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TRANSFORMING KEMPO FITNESS: ENHANCING PHYSIOLOGICAL RESPONSES AND PHYSICAL PERFORMANCE IN ADOLESCENTS VIA A TABATA-BASED METHOD

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Abstract

Study purpose. Examining the physiological and physical effects of Tabata training with Kempo sports movement techniques.

Materials and methods. The study participants were 16 adolescents divided into two distinct groups: the Tabata group and the non-Tabata group. The training was conducted for 6 weeks, 3 times per week, with each session lasting 2 hours. The training components for kicks and punches included Gyaku Geri, Jun Mawashi Geri, Jun Zuki, and Gyaku Mawashi Geri. Each teenager did physical exercise once a week for 2 hours. A normality test (Shapiro-Wilk) was used to assess the normality of the data. A Two-Way ANOVA with a significance level of less than 0.05 was conducted to examine the difference in means between the two groups. Furthermore, the researchers also tested the N-Gain Score to assess the effectiveness of the 6-week Tabata training program. All tests were conducted using SPSS version 23 and GraphPad Prisma version 10 for graph creation.

Results. The statistics indicate that a 6-week training with Tabata can effectively reduce resting heart rate and improve Standing Broad Jump (SBJ) performance by a value of sig. <0.05. In the pretest-posttest difference test within the group, the results show sig. <0.05. The results of the N-Gain Score test show that Kempo training using the Tabata method is effective in reducing resting heart rate by up to 88%, but is not effective in increasing power (SBJ) by a value of 10%.

Conclusions. The study revealed that incorporating the Tabata method into Kempo training, with necessary adjustments for 6 weeks, led to a notable reduction in resting heart rate. A decrease in resting heart rate is a dependable indicator of the advancement in physical fitness and general well-being in adolescents.

Keywords: Tabata, resting heart rate, modification.

Introduction

The physical fitness of an individual is closely related to their ability to perform daily physical activities (Aslan et al., 2019; Vukasevic et al., 2019). Consistent physical activity yields health advantages, specifically by enhancing physical fitness (Warburton & Bredin, 2016, 2017, 2018), and can improve vascular function (Black et al., 2008; Mora et al., 2007; Moriguchi et al., 2005). However, the benefits obtained depend on the individual's fitness level, age, and training intensity (Vina et al., 2012).

Mutohir et al (Mutohir et al., 2022, 2023) said in their research entitled "National Sports Development Index Report for 2021 and 2022" that today's fitness level is still quite low for teenagers in Indonesia. Someone who has low fitness is at risk of getting sick easily (Bratland-Sanda et al., 2020; Kakanis et al., 2010), such as cardiovascular disease, obesity, hypertension and hyperglycemia (Fornoni & Raij, 2005). The risk of cardiovascular disease that teenagers today have is due to lifestyle changes such as lack of activity, which causes lack of movement, stress and consuming unhealthy foods (Snel et al., 2022).

Sacher and Cable's research (Sacker & Cable, 2006) stated that having high fitness during adolescence positively impacts health later in life (Moliner-Urdiales et al., 2010; Silventoinen et al., 2021). The World Health Organization (WHO) recommends that teenagers exercise at least 60 minutes at moderate intensity (Chaput et al., 2020). Various studies show that physical activity has a good impact, namely reducing depression, improving cognitive function and improving mood (Penedo & Dahn, 2005).

To increase your fitness level, you need to do high-intensity interval training (HIIT) (Hottenrott et al., 2012); HIIT has also been proposed as an exercise that can save time in daily activities (Helgerud et al., 2007; Milanović et al., 2015; Ramos et al., 2015). Please note that there are several studies that say using HIIT training can improve aerobic fitness (VO_2max) (Cocks et al., 2013; Keteyian et al., 2008; McRae et al., 2012) dan anaerobic (Whyte et al., 2010). The intensity used in aerobic HIIT training is around 85% to 95% of the maximum heart rate (Gibala et al., 2012; Weston et al., 2014; Wisløff et al., 2007). Meanwhile, the frequency of HIIT training done 3 days/week with moderate to high intensity can increase a person's maximum aerobic strength (Garber et al., 2011) so that it can result in an increase in maximum oxygen supply in the endurance system.

