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[Teorià ta Metodika Fìzičnogo Vihovannâ]



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THE EFFECT OF LOW-IMPACT AEROBIC DANCE EXERCISE VIDEO ON CARDIOVASCULAR ENDURANCE, FLEXIBILITY, AND CONCENTRATION IN FEMALES WITH SEDENTARY LIFESTYLE

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Abstract

The study purpose was to prove the effectiveness of a low-impact aerobic dance exercise video on cardiovascular endurance, flexibility, and concentration in women with a sedentary lifestyle.

Materials and methods. This study used the Pre-Experimental method with a One-Group Pretest-Posttest Design research design. Total of 18 females aged 18-20 y.o., body mass index (BMI) 19 kg/m² – 24 kg/m², normal systolic and diastolic blood pressure, normal resting heart rate, oxygen saturation (SpO₂) 96% – 100% participated in the research. Low-impact aerobic dance exercise was done using video for 30 minutes/exercise session with an intensity of 75% – 85% HRmax with a frequency of 3 times/week for 6 weeks. Measurement of cardiovascular endurance was done using the Multi-Stage 20-m Shuttle Run Fitness Test, flexibility was measured with the Sit and Reach Test, and concentration was measured with the Grid Concentration Test. The statistical analysis technique used the Paired Sample T-Test with a significance level of 5%.

Results. The results showed the average cardiovascular endurance of the pretest vs. posttest (28.13 ± 4.80 vs. 30.52 ± 0.88 mL/kg/min (p ≤ 0.001)), mean flexibility of pretest vs. posttest (17.79 ± 4.72 vs. 18.75 ± 5.02 cm (p ≤ 0.001)), mean concentration of pretest vs. posttest (7.39 ± 2.38 vs. 9.11 ± 2.45 score (p ≤ 0.001)).

Conclusions. Based on the results of the study, it was concluded that a low-impact aerobic exercise dance video performed with a frequency of 3 times/week for 6 weeks increased cardiovascular endurance, flexibility, and concentration in adolescent girls with a sedentary lifestyle.

Keywords: aerobic dance exercise, cardiovascular endurance, flexibility, concentration, sedentary lifestyle.

Introduction

Indonesia faces a serious problem, namely the lack of participation of the Indonesian people in physical activity (Rachmi et al., 2017). This issue refers to people of various ages, including adolescents (17-25 years), early adults (26-35 years) and late adults (36-45 years) who experience difficulty in carrying out physical activities due to their busy working hours. Furthermore, the Ministry of Health of the Republic of Indonesia stated that obesity and stress are one

of the symptoms and impacts of the limited participation of Indonesian people in physical activity (Ramanian et al., 2020). Likewise, the increasing development of technology that significantly reduces the volume and intensity of physical activity can lead to health problems, such as the increased risk of cardiovascular diseases (CVD), type 2 diabetes mellitus (T2DM), obesity (Kovacova et al., 2011; Chuprun & Yurchenko, 2020; Rejeki et al., 2021; Rejeki et al., 2022).

Currently, aerobic dance is very popular in various parts of the world (Schroeder et al., 2017). Aerobic dance is one type of gymnastics that is developing, it is favored by the community for several reasons, such as being able to practice anywhere, alone or together, and at low cost. Several previous studies reveal the benefits of doing aerobic dance can reduce the level of the individual stress response, and reduce

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psychosomatically (Ramanian et al., 2020). The popularity of aerobic dance is associated with the type of physical activity that is following the concept of gender identity, the concept of femininity, and female body image (Chuprun & Yurchenko, 2020).

Aerobic dance is a form of endurance training, including the most preferred physical activity, especially for women. In line with the results of this study, it shows that the female population prefers aesthetically oriented physical activities, such as aerobic dance (Kovacova et al., 2011). Movement in aerobic dance is always accompanied by music, this is intended to make this aerobic dance interesting (Stamford, 2016). In carrying out the aerobics dance, participants really enjoyed the process that took place, this was helped by the support of music (Hua & Ye, 2020). In socializing dance aerobics, movements and music must always be updated, because this will greatly impact the popularity of aerobics itself (Dun et al., 2021). Therefore, music that is fun, full of energy, and has moving colors is chosen. The music selected usually has four beats per beat with a steady beat (Arfanda, 2015). It is hoped that with interesting music there will be harmony between movement and rhythm, it is intended that this aerobics dance is interesting for various variations and creativity.

Aerobic dance is one of the most common forms of aerobic exercise (Zarebska et al., 2016). Aerobic exercise is an activity that requires a lot of oxygen and will ultimately improve the oxygen transport system in the body. This system is often referred to as the cardiovascular system because the heart and blood vessels are the means of transporting oxygen (Arfanda, 2019). In general, aerobics dance is a sport that can improve heart and respiratory function.

Someone who does not do a lot of physical activity will have a higher risk of cardiovascular disease than those who are active (Mehta et al., 2020). Cardiorespiratory endurance is the ability of the heart, lungs, and blood vessels to function optimally at work to take oxygen optimally and distribute it throughout the body, especially to active tissue so that it can be used for the body's metabolic processes (Arimbi et al., 2019). Success in endurance sports requires a good level of aerobic or cardiorespiratory and endurance exercise depends on aerobic metabolism (Arimbi et al., 2017).

Flexibility is an important contributor to sports performance, the fact is that high levels of flexibility can reduce the risk of injury. Flexibility is a parameter that can affect the risk of injury (Setyawan et al., 2021). Flexibility refers to the intrinsic property of body tissues that determines range of motion (ROM) without causing injury (Nuzzo, 2020). This study deals with static flexibility by performing sit and reach tests. Sit-and-reach requires participants to sit on the floor or a chair and reach toward their toes.

