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Assessment of Motor Fitness Metrics among Athletes in Different Sports: An Original Research

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Abstract

Background. Motor fitness is one of the keys to athletes' success and is the initial factor mixed with game-specific technique and tactics that has an impact on game performance. All athletes should incorporate these elements into their sport and game actions.

Study purpose. The aim of this study was to evaluate differences in motor fitness metrics among university-level male athletes participating in various sports.

Materials and methods. Sixty (60) male athletes, ranging in age from 18 to 25 years, were selected from six different sports: Athletics, Basketball, Cricket, Football, Handball, and Volleyball. Each group consisted of 10 athletes who had competed at the inter-university level. The research focused on six key fitness metrics: agility, speed, power, arm strength, abdominal muscle strength, and cardiovascular endurance. Appropriate testing methods and instruments were used to measure these parameters. Statistical analysis, including one-way ANOVA and post hoc LSD tests, was performed to identify significant differences between the groups. A significance level of 0.05 was set for the study.

Results. The results showed statistically significant differences among the groups in agility ($F_{(5,54)} = 4.776$, $p<0.001$), speed ($F_{(5,54)} = 5.602$, $p<0.000$), and cardiovascular endurance ($F_{(5,54)} = 3.578$, $p<0.007$). However, no significant differences were observed for power ($F_{(5,54)} = 2.079$, $p>0.082$), arm strength ($F_{(5,54)} = 1.368$, $p>0.251$), and abdominal muscle strength ($F_{(5,54)} = 1.947$, $p>0.102$). According to the post hoc (LSD) test findings, each group's agility, speed, and cardiovascular endurance parameters were compared to each other to check the significance level.

Conclusions. In summary, the study has revealed that agility, speed, and cardiovascular endurance were significantly different among athletes in various sports, whereas power, arm strength, and abdominal muscle strength were not. The findings suggest that athletes and coaches should prioritize sport-specific fitness components to improve game performance.

Keywords: athletes, motor fitness, team sports, performance.

Introduction

Motor fitness has multiple benefits for physical, mental, and psychosocial health and is a crucial aspect of assessing an individual's physical capability, particularly in athletes, which includes various components of agility, balance, coordination, strength, reaction time, and speed (Kohl & Cook, 2013; Kumar & Kumar, 2011). Motor fitness evaluations play an important role in assessing adult health, as they are closely linked to cardiovascular issues, susceptibility to falls, cognitive decline, mobility challenges, difficulties in daily tasks, and overall mortality risk (Castro-Piñero et al., 2023). It has been recognized that maintaining motor fitness is essential to counteract the age-associated decline in physical capabilities, ensuring a good quality of life for the elderly (Rikli & Jones, 1999). For athletes, in particular, the

level and type of physical fitness required can vary greatly depending on the specific demands of their sport. Different sports have distinct physical demands, and as such, optimal fitness criteria can differ significantly from one sport to another. Team sports, such as handball, football, volleyball, and basketball, contribute to increasing various fitness aspects like speed and strength (Pandey & Sardar, 2015). In basketball, agility and jump metrics assess players' physical skills (Hoffman et al., 1996). Similarly, soccer uses the Yo-Yo intermittent recovery test to assess aerobic capacity during intense exercise (Krustrup et al., 2003). Research indicates that genetics, training, and motor fitness are interconnected in athletes (Bouchard & Malina, 1983). A player's physical fitness level is influenced by the characteristics of the game and external traits. These traits, influenced by genetics, nutrition, and training level, significantly affect an athlete's performance (Begum, 2019). Strength training is particularly effective in increasing physical performance (Stølen et al., 2005; Ziv & Lidor, 2010), and muscle strength requires regular flexibility training (Rahman & Islam, 2020).

