protocols on Hamstring Muscle Flexibility in Professional Soccer Players: a Randomized Study. *Journal of Sports Medicine and Physical Fitness, 60*(7), 999-1004. https://doi.org/10.23736/S0022-4707.20.10562-0

Doroshenko, E. (2015). Application of Stretching Techniques in Physical Rehabilitation of Football Players with Traumas of Upper and Lower Limbs. *Pedagogics, psychology, medical-biological problems of physical training and sports, 19*(7), 11-16. https://doi.org/10.15561/18189172.2015.0702

Doroshenko, E., Malakhova, S., Chernenko, O., Hurieieva, A., Shapovalova, I., Sazanova, I., Oliinyk, M., & Svitlychna, T. (2019). Therapeutic Exercises in the Process of Physical Rehabilitation of Athletes with Traumatic Injuries of the Musculoskeletal System (Based on Futsal). *Current Issues in Pharmacy and Medicine: Science and Practice,* 3, 357-364. https://doi.org/10.14739/2409-2932.2019.3.184252

Kostiukevich, V., Stasiuk, V., Shchepotina, N., & Dyachenko, A. (2017). Programming of Skilled Football Players Training Process in the Second Cycle of Specially Created Training During the Year. *Physical Education of Students, 21*(6), 262-269. https://doi.org/10.15561/20755279.2017.0602

Lisenchuk, G., Leleka, V., Kokareva, S., Rodionenko, M., & Boychenko, S. (2022). Innovative Fitness Methods to Improve the Functional Capacities of Highly Skilled Footballers. *Theory and Methods of Physical Education and Sports,* 2, 21-28. https://doi.org/10.32652/tmfvs.2022.2.21-28

Hammami, A., Zois, J., Slimani, M., Russell, M., & Bouhlel, E. (2016). The Efficacy and Characteristics of Warm-Up and Re-Warm-Up Practices in Soccer Players: a Systematic Review. *Journal of Sports Medicine and Physical Fitness, 58*(1), 10. https://doi.org/10.23736/S0022-4707.16.06806-7

Taberner, M., & Cohen, D. (2018). Physical Preparation of the Football Player with an Intramuscular Hamstring Tendon Tear: Clinical Perspective with Video Demonstrations. *British Journal of Sports Medicine, 52*(19), 1275-1278. https://doi.org/10.1136/bjsports-2017-098817

Kadir, G., & Osman, K.A. (2021). The Effect of High Intensity Interval Training During Eight Weeks on Speed, Agility and Acceleration in U19 Soccer Players. *Pakistan Journal of Medical and Health Sciences, 15*(8), 2390-2395. https://doi.org/10.53350/pjmhs211582390

Mohammadtaghi, A.K., Calleja, G.J., & Mansooreh, M.M. (2016). Acute Effect of Different Combined Stretching Methods on Acceleration and Speed in Soccer Players. *Journal of Human Kinetics, 50*(1), 179-186. https://doi.org/10.1515/hukin-2015-0154

Evangelos, B., Georgios, K., Papadopoulou, Z., & Gissis, I. (2017). The Effect of a Strength and Speed Training Program in Speed Improvement of Female Soccer Players. *Global Journal for Research Analysis, 6*(2), 672-674.https://www.researchgate.net/publication/313730290_The_effect_of_a_strength_and_speed_training_program_in_speed_improvement_of_female_soccer_players#fullTextFileContent

Gomez-Piqueras, P., Gonzalez-Rubio, J., Sainz de Baranda, P., & Najera, A. (2018). Use of Functional Performance Tests in Sports: Evaluation Proposal for Football Players in the Rehabilitation Phase. *Turkish Journal of Physical Medicine and Rehabilitation, 64(*2), 148-154. https://doi.org/10.5606/tftrd.2018.1462

Kostiukevych V., Lazarenko N., Shchepotina N., Kulchytska I., Svirshchuk N., Vozniuk T., Kolomiets A., Konnova M., Asauliuk I., Bekas O., Romanenko V., & Hudyma S. (2019). Management of Athletic Form in Athletes Practicing Game Sports over the Course of Training Macrocycle. *Journal of Physical Education and Sport, 19*(1), 28-34. https://doi.org/10.7752/jpes.2019.s1005

Mitova, O. (2020). Formation of a Test System for Controlling the Preparedness of Players in Team Sports Games. *Sport Science and Human Health, 4*(2), 88-101. https://doi.org/10.28925/2664-2069.2020.2.8