The more specific concentration of mind in training and sports competitions can affect attention and concentration during the athlete's activity. Athletes who can train their concentration, then they will be able to control the negative things that affect training and competition (Manikam, 2021). Therefore, this study aims to prove the effectiveness of low-impact aerobic dance exercise videos on increasing cardiovascular endurance, flexibility, and concentration in women with a sedentary lifestyle. We hypothesized that the provision of low-impact aerobic dance exercise videos was effective in improving cardiovascular endurance, flexibility, and concentration in women with a sedentary lifestyle.

Material and Methods

Study participants

This research is Pre-Experimental with One-Group Pre-test-Posttest Design. A total of 18 female adolescents aged 18-20 y.o., body mass index (BMI) 19-24 kg/m², normal systolic and diastolic blood pressure, normal resting heart rate, oxygen saturation (SpO₂) 96-100% participate in research.

Study organization

Before participating in the study, all respondents received information orally and in writing about this research. All respondents stated that they were willing to sign the informed consent. All procedures performed in our study complied with the Declaration of the World Medical Association of Helsinki on the ethical conduct of research involving human subjects. The low impact aerobic dance exercise video program was implemented and supervised by professional officers from the Faculty of Sports Science, Makassar State University. Low impact aerobic dance exercise videos are performed using videos for 30 minutes/exercise session with an intensity of 75% – 85% HRmax with a frequency of 3x/week for 6 weeks. Heart rate monitoring during a low-impact aerobic exercise dance video using a polar heart rate monitor (Polar H7 Bluetooth Heart Rate Sensor & Fitness Tracker, Inc., USA).

Data were collected for measurement of body height (BH) using a Stadiometer (Portable Seca® Stadiometer, North America). Body weight (BW) was measured using a digital scale (OMRON Model HN-289, Omron Co., Osaka, Japan). BMI is calculated by dividing the BW (kg) divided by the BH (m²). Measurement of blood pressure using an OMRON digital sphygmomanometer (OMRON Model deluxe HEM-7130-L, Osaka, Japan) on the non-dominant arm 3 times in a row with a 2-minute rest interval between the two measurements then the average value of the three measurements was taken (Andarianto et al., 2022). The Beurer Pulse Oximeter PO-30 (PO 30 Pulse Oximeter) is used to measure resting heart rate and SpO₂. Cardiovascular endurance measurement using the Multi-Stage 20-m Shuttle Run Fitness Test (Paradisis et al., 2014), flexibility with Sit and Reach Test (ACSM, 2000; Baltaci et al., 2003) and concentration with Grid Concentration Test (Tache et al., 2017). Measurements of cardiovascular endurance, flexibility, and concentration were carried out before and 2x24 hours after 6 weeks of low-impact aerobic exercise dance video intervention.

Statistical analysis

The statistical analysis technique used the Statistic Package for Social Science (SPSS) version 21 software. The normality test used the Shapiro-Wilk test, while to determine the difference between cardiovascular endurance, flexibility, and concentration before and after the intervention, the Paired Sample T-Test with significant level ($p \leq 0.05$). All data displayed Mean $\pm$ Standard Deviation (SD).

Results

The results of the descriptive analysis of the respondent's characteristic data between the pretest vs. posttest include age, height, weight, body mass index, systolic blood pres-

sure, diastolic blood pressure, resting heart rate, oxygen saturation is presented in Table 1.

Table 1. Data on the characteristics of respondents between pretest vs. posttest

Parameters	n	Low Impact Aerobic Exercise Dance Video		p-value
		Pretest	Posttest	
Age (yrs)	18	19.22±0.81	19.22±0.81	1.000
Body height (m)	18	1.62±0.04	1.62±0.04	1.000
Body weight (kg)	18	56.72±3.29	55.00±2.98*	0.000
Body mass index (kg/m ²)	18	21.76±1.33	21.10±1.24*	0.000
Systolic blood pressure (mmHg)	18	118.61±2.81	112.11±2.52*	0.000
Diastolic blood pressure (mmHg)	18	79.11±3.94	74.78±3.69*	0.000
Resting heart rate (bpm)	18	78.06±3.79	75.50±3.33*	0.000
Oxygen saturation (%)	18	96.83±0.86	98.17±0.10*	0.000

Description: (*)Significant vs. Pretest ($p \leq 0.001$). p-value was obtained by using the Paired Sample T-Test. Data are presented with Mean $\pm$ Standard Deviation (SD).

Based on Table 1, it can be seen that there are changes in the average body weight, body mass index, systolic blood pressure, diastolic blood pressure, resting heart rate, oxygen saturation between pretest vs. post-test, while the mean age and body height did not show any change between pretest vs. posttest. The results of the Paired Sample T-Test showed that there was a significant difference in average body weight, body mass index, systolic blood pressure, diastolic blood pressure, resting heart rate, oxygen saturation between pretest vs. posttest ($p \leq 0.001$), while the mean age and body height did not show any significant difference between pretest vs. posttest ($p \geq 0.05$). The results of the analysis of the average cardiovascular endurance, flexibility, and concentration between the pretest vs. posttest can be seen in Figure 1.

Based on Table 1, it can be seen that there is an increase in the average cardiovascular endurance, flexibility, and concentration between the pretest vs. posttest. The results of the Paired Sample T-Test showed a significant difference in the average increase in cardiovascular endurance, flexibility, and concentration between the pretest vs. posttest ($p \leq 0.001$).

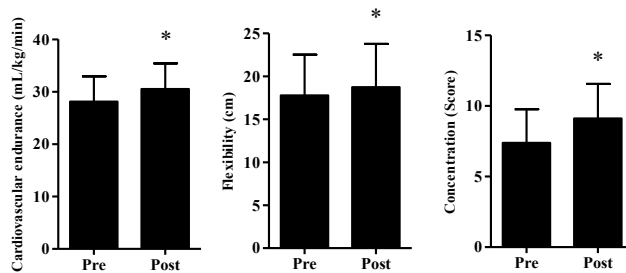


Figure 1. Results of statistical analysis of cardiovascular endurance, flexibility, and concentration between pretest vs. posttest. Description: (*)Significant vs. Pretest ($p \leq 0.001$). p-value was obtained by using the Paired Sample T-Test. Data are presented with Mean $\pm$ Standard Deviation (SD).