Currently, teenagers are more motivated to do a physical activity based on the type of sport (Molanorouzi et al., 2015), and combat sports are one of the sports that people are interested in apart from team sports such as football and basketball. On the other hand, an individual's inability to carry out physical activities due to limited time in carrying out physical activities (Koh et al., 2022) is another obstacle to the decline in adolescent physiological components. In this study, researchers examined the use of Tabata training methods combined with martial arts sports movement techniques (Kempo) in improving the physiological and physical components of adolescents. In previous research (Akcan et al., 2021; Mischenko et al., 2021; Patah et al., 2021), Tabata training uses a lot of functional training and weight training. However, there has been no research that has studied further whether movement and punch technique training using the Tabata method can improve cardiorespiratory.

Tabata is one of the most efficient HIIT training methods (Tabata, 2019). The Tabata protocol is characterized by 8 repetitions with 20 seconds of work and 10 seconds of rest performed in 8 sets (Tabata, 2019). The research of Menz et al. and Popowczak et al. (Menz et al., 2019; Popowczak et al., 2022) states that doing Tabata training with an intensity of 70%-80% of your maximum heart rate will get health benefits.

The aim of this study was to identify the effects of Tabata training modified with Kempo sports movement techniques on physiological and physical responses. According to researchers, this research uses the Tabata training method and combines movements from one sport, which is something new that has not been researched and developed, so it is necessary to research the success of this new method in increasing aerobic and anaerobic capacity.

Materials and methods

Study participants

Sixteen teenagers participated in this research; they had an average age of 19-20 years when this research was carried out. Participants were characterized by only doing physical activity once a week with an average of 2 hours of exercise per week. Participants were divided into 2 groups, namely 8 teenagers in the Tabata group and 8 teenagers in the non-Tabata training group.

Table 1. Sample characteristics

	Tabata	Non-Tabata
Age (years)	20.00±2.27	19.60±1.41
Body Weight (Kg)	54.13±8.03	58.63±10.9
Body height (m)	1.66±0.06	1.60±0.07
IMT (Kg/m^2)	19.22±2.39	22.21±3.97

Study organization

The Tabata group will do the exercises as in table 2 with a pulse intensity of 75% - 85% of the maximum pulse with a work:rest ratio of 20:10 seconds in 4 minutes for up to 6 training sessions, resting for 3 minutes each session while the non-tabata group will do Kempo training for 2 hours.

When assessing physical condition, researchers used Push-ups, Standing Board Jump (SBJ) and also the Multi Fitness Test (MFT) and these exercises had to be carried out until the sample was exhausted to measure upper and lower body strength and endurance.

Push-up

This research used 90° push-up for protocol from (Hashim et al., 2018) for push up 30 seconds. In order to perform the 90° push-up, the test subject was required to lie face down on the floor with their hands beneath their shoulders, fingers pointing forward, and elbows positioned backward along the sides of their body. In the up position, the individual supported their body weight with their hands and toes while pushing themselves to full arm extension. The participant then lowered herself until her entire body, from the chest to the thighs, made contact with the floor while maintaining a straight posture. The participant then returned to the up position by pushing up to full arm extension. These ups and downs constituted one push-up test at 90 degrees. The subject of the test proceeded with these steps without pause until they became fatigued. A push-up test consisting of one 90-degree turn was recorded as the subject transitioned from the up position to the down position and back to the up position. The score was determined by the quantity of accurately performed 90-degree push-up tests prior to cessation or alteration of body position (Wood & Baumgartner, 2004).

Standing Board Jump (SBJ)

The broad jump test while standing was conducted on a hard surface. The participants maintained a parallel stance with their feet parallel to the starting line and their heels on the line. Subsequent to receiving instructions from the investigator, the participants were required to execute a horizontal jump of maximum distance. Since neither the movement of the arms nor the legs had been specified, the participants were free to execute a self-determined depth countermovement of the legs and a free-arm amplitude swing. The contestants were required to land with both feet jointly and halt the jump without making any additional progress. Each experiment was conducted in triplicate, with a five-minute interval between each iteration. The distance from the starting line to the heel of the foot closest to the starting line was measured in centimeters using a measuring tape. The highest score obtained from the three attempts was retained for further analysis (Thomas et al., 2020).

Multi_stage Fitness Test (MFT)

Test of Multi-Stage Fitness (MSFT) Participants in the MSFT run a series of 20-meter shuttle runs until they become exhausted(Ramsbottom et al., 1988). Beginning at 8.5 km/h, the MSFT accelerates by 0.5 km/h for every one-minute stage that is finished. Before the test began, each participant received a Polar Verity Sense heart rate monitor, which was used to track their heart rate in real time during the entire test. Encouragement was given verbally to make sure that participants worked until they were completely exhausted. The MSFT running distance served as the criteria measure.