Sports not only benefit the players but also affect society and nation-building, as physical fitness is important for individual health, development, and the security of a country (Kumar, 2021; Kumar & Kumar, 2011). As sports have become more commercial, athletes are placing greater emphasis on their physical condition and performance (Babu, 2013). Different sports require specific sets of physical abilities. For all ball game players, having maximal isometric strength, including explosive strength and power, is essential to achieving ball-game skills (Rahman & Sharma, 2023). For example, while basketball, soccer, and tennis athletes prioritize motor fitness components, particularly speed, agility, endurance, and changing directions quickly on the field as the game demands (Sheppard & Young, 2006; Kumar & Singh, 2018; Islam, 2018). Volleyball demands strength and coordination for serving and spiking (Suharjana et al., 2020), while basketball necessitates a blend of speed, endurance, and agility (Metgud et al., 2019; Tiwari et al., 2012). Even in cricket, various components of physical fitness, such as muscle strength and agility, are crucial (Ghosalkar et al., 2020). In ball games, especially soccer and handball, players must have quick reflexes, as it is unusual to switch offensive and defensive positions (Bansod, 2018; Islam & Kundu, 2020). Endurance is a key component common to almost all sports, especially football and basketball, that require sustained physical activity (Singh & Thapa, 2015). Different sports prioritize different aspects of conditioning programme, but it remains a fundamental factor for improved athletic performance (Lee et al., 2020). Sports that require rapid directional changes, such as American football and basketball, place a high emphasis on agility (Zemková & Hamar, 2014). Moreover, optimum motor fitness in youth can foster lifelong physical activity habits, reducing the risks associated with sedentary lifestyles (Lubans et al., 2010). Individuals with high motor fitness levels also show better cognitive functioning, power of mental imagination, and overall quality of life (Best, 2010; Rahman & Islam, 2021). In essence, motor fitness is fundamental for athletes, highlighting its multifaceted nature, including strength, speed, agility, endurance, and coordination (Clark et al., 2010).

Athletic performance is greatly influenced by game specific fitness, which are key elements to success in any sport. All athletes need essential motor fitness components for their respective activities. Although fitness varies from sport to sport, basic motor fitness is the same for every player. However, university-level players have access to similar practices, so their basic fitness is roughly the same. The aim of this study was to evaluate the motor fitness components of different team athletes participating in university-level sports.

Materials and methods

Participants

Sixty (N=60) male athletes from Jashore University of Science and Technology, located in Jashore district, Bangladesh, were randomly selected for the study. Each group consisted of ten (n=10) players aged 18 to 25, representing six different sports: athletics, basketball, cricket, football, handball and volleyball. All were competitors in Inter-University games.

Variables and Criterion Measures

Six (6) essential fitness indicators were the focus of the study: cardiovascular endurance, abdominal muscle strength, arm strength, speed, agility and power. These parameters were measured with proper equipment and testing techniques.

Test Procedure

The shuttle run test is used extensively and appears to be a useful field test for evaluating high intense capacity of

Table 2. Variables and criterion measures

Variables	Test items	Unit of measure
Agility	4 × 10 m SR	Second (s)
Speed	50 m sprint	Second (s)
Power	SBJ	Meter (m)
Arm strength	PU	Number (n)
Abdominal muscle strength	60s. SU	Number (n)
Cardiovascular endurance	Cooper/12 minutes run	Meter (m)

SR= Shuttle Run, SBJ= Standing Broad Jump, PU= Pull-up, SU= Sit-up

Table 1. Characteristics of the subjects

Variables	Athletics	Basketball	Cricket	Football	Handball	Volleyball
Age (years)	20.40±1.43	21.70±1.34	21.30±1.16	21.20±1.62	21.00±1.15	21.40±1.26
Height (cm)	68.80±2.10	76.30±5.44	70.70±2.31	72.90±3.48	66.60±4.45	74.90±3.28
Weight (kg)	174.00±4.94	181.30±5.52	175.00±3.16	177.20±2.39	172.10±4.48	180.20±2.53
BMI (kg/m^2)	22.80±1.69	23.18±0.87	23.11±0.96	23.21±0.72	22.58±1.02	23.02±0.79

the sports person. The course consists of two lines 10 meters apart and two cones placed on opposite sides of the starting line. Each subject ran a marked area 4x10 m long at a set increasing speed (Verschuren & Takken, 2010). Participants were tested for speed using a 50-meter sprint, where they were asked to run as fast as possible in a straight line. The test was conducted twice, timed to the nearest 0.1 seconds, with the best time noted (Shang et al., 2010). The standing broad jump (SBJ) is a reliable test used to assess lower limb strength and power. Participants stand with their heels on a line, then jump horizontally as far as they can without specific instructions on leg or arm movements. After landing with both feet together, the jump's distance is measured from the start line to the heel nearest the start (Thomas et al., 2020). For the PUT, participants began by holding their arms fully extended and their shoulders completely flexed for a duration of 2 seconds. To count as a valid rep, the upper part of the jawbone had to go above the level of the bar. After that, participants needed to return to the starting position to finish the rep. Techniques like swinging, kipping, or continuous bouncing from the lowest point were not permitted (Coyne et al., 2015). The SUT assesses the stamina of the abdominal muscles, requiring the participant to complete the maximum number of sit-ups in a minute. The participant starts by lying flat on their back with their knees bent at a 90-degree angle. Their hands should be positioned behind their heads, with their elbows extended directly out in front. A proper sit-up is counted when the elbows meet the knees and then return to a position where the shoulders are in contact with the floor (Blomqvist et al., 2013). The Cooper 12-minute run test serves as a quantitative assessment of an individual's aerobic capacity and cardiovascular fitness. By setting markers at specific points around a track, the distance covered in a 12-minute period can be measured. Participants are required to walk or run during this period, and the cumulative distance they traverse is noted down (Cooper, 1968).