Discussion

Based on the results of the study, there was a significant increase in the average cardiovascular endurance between before and after the low impact aerobic exercise dance video intervention (Figure 1). Such results with the research results of Said et al. (2015) reported that a low-impact aerobic exercise intervention significantly improved aerobic fitness in overweight and obese women. Kwannai (2020) also reported that there was an increase in maximal oxygen consumption (VO₂max) after aerobic dance exercise. This increase in cardiovascular endurance may be due to increased skeletal muscle contraction during low-impact aerobic exercise.

The exercise dance intervention effectively prevents the decline in physical function, cognitive function, and quality of life associated with aging. Physical functions include balance, endurance performance, flexibility, muscle strength, and mobility, and a decline in these abilities is considered a sign of aging (Liu et al., 2021). This is in line with the results of the study that we found that low impact aerobic exercise dance performed for 30 minutes/exercise session with an intensity of 75-85% HRmax with a frequency of 3 times/week for 6 weeks increased flexibility. Physical activity causes changes in body balance (homeostasis). Changes in balance start from the body's response by the nervous system, then internal hormones will affect the muscles from which there will be a gradual change in body balance. In addition, exercise responds to changes in the body's metabolism, hormonal system, neuromuscular system, cardiovascular system, and respiratory system. The function of exercise in the musculo-skeletal system is to increase aerobic metabolism, the number and size of mitochondria, regulation of blood flow in muscles, myoglobin in skeletal muscles, muscle hypertrophy, as well as metabolic range, joint mobility and flexibility (Saryono, 2011).

Aerobic exercise can also strengthen memory in adults who have mild cognitive impairment (Wong et al., 2020). Several other studies state that aerobic exercise can improve cardiorespiratory fitness, prevent several diseases related to age, improve physical and cognitive, and psychological conditions (Vrinceanu et al., 2019). Most of these athletes prove their behavior and performance on mental training, especially increased attention or concentration (Manikam, 2021). Aerobics dance also involves focusing attention, memory, sensory stimulation, and social interaction. Aerobics dance is a good exercise to improve cognitive, mood and physical function (Wong et al., 2020). The results of our study showed that there was a significant increase in the average concentration between before and after the low impact aerobic exercise dance video intervention (Figure 1). The results of research conducted by Johar et al. (2012) reported that a low-impact aerobic dance exercise intervention carried out for 50 minutes, 3 days per week, for 12 weeks reduced psychological health (stress) in sedentary women. Physical activity will improve the cognitive function of the brain (Pranoto et al., 2020), one of which is the function of attention which results in an increase in one's concentration (Samuel et al., 2017). This physical activity also affects the frontal lobe, an area of the brain for concentration, mental and planning. Good and structured physical activity can encourage someone to be physically active and show a positive effect on academic scores, including increased concentration (Ambardini, 2009). Increased concentration is also supported by the presence of

Sensory Motor Rhythm (SMR) waves that are delivered by nerves in the brain. These waves include low beta vibrations and have a frequency of around 12-16 Hz (Ulfa, 2017).

Conclusion

Based on the results of our study, it was concluded that a low impact aerobic exercise dance videos performed for 30 minutes/exercise session with an intensity of 75-85% HRmax with a frequency of 3 times/week for 6 weeks increased cardiovascular endurance, flexibility, and concentration in a female adolescent with a sedentary lifestyle. The results of this study cannot be generalized by gender, so future research is recommended to compare the effects of low impact aerobic exercise dance videos on increasing cardiovascular endurance, flexibility, and concentration in male and female adolescents. Further research is also suggested to compare dance videos of low impact aerobic exercise dance videos versus aerobic exercise dance videos.

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Conflict of interest

All authors declare no conflict of interest.

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ВПЛИВ ВИКОНАННЯ ПРЕДСТАВЛЕНИХ НА ВІДЕОЗАПИСІ ВПРАВ ІЗ ТАНЦЮВАЛЬНОЇ АЕРОБІКИ З НИЗЬКИМ УДАРНИМ НАВАНТАЖЕННЯМ НА СЕРЦЕВО-СУДИННУ ВИТРИВАЛІСТЬ, ГНУЧКІСТЬ І КОНЦЕНТРАЦІЮ УВАГИ В ЖІНОК, ЯКІ ВЕДУТЬ МАЛОРУХЛИВИЙ СПОСІБ ЖИТТЯ

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Авторський вклад: А – дизайн дослідження; В – збір даних; С – статаналіз; D – підготовка рукопису; Е – збір коштів

Реферат. Стаття: 6 с., 1 таб., 1 рис., 36 джерел.

Метою дослідження було довести ефективність впливу виконання представлених на відеозаписі вправ із танцювальної аеробіки з низьким ударним навантаженням на серцево-судинну витривалість, гнучкість і концентрацію уваги в жінок, які ведуть малорухливий спосіб життя.

Матеріали та методи. У цьому дослідженні використовували доекспериментальний метод із планом дворазового попереднього та підсумкового тестування на одній групі. У дослідженні брали участь загалом 18 жінок віком 18-20 років, з індексом маси тіла (ІМТ) 19 кг/м² – 24 кг/м², з нормальним систолічним і діастолічним артеріальним тиском, з нормальною частотою серцевих скорочень у стані спокою, з показником насиченості крові киснем (SpO₂) 96% – 100%. Вправи

з танцювальної аеробіки з низьким ударним навантаженням виконували з використанням відеозапису протягом 30 хв/тренування з інтенсивністю 75% – 85% максимальної ЧСС (HRmax) із частотою 3 рази/тиждень протягом 6 тижнів. Вимірювання серцево-судинної витривалості здійснювали за допомогою багатоступінчастого тесту функціонального стану за результатами човникового бігу на 20 м, вимірювання гнучкості – за допомогою тесту на нахил тулуба вперед із положення сидячи, а вимірювання концентрації уваги – за допомогою тесту-решітки на концентрацію уваги. Як метод статистичного аналізу використовували t-критерій Стюдента для парних вибірок із рівнем значущості 5%.