Komotska, O., & Sushko, R. (2022). Modern Approaches for the Physical Training of Young Female Basketball Players. *Physical Education Theory and Methodology, 22*(2), 260-267. https://doi.org/10.17309/tmfv.2022.2.17

Kokareva, S., Kokarev, B., & Doroshenko, E. (2018). Analysis of the State of Highly Skilled Football Players' Musculoskeletal System at the Beginning of the 2nd Preparatory Period of the Annual Macrocycle. *Physical Education, Sports and Health Culture in Modern Society,* 4, 64-68. https://doi.org/10.29038/2220-7481-2018-04-05-64-68

Selmi, O., Ouerghi, N., Ben Khalifa, W., Amara, F., & Bouassida A. (2018). The Influence of Total Quality Recovery in Perceived Enjoyment During Football Specific Training. *Iran Journal of Public Health, 47*(8), 1211-1212. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6123594/

Lisenchuk, G., Zhigadlo, G., Tyshchenko, V., Odynets, T., Omelianenko, H., Pyptiuk, P., Bessarabova, O., Galchenko, L., & Dyadechko, I. (2019). Assess Psychomotor, Sensory-Perceptual Functions in Team-Sport Games. *Journal of Physical Education and Sport, 19*(2), 1205-1212. https://doi.org/10.7752/jpes.2019.02175

Dalla Rosa Nogales, J., & Nogales Zafra, J. (2019). Bilateral Simultaneous Tibial Tubercle Avulsion in an Adolescent Football Player with Previous Bilateral Osgood-Schlatter Disease. *Case Reports in Orthopedics,* 1-4. https://doi.org/10.1155/2019/8535370

Morris, T., McCracken, C., Baggish, A., Weisskopf, M., Zafonte, R., Taylor, H., Nadler, L.M., Frank E Speizer

F.E., & Pascual-Leone A. (2019). Multisystem Afflictions in Former National Football League Players. *American Journal of Industrial Medicine,* 62, 655-662. https://doi.org/10.1002/ajim.22992

Ramirez-Campillo, R., Alvarez, C., Sanchez-Sanchez, J., Slimani, M., Gentil, P., Chelly, M., & Shephard, R. (2019). Effects of Plyometric Jump Training on the Physical Fitness of Young Male Soccer Players: Modulation of Response by Inter-Set Recovery Interval and Maturation Status. J*ournal of Sports Sciences, 37*(23), 2645-2652. https://doi.org/10.1080/02640414.2019.1626049

«*FIFA 11+ Program»: Soccer Injury Prevention*. Electronic resource: https://www.physioinq.com.au/blog/fifa-11-program-soccer-injury-prevention

Sadigursky, D., Braid, J.A., Lira, D., Machado, B.A.B., Carneiro, R.J.F., & Colavolpe P.O. (2017). The FIFA 11+ Injury Prevention Program for Soccer Players: a Systematic Review. *BMC Sports Sci Med Rehabil.,* 9, 18. https://doi.org/10.1186/s13102-017-0083-z

Patti, A., Giustino, V., Cataldi, S., Stoppa, V., Ferrando, F., Marvulli, R., Farì, G., Bianco, A., & Muscella, A. (2022). Effects of 5-Week of FIFA 11+ Warm-up Program on Explosive Strength, Speed, and Perception of Physical Exertion in Elite Female Futsal Athletes. *Sports,* 10, 100. https://doi.org/10.3390/sports10070100

Vlachas, T., & Paraskevopoulos, E. (2022). The Effect of the FIFA 11+ on Injury Prevention and Performance in Football: a Systematic Review with Meta-Analysis. *BioMed,* 2, 328-340. https://doi.org/10.3390/biomed2030026

Longo U.G., Loppini M., Berton A., Marinozzi A., Maffulli N., Denaro V. (2012). The FIFA 11+ Program is Effective in Preventing Injuries in Elite Male Basketball Players: a Cluster Randomized Controlled Trial. *Am J Sports Med., 40*(5), 996-1005. https://doi.org/10.1177/0363546512438761

Declaration of Helsinki of the World Medical Association «Ethical principles of medical research with the participation of a person as an object of research»: Electronic resource: https://ips.ligazakon.net/document/MU64021