Lactate

Blood lactate measurements were taken using the accutrend plus roche device. the measurement was carried out at the time after performing the MFT test before and after the 6-week training program ended. Measurement

Table 2. 6-week Tabata Kempo training program

		Sesi 1	Sesi 2	Sesi 3	Sesi 4	Sesi 5	Sesi 6
Repetisi 1	20 Seconds	Punch A	Punch B	Punch A	Punch B	Punch A	Punch B
Rest	10 Seconds	Rest	Rest	Rest	Rest	Rest	Rest
Repetisi 2	20 Seconds	Kick A	Kick B	Kick A	Kick B	Kick A	Kick B
Rest	10 Seconds	Rest	Rest	Rest	Rest	Rest	Rest
Repetisi 3	20 Seconds	Punch A	Punch B	Punch A	Punch B	Punch A	Punch B
Rest	10 Seconds	Rest	Rest	Rest	Rest	Rest	Rest
Repetisi 4	20 Seconds	Kick A	Kick B	Kick A	Kick B	Kick A	Kick B
Rest	10 Seconds	Rest	Rest	Rest	Rest	Rest	Rest
Repetisi 5	20 Seconds	Punch A	Punch B	Punch A	Punch B	Punch A	Punch B
Rest	10 Seconds	Rest	Rest	Rest	Rest	Rest	Rest
Repetisi 6	20 Seconds	Kick A	Kick B	Kick A	Kick B	Kick A	Kick B
Rest	10 Seconds	Rest	Rest	Rest	Rest	Rest	Rest
Repetisi 7	20 Seconds	Punch A	Punch B	Punch A	Punch B	Punch A	Punch B
Rest	10 Seconds	Rest	Rest	Rest	Rest	Rest	Rest
Repetisi 8	20 Seconds	Kick A	Kick B	Kick A	Kick B	Kick A	Kick B

Note: Punch A = Gyaku Geri; Kick A = Jun Mawashi Geri; Jun Zuki = Punch B; Gyaku Mawashi Geri = Kick B

Table 3. Normality Test

Variable		Tabata			Non-Tabata		
		Shapiro-Wilk					
		Statistic	df	Sig	Statistic	df	Sig
Resting Heart (beat/minutes)	Pre	0.97	8	0.88	0.91	8	0.33
	Post	0.92	8	0.40	0.89	8	0.24
Standing Board Jump (cm)	Pre	0.97	8	0.92	0.92	8	0.44
	Post	0.96	8	0.83	0.90	8	0.32
Lactate (mg/dL)	Pre	0.89	8	0.23	0.90	8	0.28
	Post	0.90	8	0.32	0.89	8	0.24
VO_2max (ml/kg/min)	Pre	0.89	8	0.24	0.96	8	0.80
	Post	0.86	8	0.12	0.97	8	0.90
Push Up (30 Second)	Pre	0.90	8	0.27	0.92	8	0.47
	Post	0.90	8	0.26	0.79	8	0.02

Table 4. The present study examines the mean changes in physiological and physical parameters following a six-week training intervention

Variable		N	Mean±SD	Min	Max	Mean±SD Pre-Post	Sig.
		Tabata					
Resting Heart (beat/minutes)	Pre	8	85.25±12.03	70	108	23.00±14.57	0.003*
	Post		62.25±10.61	48	78		
Standing Board Jump (cm)	Pre	8	191.50±29.94	151	238	7.87±3.48	0.000*
	Post		199.40±29.65	161	244		
Lactate (mg/dL)	Pre	8	10.36±3.11	6.2	14.7	3.38±1.69	0.001*
	Post		13.75±2.30	9.3	16.8		
VO2max (ml/kg/min)	Pre	8	36.60±4.07	30.6	41.5	2.87±1.70	0.002*
	Post		39.48±4.71	32.6	44.5		
Push-Up (30 Second)	Pre	8	27.63±11.51	13	45	3.75±4.46	0.049*
	Post		31.38±11.3	19	48		
		Non-Tabata					
Resting Heart (beat/minutes)	Pre	8	101.80±14.44	84	132	16.00±11.95	0.007*
	Post		85.75±6.71	78	96		
Standing Board Jump (cm)	Pre	8	153.80±21.09	126	181	11.75±7.28	0.003*
	Post		165.50±18.76	140	188		
Lactate (mg/dL)	Pre	8	10.53±2.06	7.8	14.8	3.26±1.82	0.001*
	Post		13.79±2.01	9.7	15.9		
	Pre		28.81±3.01	23.2	32.6		
VO_2max (ml/kg/min)	Post	8	34.98±5.09	27.6	42.2	6.16±4.03	0.003*
	Post		21.13±4.51	17	28		

*Mean scores when comparing points from the baseline: a two-tailed sig. < 0.05

using accutrend plus roche has a good level of effectiveness in measuring blood lactate for physical activity (Baldari et al., 2009).