Результати. Результати показали середні значення показників попередніх вимірювань у порівнянні з показниками підсумкових вимірювань серцево-судинної витривалості ($28,13 \pm 4,80$ проти $30,52 \pm 0,88$ мл/кг/хв ($p \leq 0,001$)), середні значення показників попередніх вимірювань у порівнянні з показниками підсумкових вимірювань гнучкості ($17,79 \pm 4,72$ проти $18,75 \pm 5,02$ см ($p \leq 0,001$)), середні значення показників попередніх вимірювань у порівнянні з показниками підсумкових вимірювань концентрації уваги ($7,39 \pm 2,38$ проти $9,11 \pm 2,45$ очка ($p \leq 0,001$)).

Висновки. На підставі результатів дослідження було зроблено висновок про те, що виконання представлених на відеозаписі вправ із танцювальної аеробіки з низьким ударним навантаженням із частотою 3 рази/тиждень протягом 6 тижнів підвищило показники серцево-судинної витривалості, гнучкості та концентрації уваги в молодих жінок, які ведуть малорухливий спосіб життя.

Ключові слова: вправи з танцювальної аеробіки, серцево-судинна витривалість, гнучкість, концентрація уваги, малорухливий спосіб життя.

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TRADITIONAL SPORT MODEL TO IMPROVE FUNDAMENTAL MOVEMENT SKILLS AND SOCIAL ATTITUDES OF STUDENTS DURING COVID-19

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Abstract

The study purpose. COVID-19 caused many negative impacts, including a significant decrease in the fundamental movement skills and social attitudes among students, which becomes the main problem in this study. Therefore, this study aims to investigate the effect of traditional sport on improving students' fundamental movement skills and social attitudes.

Materials and methods. This study adopted an experimental method with a pretest-posttest design. The subjects were elementary school students in Yogyakarta city and they were selected using random sampling ($n = 30$). The traditional sports program was carried out for 7 weeks with once-a-week meetings. The instrument for assessing students' fundamental movement skills was using a gross motor development test and social attitudes were assessed using the questionnaire of Physical Education Activity Attitude. Shapiro-Wilk was used to test the normality of the data, while the Paired Sample t-test was used to assess differences in the values of students' fundamental movement skills and social attitudes before and after the program.

Results. The results of this study indicate that traditional sports have a significant effect on improving fundamental movement skills ($p < 0.05$) and social attitudes ($p < 0.05$).

Conclusions. Thus, traditional sports programs can be used as an alternative activity that can be used by physical education teachers during the COVID-19 crisis.

Keywords: traditional sports, fundamental movement skills, social attitudes, experimental method.

Introduction

The COVID-19 pandemic has caused all sectors including education, industry, offices, medical as well as physical and exercises activities meet obstacles and cannot run normally throughout the world (Taufik, Solahuddin, Pratama, Iskandar & Ridlo, 2021; Alhazmi et al., 2020). In addition, the COVID-19 pandemic had a negative impact on children in elementary schools, namely by reducing fundamental movement skills (FMS). FMS is the ability to perform three basic movement skills such as locomotor skills, sta-

bility skills, and manipulative/object control skills (Engel, Broderick, Broderick, Hardy & Parmenter, 2018; Platvoet et al., 2018; Behan, Belton, Peers, O'Connor & O'Connor, 2019). FMS is an important factor that causes students to be able to perform physical movements in physical education classes (Eddy et al., 2021; Basman, 2019; Lawson, Eyre, Talis & Duncan, 2021), and various kinds of physical activities (Haeghele, Brian & Brian, 2015). There were some data reported that the FMS aspect of students during the pandemic has decreased significantly (Bai et al., 2020; Nurulfa et al., 2021). Several factors causing a significant decline in FMS during the COVID-19 pandemic crisis are including staying at home, closures, isolation/lockdown, and social distancing (Pombo, Luz, de Sá, Rodrigues & Cordovil, 2021). Many experts and international health organizations in several countries highlight that isolation/lockdown was able to re-

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duce the transmission rate of COVID-19, but it has a negative impact on reducing FMS levels (Nurulfa et al., 2021). Therefore, developing FMS in primary school students is an extremely important goal and a priority during the current pandemic (Logan et al., 2015; Foulkes et al., 2017). In addition, the impact of COVID-19 has attacked psychological aspects in a person (Ai, Yang, Lin & Wan, 2021). For example, lack of social attitudes among students (Buzzi et al., 2020). A social attitude is a person's behavior to socialize or interact with other people (Krings, Steeden, Abrams & Hogg, 2021). Students who have a social attitude will be able to establish a harmonious relationship when working together in the learning process (Baker et al., 2021). A recent study reported that COVID-19 has attacked the health aspects of students in Saudi Arabia and another negative impact is a disruption in social attitudes, for example, students cannot conduct group discussions to complete the assignments, cannot interact intensely with relatively large numbers of students (Elmer, Mephram & Stadtfeld, 2020; Alghamdi, 2021). Considering the importance of physical activity and social attitudes for students in the current era of the COVID-19 pandemic, it is needed to improve these two aspects.

One method that is used to increase the level of FMS and social attitudes of students is through traditional sport. Traditional sport is a game activity that is passed down from one generation to the next generation that is available in a country (Martínez-Santos, Founaud, Aracama & Oiarbide, 2020; Saputra, Hanif, Sulaiman & Ningrum, 2021). According to Maryuni and Nasrulloh, (2022), traditional sports involve physical activity and the movement of running and throwing an object, which causes children until teenagers to like to play this game. Several previous studies claimed that traditional sports could improve physical fitness (Birri, Hariyanto & Tuasikal, 2020). Research on traditional sports has been reported internationally by previous studies (Gipit, Abdullah, Musa, Kosni & Maliki, 2017; Trajkovik, Malinovski, Malinovski & Vasileva, 2018; Bhinder et al., 2021). However, according to our knowledge, there is limited literature that discussed the effects of traditional sports on increasing students' FMS and social attitudes during the COVID-19 crisis. This research has the implication to provide benefits for students' FMS and social development, as well as becoming important information for teachers to improve both aspects. Therefore, our study aims to investigate the effects of traditional sport on increasing students' FMS and social attitudes during the COVID-19 period. We hypothesized that: traditional sports programs have a significant effect on improving students' FMS and social attitudes.