Table 3. Descriptive statistics on fitness components

Parameters	Groups	N	Mean	Std. Deviation	Std. Error	Minimum Value	Maximum Value
Agility	Athletics	10	9.46	0.29	0.09	9.10	9.90
	Basketball	10	9.70	0.58	0.18	8.60	10.70
	Cricket	10	10.20	0.32	0.10	9.50	10.51
	Football	10	9.57	0.48	0.15	9.05	10.50
	Handball	10	9.95	0.46	0.14	9.30	10.80
	Volleyball	10	10.09	0.38	0.12	9.35	10.65
Speed	Athletics	10	6.48	0.51	0.16	5.43	7.08
	Basketball	10	6.95	0.30	0.10	6.59	7.62
	Cricket	10	7.30	0.29	0.09	6.88	7.91
	Football	10	6.73	0.25	0.08	6.46	7.27
	Handball	10	6.90	0.50	0.16	6.14	7.75
	Volleyball	10	7.16	0.44	0.14	6.52	8.00
Power	Athletics	10	2.39	0.22	0.07	2.00	2.80
	Basketball	10	2.46	0.12	0.04	2.25	2.65
	Cricket	10	2.31	0.17	0.05	1.91	2.52
	Football	10	2.51	0.14	0.04	2.25	2.70
	Handball	10	2.39	0.13	0.04	2.20	2.60
	Volleyball	10	2.47	0.15	0.05	2.24	2.73
Arm Strength	Athletics	10	11.50	5.56	1.76	2.00	20.00
	Basketball	10	9.40	2.76	0.87	3.00	13.00
	Cricket	10	8.40	1.65	0.52	7.00	12.00
	Football	10	10.60	2.84	0.90	7.00	14.00
	Handball	10	9.60	1.71	0.54	8.00	13.00
	Volleyball	10	8.60	3.10	0.98	3.00	14.00
Abdominal Strength	Athletics	10	42.10	8.44	2.67	28.00	53.00
	Basketball	10	43.60	9.31	2.94	30.00	60.00
	Cricket	10	37.60	8.09	2.56	26.00	51.00
	Football	10	41.40	6.72	2.12	34.00	52.00
	Handball	10	44.50	7.92	2.50	36.00	60.00
	Volleyball	10	35.30	7.97	2.52	22.00	46.00
Cardiovascular Endurance	Athletics	10	2721.00	274.37	86.76	2140.00	3220.00
	Basketball	10	2605.50	240.26	75.98	2190.00	3000.00
	Cricket	10	2294.00	355.75	112.50	1820.00	2850.00
	Football	10	2715.50	99.01	31.31	2600.00	2920.00
	Handball	10	2504.20	236.69	74.85	2025.00	2790.00
	Volleyball	10	2474.00	347.79	109.98	1900.00	3200.00

Table 4. Fitness testing of various disciplines was carried out using the ANOVA

Parameters	Groups	Sum of Squares	df	Mean Square	F-Value	Sig. Level
Agility	Between Groups	4.40	5	0.88	4.776*	.001
	Within Groups	9.95	54	0.18		
Speed	Between Groups	4.39	5	0.88	5.602*	.000
	Within Groups	8.46	54	0.16		
Power	Between Groups	0.27	5	0.05	2.079	.082
	Within Groups	1.39	54	0.03		
Arm Strength	Between Groups	70.48	5	14.10	1.368	.251
	Within Groups	556.50	54	10.31		
Abdominal Strength	Between Groups	640.55	5	128.11	1.947	.102
	Within Groups	3552.70	54	65.79		
Cardiovascular Endurance	Between Groups	1330875.33	5	266175.07	3.578*	.007
	Within Groups	4017112.60	54	74390.97		

*. Significant at 0.05 level

Statistical analysis

The data was analyzed using IBM's SPSS software (version 21 for Windows) to compare different motor fitness metrics. For each group, we calculated the mean, standard deviation, standard error of the mean, as well as the minimum and maximum values. We employed a one-way ANOVA followed by a post hoc LSD test to examine significant differences in the data. A significance level of 0.05 was used for the analyses. To check for data normality, the Shapiro-Wilk test was conducted, confirming that the data followed a normal distribution.