Statistical analysis

This research uses descriptive tests to present profile sample data. Data Normality Test (Shapirowilk) to see the normality of the data. Paired sample t-test was used to see the differences before and after in each group. Two-way ANOVA test with sig. < 0.05 to see the difference in the average of the two groups. Furthermore, the researchers also tested the N-Gain Score to see the Tabata training program's effectiveness for six weeks. To create graphs, all tests were conducted using SPSS version 23 and GraphPad Prisma version 10.

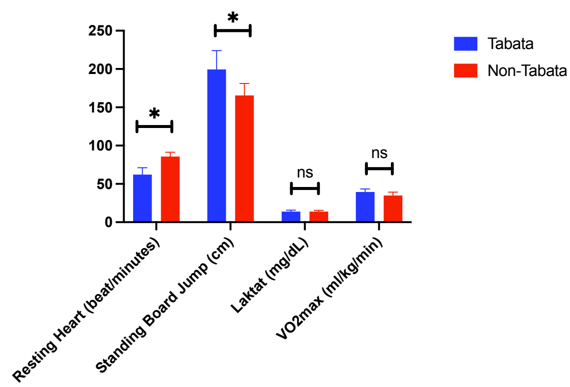

Fig. 1. Comparative analysis of six-week average training outcomes for four variables across groups

Results

Table 3 presents data on the results of the normality test using the Shapiro wilk test, normality data if sig. ≥0.05 so that the post Push-up data is declared abnormal.

Table 4 presents the pre and post data on the 5 variables measured in this study. mean and SD data are presented in table 4 to provide an overview of the results of this study. each variable experienced pre and post-test changes through analysis of the Pre-post mean and SD used paired sample t test.

Fig. 1 shows that only the physiological component (resting heart rate) with the physical component (standing board jump) showed different results after 6 weeks of training between the two groups, where the sig. value of each group sig. <0.05 (resting heart rate) and (standing board jump). Meanwhile, lactate accumulation and VO_2max achievement for both groups were the same.

Furthermore, to assess the effectiveness of the training program for 6 weeks of tabata training on resting heart rate and standing board jump indicators, the N-Gain Score test results showed a value of 88% for resting heart rate and 10% for Standing Board jump. So, it can be concluded that Kempo training using the tabata method is more effective in reducing resting heart rate achievements, on the other hand for SBJ Kempo training using the tabata method is declared ineffective.

Discussion

This study found that only resting heart rate and standing board jump differed from the control group. The Resting heart rate component is very important to continuously monitor its development because it is directly related to indicators of a person's fitness development (Pramono et al., 2021; Quan et al., 2014). Changes in heart rate are influenced by the type of exercise a person does (Perrone et al., 2021); included in this study were differences in changes in heart rate influenced by exercise using the Tabata method and not using the Tabata method.

Heart performance has been used for a long time as an indicator of the human body's performance. As in research by Garcia (2022), resting heart rate can explain the variance of HR at rest, during exercise testing, and recovery from 11% to 48% (Garcia et al., 2022). Then, the heart rate reserve (HRR) is related to the VO_2max percentage (Matsuura et al., 2019). HRR achievement itself depends on age and resting heart rate. Another effect of Tabata exercise that was not examined in this study and is related to heart rate is decreased blood pressure (Popowczak et al., 2022).

To support a high adolescent lifestyle, a lower RHR value can be used as an indicator and achievement target to support the adolescent lifestyle. As in Samuel's (2022) research, physical activity will support changes in resting heart rate, which will later support adolescent activity patterns (Honório et al., 2022).

Interestingly, in this study, the two groups' physical components (power) were significantly different, but in the N-Gain score assessment, Kempo training using the Tabata method was not considered effective. SBJ is one part of fitness assessment (Brudecki & Gołab, 2006; Yi et al., 2019). The ineffectiveness of Kempo training using the Tabata method is due to the absence of additional indicator elements in training and only using 100% punch and kick techniques as training items for each session. This is in contrast to research (Caglayan & Ozbar, 2017; Gani et al., 2022), which succeeded in increasing power when adding a combination of technical training and functional training.