МІОФАСЦІАЛЬНИЙ РЕЛІЗ ЯК ЗАСІБ ПРОФІЛАКТИКИ ТРАВМАТИЗМУ І ВІДНОВЛЕННЯ АМПЛІТУДИ РУХІВ У КВАЛІФІКОВАНИХ ФУТБОЛІСТІВ

Едуард Дорошенко[1ABCD], Світлана Кокарева[2BCE], Борис Кокарев[3BCE], Руслана Сушко[4ABE], Олексій Ніканоров[5ABE], Людмила Сущенко[6ACE]

[1]Запорізький державний медико-фармацевтичний університет
[2]Національний університет «Запорізька політехніка»
[3]Запорізький національний університет
[4]Київський університет імені Бориса Грінченка
[5]Національний університет фізичного виховання і спорту України
[6]Український державний університет імені Михайла Драгоманова

Авторський вклад: A – дизайн дослідження; B – збір даних; C – статаналіз; D – підготовка рукопису; E – збір коштів

Реферат. Стаття: 9 с., 2 табл., 1 рис., 27 джерел.

Мета дослідження – визначити ефективність застосування засобів MFR, які використовуються у тренувальному процесі кваліфікованих футболістів.

Матеріали і методи. Контингент: 28 фахівців з футболу футбольних команд української Прем'єр-Ліги; 36 футболістів ФК «Зоря» (Луганськ). Методи: аналіз, узагальнення та систематизація даних науково-методичної літератури і глобальної інформаційної мережі «Internet»; анкетне опитування; педагогічні спостереження; педагогічне тестування показників гнучкості, педагогічний експеримент, методи математичної статистики.

Результати. Результатом застосування мануальних технік MFR у тренувальному процесі кваліфікованих футболістів є: розслаблення хронічно напружених м'язів; відновлення рухливості та нормальної амплітуди руху у суглобах; поліпшення еластичних властивостей м'язово-зв'язкових структур опорно-рухового апарату футболістів; оптимізація гемодинаміки і лімфодинаміки на мікроциркуляторному рівні; оптимізація загальних і локальних метаболічних процесів в організмі; відновлення функцій опорно-рухового апарату футболістів після надмірних фізичних навантажень і травм; поліпшення пропріорецепції та нейром'язового контролю; оптимізація психоемоційного стану.

Висновки. Аналіз результатів тестування гнучкості футболістів ФК «Зоря» (Луганськ) наприкінці першого та другого підготовчих періодів спортивного сезону 2019-2020 рр. дозволяє констатувати наявність більш високих показників у порівнянні з результатами попереднього тестування у спортивному сезоні 2018-2019 рр. За результатами моніторингу фахівцями комплексної наукової групи ФК «Зоря» (Луганськ), зафіксовано зменшення показників спортивного травматизму, які пов'язані з пошкодженнями м'язово-зв'язкових структур нижніх кінцівок і тулубу футболістів – на 11,11%.

Ключові слова: засоби MFR, профілактика, травматизм, амплітуда рухів, футбол.

Information about the authors:

Doroshenko, Eduard: doroe@ukr.net; https://orcid.org/0000-0001-7624-531X; Department of Physical Rehabilitation, Sports Medicine, Physical Education and Health, Zaporizhzhia State Medical and Pharmaceutical University, Mayakovsky St, 26, Zaporizhzhia, 69035, Ukraine.

Kokareva, Svitlana: kokarevas@gmail.com; https://orcid.org/0000-0002-3435-4929; Department of Physical Culture, Olympic and non-Olympic sports, National University "Zaporizhzhia Polytechnic", Zhukovsky St, 64, Zaporizhzhya, 69063, Ukraine.

Kokarev, Borys: kokarevb@gmail.com; https://orcid.org/0000-0002-2335-6611; Department of Physical Culture and Sports, Zaporizhzhia National University, Zhukovsky St, 66, Zaporizhzhia, 69600, Ukraine.

Sushko, Ruslana: r.sushko@kubg.edu.ua; https://orcid.org/0000-0003-3256-4444; The Faculty of Health, Physical Training and Sports, Borys Grinchenko Kyiv University, Levka Lukyanenko St, 13-B, Kyiv, 04053, Ukraine.

Nikanorov, Oleksiy: nikanorov@ukr.net; https://orcid.org/0000-0002-5326-0979; Department of Physical Therapy, Occupational Therapy, National University of Ukraine of Physical Education and Sports, Fizkultury St, 1, Kyiv, 03150, Ukraine.