Results

Table 4 shows that there was a significant difference for the parameter namely agility, $F_{(5,54)}$ =4.776, p<0.001; speed, $F_{(5,54)}$=5.602, p<0.000; and cardiovascular endurance, $F_{(5,54)}$=3.578, p<0.007. There was a non-significant difference between the groups for the variable namely power, $F_{(5,54)}$=2.079, p>0.082; arm strength, $F_{(5,54)}$=1.368, p>0.251; and abdominal strength, $F_{(5,54)}$=1.947, p>0.102.

The LSD Post-hoc Test (Table 5) was computed, and in the agility domain, significant differences were found between athletics and cricket (p<0.000), athletics and handball (p<0.014), athletics and volleyball (p<0.002), basketball and cricket (p<0.011), basketball and volleyball (p<0.044), cricket and football (p<0.002), and football and volleyball (p<0.009). In speed, significant differences were found between athletics and basketball (p<0.010), athletics and handball (p<0.020), athletics and volleyball (p<0.000), basketball and cricket (p<0.050), cricket and football (p<0.002), cricket and handball (p<0.028), and football and volleyball (p<0.017). In cardiovascular endurance, significant differences were found between athletics and cricket (p<0.001), athletics and volleyball (p<0.048), basketball and cricket (p<0.014), and cricket and football (p<0.001).

Discussion

In the present study, Table 4 indicates significant differences in agility, speed, and cardiovascular endurance between groups, but no significant differences in power, arm strength, and abdominal strength. Existing studies present a mixed view of differences in fitness ability across sports. For example, handball and basketball players have been found to be similar in terms of speed and agility (Phatangare, 2019).