Materials and Methods

Study participants

This study adopted a pre-experimental method with One Group Pretest-Posttest Design (Fraenkel & Wallen, 2012). There were 30 subjects came from 3 elementary schools located in Yogyakarta city (Indonesia) and they were selected using a random sampling technique. Before the research was carried out, all subjects were given an explanation regarding the rules in this research and they were asked to sign a statement letter that describe their willingness to participate in all activities in this research. The detail on the characteristics of the subject is presented in Table 1.

Table 1. Subject Characteristics

Explanation	Frequency	%
Gender		
Male	15	50
Female	15	50
Age		
11 years	7	23
12 years	10	33
13 years	13	43
Weight		
35 kg	5	17
36 kg	15	50
37 kg	10	33
High		
135 cm	6	20
136 cm	16	53
137 cm	8	27
Class		
5	9	30
6	21	70
School		
Elementary School 1	10	33
Elementary School 2	10	33
Elementary School 3	10	33

Instrument

Fundamental movement skills. The instrument for assessing FMS among students was the Test Gross Motor Development (TGMD-2) second edition created by Ulrick in 2000 (Cohen, Morgan, Plotnikoff, Callister & Lubans, 2014). The FMS test consists of a locomotor movement test and an object control test (De Meester et al., 2016; Ryu, Lee, Liu, McDonough & Gao, 2021). Each FMS in TGMD-2 is accompanied by performance criteria. For example, in locomotor motion the criteria was: running, leap, jumping, horizontal jump was carried out correctly according to the assessment norm, then subject would get a score of 1 to 4 and if the activity did not match the assessment norm the subject would obtain a value of 0. Meanwhile, for object control, there were three performance criteria for catching movement: a.) the preparatory phase in which the hands are in front of the body and the elbows are bent, b) the arms are outstretched while reaching for the ball as the ball enters, and, c) the ball is caught with the hands only. Each student tried twice for each movement skill and was assessed on the performance criteria (Vernadakis, Papastergiou, Zetou & Antoniou, 2015). The total score of children (the sum of individual scores) was calculated. This instrument has a Cronbach Alpha reliability coefficient of 0.90, and a validity coefficient scale of 0.87 in this study.

Social Attitude. Instruments for assessing students' social attitudes was a questionnaire of Physical Education Activity Attitude with a Likert scale from score 1 = strongly agree to 5 = strongly disagree (Zeng, Hipscher & Leung, 2011). The questionnaire consists of 27 items questions. This instrument has a Cronbach Alpha reliability coefficient of 0.92, and a validity coefficient scale of 0.93.

Table 2. Traditional Sport Program

Meeting	Types of game	How to play	Repetition/Rest
Week 1-3	Benteng Bate	This sport is played by 4-6 people. Players are divided into two groups, where the first group is tasked with throwing the ball so that it hits the arranged ceramic shards and the second group is tasked with guarding. If the arranged ceramic shards can be knocked down by the ball, then the throwing group must run to find a hiding place and the watch group must catch the throwing group.	This sport is done for 4 repetitions and each repetition is done with a duration of 5 minutes. In addition, each repetition of students are given a rest for 5 minutes.
Week 4-7	Ketik Kuda	This sport is played by 5-10 people. Players are divided into two groups, where the first group is tasked with keeping the ball in the circle from being taken. While the second group (thief) tries to steal the ball contained in the circle.	This sport is done for 4 repetitions and each repetition is done with a duration of 5 minutes. In addition, each repetition of students are given a rest for 5 minutes.

Study organization

This research was conducted from January to February 2022 at Yogyakarta State University for 7 weeks with three times meetings in a week, namely Tuesday, Wednesday and Saturday. This research has been approved by the ethics committee of Yogyakarta State University (N0:458/UNY/2022). In addition, this research has followed the guidelines of the Declaration of Helsinki for research with human objects. On the first day, 30 subjects carried out the initial test, namely

the FMS test and filling out a social attitude questionnaire from 0.08 to 10.00 in the morning. On the second day all subjects received treatment, namely traditional sport for 40 minutes. This treatment was carried out for 13 meetings and in the last meeting, all subjects carried out the FMS test and filled out social attitude questionnaires. The traditional sport programs are presented in Table 2.

Statistical analysis

All data was analyzed using the IBM SPSS version 25.0 to test descriptive statistics presented in the form of $M \pm SD$ and data normality (Shapiro-Wilk). Meanwhile, Paired sample t-test was used to observe the improvement of students' FMS and social attitudes before and after the intervention of traditional sport programs. The level of significance was 0.05.