Sushchenko, Lyudmyla: kafedrafitnesy.ffvs@udu.edu.ua; https://orcid.org/0000-0002-2461-3739; Department of Fitness and Physical Culture and Sports Rehabilitation, Dragomanov Ukrainian State University, Pyrohova St, 9, Kyiv, 01601, Ukraine.

Cite this article as: Doroshenko, E., Kokareva, S., Kokarev, B., Sushko, R., Nikanorov, O., & Sushchenko, L. (2023). Myofascial Release as a Means of Injury Prevention and Movement Amplitude Recovery in Qualified Football Players. *Physical Education Theory and Methodology, 23*(2), 299-309. https://doi.org/10.17309/tmfv.2023.2.20

Received: 15.03.2023. Accepted: 20.04.2023. Published: 28.04.2023

ІНСТРУКЦІЇ ДЛЯ РЕЦЕНЗЕНТІВ

Цей журнал є рецензованим. Оригінальні наукові статті, повідомлення та огляди надсилаються для розгляду одному з рецензентів. Рецензування відбувається за подвійною сліпою схемою. Статті, які мають позитивні оцінки приймаються до публікації. Редакція журналу залишає за собою право внести зміни до тексту, щоб відповідати стандартам стилю журналу та мови.

Головний редактор журналу визначає відповідність статті профілю журналу, вимогам до оформлення і направляє її на рецензування фахівцю, що має найбільш близьку до теми статті наукову спеціалізацію. Рецензування проходить за подвійною сліпою схемою.

У кожній статті у процесі рецензування завжди розглядаються:

- етичні аспекти;
- оригінальність твору;
- важливість інформації;
- чіткість та зрозумілість тексту;
- доцільність використання методів дослідження;
- інтерпретація результатів;
- обґрунтованість висновків.

Типовий період, необхідний для проведення рецензування складає 4 тижні.

Етичні принципи у діяльності рецензента

Рецензент здійснює неупереджене фахове рецензування поданої до розгляду статті на основі таких принципів:

- рецензент повинен поважати інтелектуальну власність авторів, і розглядати рукопис статті, що надійшов на рецензування, як конфіденційний, який не можна передавати для ознайомлення або обговорення третім особам, які не мають на це повноважень від редакції;
- рецензент зобов'язаний давати об'єктивну оцінку викладеним результатам дослідження, персональна критика автора неприпустима;
- у разі конфлікту інтересів з автором, слід повідомити про це редактора з проханням виключити його з процесу рецензування даної статті.

Політика щодо плагіату

Редакція журналу вважає неприйнятним наявність плагіату в статтях (оприлюднення у письмовій або електронній формі наукових результатів, отриманих та оприлюднених іншими особами, як результатів власного дослідження та/або відтворення опублікованих текстів інших авторів без відповідного посилання).

У статтях не допускається:

- копіювання та оприлюднення виконаної іншим автором роботи як своєї;
- дослівне копіювання фрагментів тексту (від фрази до набору речень) без належного оформлення цитування;
- внесення незначних правок у скопійований матеріал (переформулювання речень, зміна порядку слів в них тощо) та без належного оформлення цитування;
- переказ своїми словами чужих думок, ідей або тексту без належного оформлення посилання на джерело.

Обов'язковим є посилання на власні, раніше опубліковані роботи.

Редакція відхиляє поданий рукопис, якщо він містить запозичення з інших публікацій без належного цитування, та може скасувати публікацію за скаргою в плагіаті.

Як підготувати рецензію?

Попередній огляд

Перш ніж прийняти або відхилити запрошення на рецензування, розгляньте такі питання:

- Чи відповідає стаття вашій спеціалізації? Приймайте запрошення, якщо ви впевнені, що можете надати якісний огляд.
- Чи є у вас конфлікт інтересів? Дайте відповідь на це питання.
- Чи є у вас час? Рецензування може вимагати багато часу – перш ніж приймати запрошення, переконайтеся, що ви можете виконати роботу до вказаного строку.

Дайте відповідь на запрошення, як тільки ви зможете. Затримка відповіді сповільнює процес розгляду матеріалу. Якщо ви відхилите запрошення, за можливості, надайте пропозиції альтернативних рецензентів.

Якщо ви приймаєте запрошення, то ви повинні розглядати матеріали як конфіденційні документи. Це означає, що ви не можете поділитися ними з ким-небудь без попереднього дозволу редактора. Оскільки експертний огляд є конфіденційним, ви також не повинні передавати інформацію про рецензію будь-кому без дозволу редакторів та авторів.