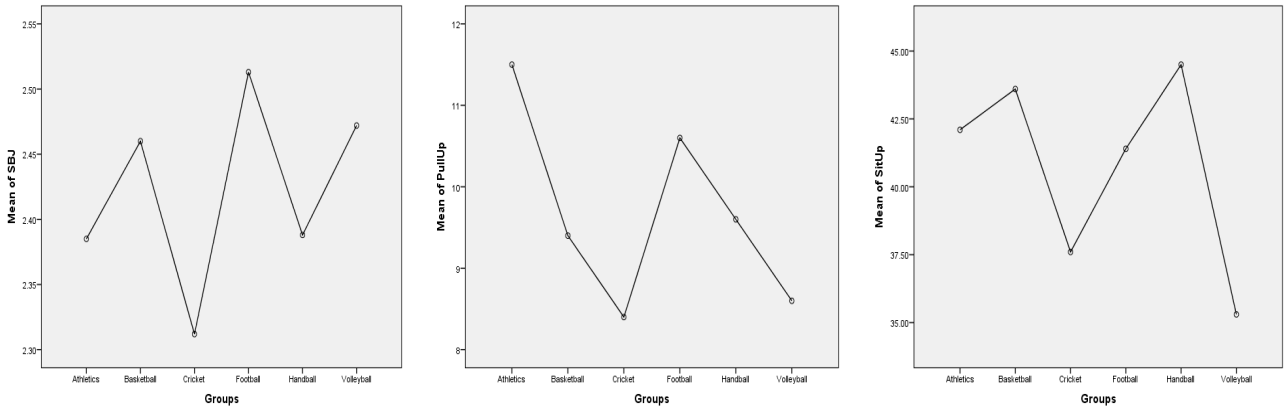

Fig. 1. Mean plots of not significant variables

Table 5. LSD Post-hoc Test

Parameters	Groups	Groups	Mean Difference	Std. Error	Sig. Level
Agility	Athletics	Basketball	0.23	0.19	0.228
		Cricket	0.73700*	0.19	0.000
		Football	0.11	0.19	0.576
		Handball	0.48700*	0.19	0.014
		Volleyball	0.63000*	0.19	0.002
	Basketball	Cricket	0.50300*	0.19	0.011
		Football	0.13	0.19	0.514
		Handball	0.25	0.19	0.193
		Volleyball	0.39600*	0.19	0.044
	Cricket	Football	0.62900*	0.19	0.002
		Handball	0.25	0.19	0.198
		Volleyball	0.11	0.19	0.580
	Football	Handball	0.38	0.19	0.053
		Volleyball	0.52200*	0.19	0.009
	Handball	Volleyball	0.14	0.19	0.460
Speed	Athletics	Basketball	0.47000*	0.18	0.010
		Cricket	0.82500*	0.18	0.000
		Football	0.25	0.18	0.164
		Handball	0.42600*	0.18	0.020
		Volleyball	0.68500*	0.18	0.000
	Basketball	Cricket	0.35500*	0.18	0.050
		Football	0.22	0.18	0.219
		Handball	0.04	0.18	0.805
		Volleyball	0.21	0.18	0.230
	Cricket	Football	0.57500*	0.18	0.002
		Handball	0.39900*	0.18	0.028
		Volleyball	0.14	0.18	0.433
	Football	Handball	0.18	0.18	0.325
		Volleyball	0.43500*	0.18	0.017
	Handball	Volleyball	0.26	0.18	0.149
Cardiovascular Endurance	Athletics	Basketball	115.50	121.98	0.348
		Cricket	427.00000*	121.98	0.001
		Football	5.50	121.98	0.964
		Handball	216.80	121.98	0.081
		Volleyball	247.00000*	121.98	0.048
	Basketball	Cricket	311.50000*	121.98	0.014
		Football	110.00	121.98	0.371
		Handball	101.30	121.98	0.410
		Volleyball	131.50	121.98	0.286
	Cricket	Football	421.50000*	121.98	0.001
		Handball	210.20	121.98	0.091
		Volleyball	180.00	121.98	0.146
	Football	Handball	211.30	121.98	0.089
		Volleyball	241.50	121.98	0.053
	Handball	Volleyball	30.20	121.98	0.805

*. The mean difference is significant at the 0.05 level

Similarly, Shukla et al. (2020) found that collegiate soccer and cricket players did not differ significantly in muscular endurance, speed, or agility, although they did differ significantly in overall physical fitness and variable muscle strength. In a study by Keshav and Harmandeep (2014) pull-ups, sit-ups, a 50-meter dash, and 600-meter run showed no significant differences between the two unspecified groups, although the shuttle run did. Handball and volleyball players differed in speed but not in agility (Akilan & Shah, 2014), thereby contradicting the findings of those who noted significant agility differences between these two groups of athletes (Sharma & Hussain, 2019). In sports as diverse

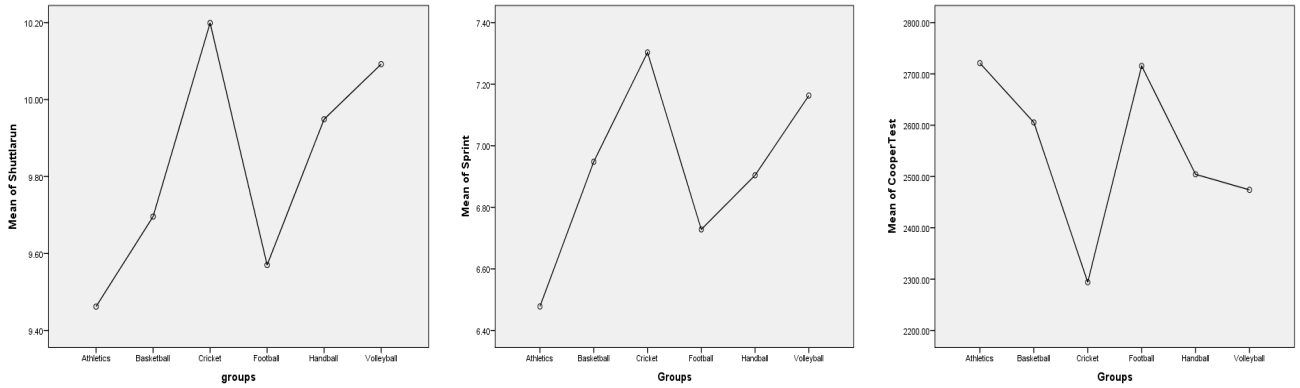

Fig. 2. Mean plot of significant variables

as track and field, basketball, handball, soccer, badminton and kabaddi, athletes outperform their counterparts in cardiovascular endurance. However, all groups showed similar results in arm strength (Reza et al., 2022).