Table 3. Descriptive statistics (n = 30)

Variable	Pre-Test		Post-Test	
	Male	Female	Male	Female
	M(SD)	M(SD)	M(SD)	M(SD)
FMS (Locomotor)	2.33(.488)	1.93(.458)	3.93(.258)	4.00(.000)
FMS (Object Control)	2.13(.640)	1.60(.507)	3.93(.258)	3.87(.352)
SA	2.67(.617)	3.07(.884)	4.47(.516)	4.60(.507)

Note: M = Mean; SD = Standard deviation; FMS = Fundamental movement skills; SA = Social Attitude

Results

The normality test of data in this study showed normally distributed ($p = 0.144 > 0.05$). Meanwhile, Table 3 shows

Table 4. Paired t-test analyses of pretest and posttest scores of FMS and Social Attitude grade 5 students (n = 9)

Variable	Pretest-Posttest			Pretest-Posttest		
	Male			Female		
	M(SD)	t	p-value	M(SD)	t	p-value
FMS (Locomotor)	2.11(.782)	8.102	0.000	2.56(.527)	14.54	0.000
FMS (Object Control)	1.33(.500)	8.000	0.000	1.88(.601)	9.430	0.000
SA	1.11(.333)	10.000	0.000	1.33(.333)	4.000	0.004

Note: M = Mean; SD = Standard deviation; FMS = Fundamental movement skills; SA = Social Attitude

Table 5. Paired t-test analyses of pretest and posttest scores of FMS and Social Attitude grade 6 students (n = 21)

Variable	Pretest-Posttest			Pretest-Posttest		
	Male			Female		
	M(SD)	t	p-value	M(SD)	t	p-value
FMS (Locomotor)	1.33(.483)	12.649	0.000	1.42(.507)	12.910	0.000
FMS (Object Control)	1.28(.463)	12.728	0.000	1.23(.539)	10.527	0.000
SA	1.19(.512)	10.66	0.000	1.42(.811)	8.076	0.000

that traditional sport programs have a significant effect on increasing FMS ($p < 0.05$) and social attitudes ($p < 0.05$).

Discussion

Our study aims to investigate the effect of a traditional sport program for 7 weeks during the COVID-19 pandemic as an effort to improve students' FMS and social attitudes. Our hypothesis proves that traditional sports programs has a positive effect on improving FMS and social attitudes abilities among students. Traditional sport are basically motion activities in the form of fun games, which encourage students actively move and have much more movement experience (Suherman et al., 2019). According to Lestari and Ratnaningsih (2016), if exercises activities has abundant motion experience, they will certainly have an optimal impact on the development of FMS among students. The results of this study are in line with previous research which explains that traditional sport are learning programs that have many traditional games, such as "Banteng Bate" and "Ketik Kuda", thus providing an effective impact on increasing students' basic movement level (Fatoni et al., 2015; Suherman et al., 2019; Saputra et al., 2021). In fact, a study confirmed that traditional sport programs are more effective than daily activities for developing FMS (Akbari et al., 2009). However, other studies have shown different results, namely not all traditional sport can be used as pedagogical tools to improve students' movement skills, so they need to be adapted to the characteristics of students (Suherman et al., 2019). Considering the diversity of types and differences among traditional sport towards the development of students' basic movement skills.

The second finding in our study showed that traditional sport have a positive impact on improving students' social attitudes. According to previous study reports, traditional sport not only have significant capability to develop students' movement skills but can also be used to develop social skills, because it has the values of discipline, responsibility, exercises, honesty, tenacity, patience (Dewi & Verawati, 2021). Moreover, this exercise can train teamwork and build a friendly, caring, and patient character. Traditional sports provide a valuable experience for students to interact with each other, show each other care, cooperate and motivate each player. This kind of social interaction is expected in every game and sport that will be carried out, children will become more communicative and care about others and have high motivation in achieving goals (Irmansyah, Lumintuarso, Sugiyanto & Sukoco 2020). According to the findings in previous studies, it was explained that traditional sport has an extraordinary culture and value for developing students' abilities, including skills, manners, activity, creativity, and practice, and a means to develop students' abilities (Widodo & Lumintuarso, 2017; Veldman et al., 2018). This study supports previous studies that reported the same result, namely that traditional sports were effective in improving social aspects in students (Nugraha, Handoyo & Sulistyorini, 2018; Nur, Ma'mun & Fitri, 2020; Irmansyah, Lumintuarso, Sugiyanto & Sukoco 2020).

Conclusions

This study confirms that the traditional sport program which was carried out for 7 weeks had a significant effect on

improving students' FMS and social attitudes. This research has implications as a way for students to continue to use this traditional sport in the long term during the COVID-19 pandemic to gradually improve FMS and social attitudes. In addition, the results of this study serve as literature to provide important information for lecturers, teachers about the benefits resulting from traditional sports.

Similar to other studies, this study also has limitations in terms of the small number of research subjects, so it is recommended for further research to use a large number of research subjects from several elementary schools in Indonesia. In addition, future research is expected to try to analyze the effects of traditional sports with other types (e.g., sondah, engrang, gatrik, boy-boyan, gobak sodor, bakiak, balap karung, tarik tambang dan galah asin) originating from other areas in Indonesia

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Conflict of interest

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

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МОДЕЛЬ НАЦІОНАЛЬНИХ ВИДІВ СПОРТУ ДЛЯ ПОКРАЩЕННЯ ОСНОВНИХ РУХОВИХ НАВИЧОК І СОЦІАЛЬНИХ УСТАНОВОК В УЧНІВ ПІД ЧАС ПАДЕМІЇ COVID-19

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Авторський вклад: А – дизайн дослідження; В – збір даних; С – статаналіз; D – підготовка рукопису; E – збір коштів

Реферат. Стаття: 6 с., 5 табл., 34 джерела.

Мета дослідження. Пандемія COVID-19 спричинила багато негативних наслідків, включаючи суттєве зниження рівня розвитку основних рухових навичок і соціальних установок в учнів, що стає основною проблемою цього дослідження. Отже це дослідження має на меті вивчення впливу національних видів спорту на покращення основних рухових навичок і соціальних установок.

Матеріали та методи. У цьому дослідженні використовували експериментальний метод із планом дворазового попереднього та підсумкового тестування. Учасниками дослідження були учні початкових класів у місті Джок'якарта (Індонезія), і вони були відібрані методом випадкової вибірки (n = 30). Програму національних видів спорту проводили

протягом 7 тижнів зі зборами раз на тиждень. Як засіб оцінювання рівня розвитку основних рухових навичок учнів використовували тест на розвиток великої моторики, а соціальні установки оцінювали за допомогою анкети «Ставлення до фізично-виховної діяльності». Для перевірки нормальності розподілу цих даних використовували критерій Шапіро-Вілка, а для оцінки відмінностей між значеннями рівня розвитку основних рухових навичок і соціальних установок учнів до та після виконання програми використовували t-критерій Стюдента для парних вибірок.