The next interesting thing in this research is that not all fitness components were successfully obtained through 6 weeks of training using modified Tabata training with Kempo movements. This exercise is only effective in developing resting heart rate because it has an N-Gain Score of 88%. So it's the same as research (Lu et al., 2023) where Tabata training affects cardiorespiratory physiological (Reppa et al., 2023).

Another finding in this study was that Tabata training for 6 weeks involving only Kempo exercise movement techniques increased VO_2max of 8%. This is in line with the results of research by Viana (2019), where variations of training using the Tabata method other than using running and ergo cycle movements will increase by only an average of 11%, while those using running and ergo cycle can increase by more than 11% (Viana et al., 2019). Even though it is only 8%, this result is quite good if used by someone to increase VO_2max to improve fitness because it uses moderate intensity with interesting movements. High-intensity exercise is not chosen by many teenagers because it causes high levels of stress (Tabata, 2019).

Training using the Tabata method with modified intensity and using Kempo movements for 6 weeks gave significant results in changes in the physiological component (resting heart rate) and the physical component, namely power, even though the power indicator stated that this Tabata training was ineffective. Because of this, this exercise can be applied as part of an exercise program to improve health components in adolescents. Further research needs to be carried out by adding loads and functional training types of exercise to provide a more optimal impact on the aerobic and anaerobic components.

Conclusions

The research results provide very important findings in the development of physical exercise to improve the health and fitness of adolescents. Kempo training using the Tabata method will provide interesting value in the training patterns that teenagers will carry out. This study found that Tabata training for 6 weeks had an impact on reducing resting heart rate. The development of Kempo training using the Tabata method is considered effective in increasing VO_2max.

Further research development needs to be carried out by future researchers by adding functional training components and providing training loads so that there is an increase in other physical components.

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Conflict of interest

All researchers affirm that there is no conflict of interest in this research.

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ТРАНСФОРМУВАННЯ КЕМПО-ФІТНЕСУ: ПОКРАЩЕННЯ ФІЗІОЛОГІЧНИХ РЕАКЦІЙ І ФІЗИЧНОЇ РЕЗУЛЬТАТИВНОСТІ В ПІДЛІТКІВ ЗА ДОПОМОГОЮ МЕТОДУ НА ОСНОВІ СИСТЕМИ ВПРАВ ТАБАТА

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Мета дослідження. Вивчення фізіологічного та фізичного впливу високоінтенсивних інтервальних тренувань за системою Табата з техніками руху кемпо-спорту.

Матеріали та методи. Учасниками дослідження були 16 підлітків, яких розподілили на дві окремі групи: група тренувань за системою Табата та група тренувань не за системою Табата. Тренування проводили протягом 6 тижнів, 3 рази на тиждень, кожне заняття тривало 2 години. Тренувальні компоненти для ударів ногами та руками включали Ґяку-ґері, Дзюн-маваші-ґері, Дзюн-цукі та Ґяку-маваші-ґері. Кожен підліток виконував фізичні вправи один раз на тиждень протягом 2 годин. Для оцінки нормальності даних використовували критерій нормальності (критерій Шапіро-Вілка). Для вивчення різниці в середніх значеннях між двома групами проводили двофакторний дисперсійний аналіз за рівня значущості менше 0,05. Крім того, для оцінки ефективності 6-тижневої програми тренувань за системою Табата дослідники також тестували показник оцінки нормалізованого приросту. Усі тести проводили з використанням програмного забезпечення SPSS версії 23 та GraphPad Prisma версії 10 для побудування графіків.

Результати. Статистичні дані показують, що 6-тижневе тренування за системою Табата може ефективно знижувати частоту серцевих скорочень у стані спокою та покращувати результативність стрибків у довжину з місця (СДМ) за величини значущості <0,05. У тесті різниці результатів попереднього та підсумкового тестування в рамках групи результати показують значущість <0,05. Результати тестування оцінки нормалізованого приросту показують, що кемпо-тренування за методом на основі системи Табата є ефективними для зниження частоти серцевих скорочень у спокої на величину до 88%, але не є ефективними для збільшення потужності (SBJ) на величину 10%.

Висновки. Дослідження показало, що включення методу на основі системи Табата до кемпо-тренувань із необхідними коригуваннями протягом 6 тижнів призвело до помітного зниження частоти серцевих скорочень у стані спокою. Зниження частоти серцевих скорочень у стані спокою є надійним показником покращення рівня фізичної підготовленості та загального самопочуття підлітків.

Ключові слова: система Табата, частота серцевих скорочень у стані спокою, модифікація.

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