По-перше, прочитайте статтю, а потім зробіть перерву. Розгляньте статтю з власної точки зору. Переконайтеся, що ви знаєте критерії оцінки статті, запропоновані журналом.

Огляд

Ваша рецензія допоможе редакторові вирішити, чи слід публікувати статтю. Важливою є ваша загальна думка та висновки про статтю. Ваші коментарі повинні бути доброзичливими та конструктивними, а також

не містити жодних особистих зауважень чи особистих даних, включаючи ваше ім'я.

Важливо надати інформацію про будь-які наявні недоліки. Ви повинні пояснити ваше судження, щоб як редактори, так і автори, могли повною мірою зрозуміти ваші коментарі.

Контрольний список

Оцініть такі аспекти статті: (якщо відповідь «Ні», будь ласка, за можливості, запропонуйте покращення в полі «Інформація для авторів»)

- Чи заголовок точно відображає зміст тексту?
- Чи чітко зазначено мету?
- Чи суттєвий внесок у розробку зазначеної проблеми робиться цією статтею?
- Чи розкриває стаття мету дослідження?
- Чи логічно викладений матеріал статті?
- Чи висвітлена в анотації суть статті, анотація є інформативною та лаконічною?
- Чи висновки автора адекватні експериментальному матеріалу?

Надайте конкретні коментарі та пропозиції, зокрема, щодо оформлення, назви, опису, вступу, гіпотези та/або предмету дослідження, матеріалів і методів, статистичної обробки матеріалів, результатів, обговорення, висновків, мови та посилань.

Якщо ви вбачаєте прояви академічної недоброчесної, обговоріть свої підозри з редактором, надайте якомога докладнішу інформацію.

Ваша рекомендація

Коли ви даєте рекомендацію, то обираєте одну з категорій, які використовуються для класифікації статті:

- прийняти подання;
- необхідні виправлення;
- необхідне додаткове рецензування;
- до іншого видання;
- відхилити подання.

Остаточне рішення

Головний редактор вирішує, чи прийняти чи відхилити статтю. Редактор, перш ніж прийняти рішення, зважить всі погляди та може зажадати третю думку або попросити автора переглянути документ. Видавнича система надає користувачам повідомлення про остаточне рішення.

Редакція журналу
«Теорія та методика фізичного виховання»

ISSN 1993-7989 (print)
ISSN 1993-7997 (online)
ISSN-L 1993-7989

Теорія та методика фізичного виховання
Physical Education Theory and Methodology
Teorìâ ta Metodika Fìzičnogo Vihovannâ
Abbreviated key-title: Teor. metod. fiz. vihov.

Науково-методичний журнал
Scientific-methodological journal

Квітень 2023. Том 23, № 2
April 2023. Vol. 23, Num. 2
https://doi.org/10.17309/tmfv.2023.2

Відповідальний за випуск О. М. Худолій
Комп'ютерна верстка М. О. Худолій
Коректор Є. Б. Бланк

Свідоцтво про державну реєстрацію серія КВ № 6255 від 21.06.2002 р. Засновник і видавець – ТОВ «ОВС».
Передплатний індекс **74667.** Адреса редакції: https://www.tmfv.com.ua.Тел.: (067) 578-40-08. E-mail: tmfv@tmfv.com.ua

Наказом МОН України від 26.11.2020 № 1471 журнал включено в категорію «А» фахових видань України.
Науки: фізичне виховання і спорт. Спеціальність: 017 – Фізична культура і спорт (26.11.2020).
Науки: педагогічні (26.11.2020). Спеціальності: 011 – Освітні, педагогічні науки (26.11.2020);
014 – Середня освіта (за предметними спеціальностями) (26.11.2020).

Підписано до друку 27.04.2023. Формат 60×84 1/8. Папір офсетний. Гарнітура Таймс. Друк офсетний.
Ум. друк. арк. 17,85. Обл.-вид. арк.18,5. Вид. № 01-2023. Зам. № 156. Тираж 300 прим. Ціна договірна.

ТОВ «ОВС» Україна, 61003 Харків, пл. Конституції, 18, к. 11.
Свідоцтво Держкомінформу України Серія ДК № 331 від 08.02.2001 р.
Друкарня ТзОВ «Цифра прінт». 61166, м. Харків, вул. Культури, 20-В