Результати. Результати цього дослідження показують, що національні види спорту значно сприяють покращенню основних рухових навичок ($p < 0,05$) і соціальних установок ($p < 0,05$).

Висновки. Таким чином, програми національних видів спорту можна використовувати як альтернативну фізичну активність, яку вчителі фізичного виховання можуть використовувати під час кризового періоду пандемії COVID-19.

Ключові слова: національні види спорту, основні рухові навички, соціальні установки, експериментальний метод.

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ORIGINAL SCIENTIFIC ARTICLE

VALIDITY AND RELIABILITY OF POLAR V800 SMART WATCH TO MEASURE CRICKET-SPECIFIC MOVEMENTS

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Abstract

The study purpose was to assess the reliability and validity of Polar V800 smart watch in measuring various cricket-specific movements.

Materials and methods. Only one trained male volunteer was selected to perform all the cricket specific movements to minimize individual error and eliminate between-subject variability. Polar V800 obtained distances were compared with real field markings.

Results. Split-half Reliability Statistical method has been used and 'r' score for the measurements taken has been found to be 0.93. 95% confidence intervals also express a good reliability score. The criterion validity method was used to determine the validity of the dataset. The Pearson correlations (r) have been found ranging from 0.86 to 0.99. Predicted best fit line of linear regression has been found as $y = 0.9722 X + 0.0046$ (where y = observed value, X = real field distance). One way ANOVA followed by Tukey's post hoc test on observed 10m sprint, 20m sprint and run-a-three movements show maximum significant difference with other cricket-specific movements. The mean percentage of bias for all cricket-specific movements has been found to be -2.20 ± 13.17 .

Conclusions. The study reveals that Polar V800 smart watch has an acceptable accuracy, reliability, and validity for measuring various cricket specific movements with certain limitations.

Keywords: Polar V800, GPS, reliability, validity, cricket-specific movements.

Introduction

Quantification of movement patterns using smart watch based global positioning system (GPS) monitors are rapidly increasing. Keeping in pace with the changing and developing technology world, the application of GPS has been started in sports science as an alternative way of time motion analysis (Dobson & Keogh, 2007). According to the available literature, Australian Football League first used a GPS monitoring system to quantify game demands in field-based team sports and gradually infiltrated to other team sports (Aughey, 2011). Initially, GPS trackers were available in the form of innerwear; thereafter Polar Electro Oy manufactured a GPS compatible heart rate monitor. That became the Polar V800 smart watch (May 2014). In the meantime,

several manufacturing companies launched GPS enabled smart watches such as Garmin Forerunner 910XT (Jan-Apr 2012), Suunto Ambit2 (May 2013). Out of all available GPS smart watches, Polar V800 smart watch is a robust, compact and reliable GPS receiver module, based on SiRFstarIV architecture which provides an accuracy of $\pm 2\%$ in distance measurement and accuracy of ± 2 km/h in speed measurement for any outdoor sport (Polar Electro Oy [PEO], 2013, p. 97). It has a 1Hz positional updating rate in high accuracy mode and has an internal accelerometer also that measures cadence from hand movement (Hernández-Vicente, Santos-Lozano, De, & Garatachea, 2016).

Cricket is one of the most popular team sports nowadays. Despite its' popularity there are only a few detailed works carried out in the field of cricket. Nowadays, due to peer pressure coaches, trainers as well as players take the initiative to learn about the game specific fitness requirements, game demands. Now, researchers are focusing on analyzing actual game demands by some typical methods

such as time-motion analysis. Global Positioning System (GPS) technology has taken a prominent role to quantify player movements in terms of time-motion analysis (Dobson & Keogh, 2007) and for that specific purpose Polar V800 seems to be the right choice. However, there is no such study expressing validity and reliability of polar V800 smart watch to measure various cricket-specific movements. Therefore, the present study has been undertaken to assess the reliability and validity of the polar V800 smart watch in measuring various short-format cricket-specific movements.

Materials and methods

Study participants

In the current study, only one trained male volunteer having age, height and body mass as 21 years, 176 cm, and 64 kg, respectively, was engaged to minimize individual error and eliminate between subject variability (Jennings, Cormack, Coutts, Boyd, & Aughey, 2010; Petersen, Pyne, Portus, & Dawson, 2009).

The volunteer was informed about the study content and written consent was taken. He was verbally instructed to follow the marked line as closely as possible and was familiarized with the test protocol. He wore the smart watch on his left hand with the dial facing up and started the trial af-

ter a two-minute stabilization period. Higher GPS accuracy mode was selected for the test (PEO, 2013, p. 97). The study was approved by the Ethical Committee of Ramakrishna Mission Vivekananda Educational and Research Institute.

Study organization

Short-Format cricket-specific movements are categorized as follows: standing (< 0.5 m/s), walking (0.5 - 2.0 m/s), jogging (2.0 - 3.5 m/s), running or striding (3.5 - 5.0 m/s), sprinting (> 5.0 m/s), trigger step out and run, run-a-three and curve running (Coutts & Duffield, 2010; Jennings, Cormack, Coutts, Boyd, & Aughey, 2010; Petersen, Pyne, Portus, & Dawson, 2009).

To measure the static error of the device, the volunteer was asked to stand still for a period of 60 seconds. The volunteer was instructed to perform all the movements listed in Table 1 separately, 30 times.

During the run-a-three trial the volunteer was instructed to cover real field distance (instead of touch and go). A circuit of 180.00 m (Figure 1) was designed to replicate all the cricket-specific movements in a single bout (Coutts & Duffield, 2010; Jennings, Cormack, Coutts, Boyd, & Aughey, 2010).