When it comes to speed and agility, Kumar and Singh (2018) reported individual differences between football, handball and volleyball players, but noted that football and cricket players did not differ in these metrics (Mandal et al., 2017). Research found no differences in leg strength between soccer players and middle-distance runners, although there were differences in speed and arm strength (Umesh, & Kumar, 2017). The study observed no significant differences in strength and endurance between basketball and football players (Singh & Thapa, 2015). There is no significant difference in cardio-respiratory fitness between football, basketball and handball players (Singh & Singh, 2017). A study found that football and handball players in Haryana differed significantly in arm and abdominal strength (Devi & Kumar, 2022). Finally, Kumar and Kumar (2011) noted significant differences in cardiovascular endurance, agility and muscular endurance between basketball and volleyball players. The results found that cricket and volleyball players differed significantly in aerobic endurance, agility, speed and strength but not in arm or abdominal strength (Chaudhary, 2020).

Conclusions

Athletes in various sports show differences in agility, speed, and cardiovascular endurance but no differences in power, arm strength, and abdominal muscle strength. To improve performance and gain a competitive advantage, athletes and coaches should focus on sport-specific fitness training. Further research could explore this effect at higher competition levels. The majority of Bangladeshi university athletes, according to the authors, follow the same practices, despite the fact that each game requires a different set of motor fitness measures. The findings demonstrated that for improved gaming performance, each player should give priority to the motor fitness parameters specific to their respective game.

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Conflicts of interest

The authors declare no conflicts of interest.

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Оцінка показників рухової підготовленості серед спортсменів у різних видах спорту: оригінальне дослідження

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

Реферат. Стаття: 9 с., 5 табл., 2 рис., 48 джерел.

Історія питання. Рухова підготовленість є однією з ключових складових успішності спортсменів і є початковим фактором, який у поєднанні з технікою і тактикою конкретної гри впливає на результативність гри. Всі спортсмени повинні включати дані елементи до своєї спортивно-ігрової діяльності.

Мета дослідження. Метою цього дослідження було оцінити відмінності в показниках рухової підготовленості серед спортсменів-чоловіків університетського рівня, які займаються різними видами спорту.

Матеріали та методи. Для дослідження було відібрано шістдесят (60) спортсменів чоловічої статі, віком від 18 до 25 років, які представляли шість різних видів спорту: Легка Атлетика, Баскетбол, Крикет, Футбол, Гандбол та Волейбол. Кожна група складалася з 10 спортсменів, які змагалися на міжуніверситетському рівні. У фокусі дослідження були шість ключових показників фізичної підготовленості: спритність, швидкість, продуктивність, сила рук, сила м'язів черевного преса та витривалість серцево-судинної системи. Зазначені параметри вимірювалися за допомогою відповідних методів тестування та інструментів. Для встановлення значущих відмінностей між групами було проведено статистичний аналіз, включаючи однофакторний дисперсійний аналіз ANOVA та post-hoc аналіз з використанням LSD-тесту (найменша значуща різниця). У дослідженні був встановлений рівень значущості 0,05.

Результати. За результатами дослідження зафіксовано статистично значущі відмінності серед груп у показниках спритності ($F(5,54) = 4,776$, $p<0,001$), швидкості ($F(5,54) = 5,602$, $p<0,000$) та витривалості серцево-судинної системи ($F(5,54) = 3,578$, $p<0,007$). Однак не спостерігалося значущих відмінностей для показників продуктивності ($F(5,54) = 2,079$, $p>0,082$), сили рук ($F(5,54) = 1,368$, $p>0,251$) і сили м'язів черевного преса ($F(5,54) = 1,947$, $p>0,102$). Відповідно до резуль-

татів post-hoc аналізу з використанням LSD-тесту, для перевірки рівня значущості було проведено порівняльний аналіз параметрів спритності, швидкості та витривалості серцево-судинної системи в кожній групі.

Висновки. Таким чином, дослідження виявило, що показники спритності, швидкості та витривалості серцево-судинної системи суттєво відрізняються між спортсменами в різних видах спорту, тоді як показники продуктивності, сили рук та сили м'язів черевного преса не мають відмінностей. Отримані дані свідчать про те, що спортсмени та тренери повинні надавати пріоритет компонентам фізичної підготовленості, що є специфічними для конкретного виду спорту з метою покращення результативності гри.

Ключові слова: спортсмени, рухова підготовленість, командні види спорту, результативність.

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