Table 1. Marked cricket specific movements patterns

Cricket specific movement patterns	Measuring marked distance (m)	Speed (km/h)	Remarks
Standing position	0.00	> 1.80	Stand still
Walking	10.00 and 20.00	1.80-7.20	Straight line
Jogging	10.00 and 20.00	7.20-12.60	Straight line
Running/Striding	10.00 and 20.00	12.60-18.00	Straight line
Sprinting	10.00 and 20.00	< 18.00	Straight line
Trigger, step out & run	10.00	Self selected pace	Diagonal and straight
Curve running	20.00	Self selected pace	Arc of a circle ($r=27.43$ m)
Run-a-three	17.68 m* 3 times	Self selected pace	To and fro
Circuit (figure 1)	180.00	Instructed pace	Mixed movements

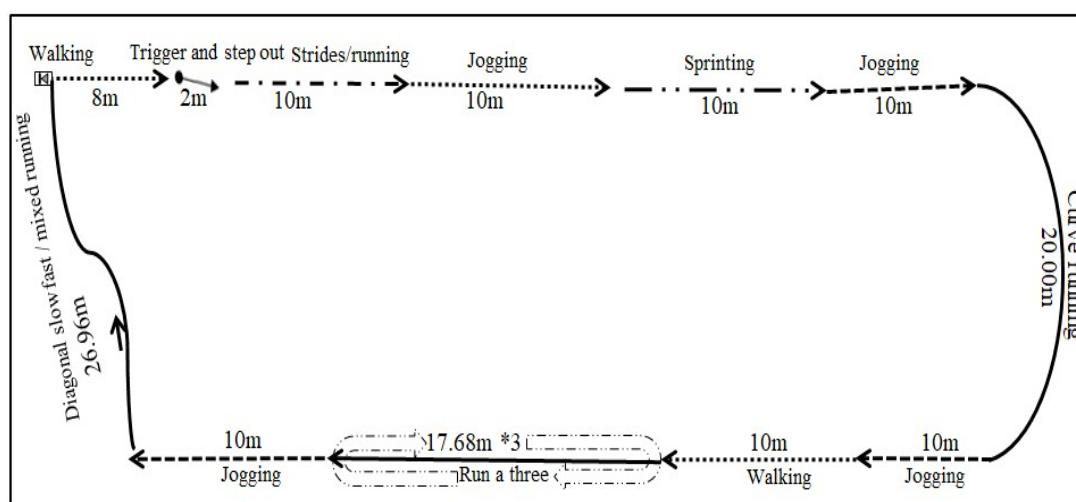


Figure 1. Circuit diagram of cricket specific movements

The experiment was done on a cricket ground between 3:30 pm to 5:00 pm and according to the local weather report, environment temperature, precipitation, humidity and wind speed has been found to be 31°C-37 °C, 0%, 57%-78% and 6-11 km/h respectively. There are no big trees, buildings or any other obstructions surrounding the ground, which helped to minimize the satellite response error of the watch (Benjamin, 2018). One certified timekeeper of the West Bengal Athletics Association assisted to track the time laps of each movement. The actual distance was measured by using a standard measuring tape and speed was monitored using a specific lap time value of known distance. Total distance covered and average speed data were collected concurrently. Obtained distance data were compared with real field marking and speed was calculated using the distance covered by the time elapse formula.

Statistical analysis

The hypotheses of normality and homogeneity of the variance were analyzed via Anderson-Darling test. Data were also cross-checked using Shapiro-Francia test to confirm the assumption of normality and homogeneity of variances. Most of the data were found to be normally distributed, so parametric analysis was performed.

The reliability of measurements was evaluated through the Split-half Reliability Statistical method which was used to measure the consistency of the scores of a test (Frey, 2018; Stephanie, 2016). The intra-class correlation coefficient (ICC) was also measured to understand reproducibility or consistency of the data measuring the same distance repeatedly (Garnacho-Castaño et al., 2021). The standard error of the estimate (SEE) and coefficient of variation (CV) were measured to understand the accuracy of predictions (Jennings, Cormack, Coutts, Boyd, & Aughey, 2010; Petersen, Pyne, Portus, & Dawson, 2009). The 95% confidence level was used to determine the precision of estimated difference. Bias and the percentage of errors (% of error) were also calculated to figure out error estimates as well as to report accuracy of measurement (Stephanie, 2013; Petersen, Pyne, Portus, & Dawson, 2009). The correlation coefficient (r) and regression technique were used to evaluate the linear association and strength of a relation between two sets of observations. The Bland-Altman plot (B&A plot) was used to quantify intervals of an agreement by constructing limits of agreement (Giavarina, 2015) as well as observing whether real field distance and polar V800 obtained distance gave different results or not. The B&A plot has also been designed to evaluate the bias in mean differences and to estimate an agreement of confidence limits, within 95% of the differences of polar V800 smart watch, compared to real field distance. The validity of the test was assessed using the Real field Validity method. The data were converted into percentile scores and a one-way single factor ANOVA followed by Tukey's post hoc test was performed to uncover specific differences among groups. The numerical value of accuracy of all short format cricket-specific movement patterns was also measured to examine the closeness of observed value to the real field distance. The least significant difference and Cohen's D effect sizes were intended to understand the magnitude of differences (Williams, & Abdi, 2010; Lakens, 2013). The level of significant for this study has been chosen as $\alpha \leq 0.05$.

Data sorting, statistical analysis and graphical representation were done using MapSphere GPS Track Editor v.1.15 beta (build 141), Gnumeric Spreadsheet 1.10.16, and Polar FlowSync.

Results

The reliability of the data set was measured through the Split-half Reliability Statistical method. The adjusted r score (estimated by Pearson product moment correlation coefficient followed by Spearman-Brown prophecy formula) was found to be 0.93 in odd-even method and 0.82 in half-way method. The ICC has been found 0.997 which indicates a very low quartile range meaning a high tendency to resemble interclass data. The SEE, CV and % of error of short format cricket-specific locomotive movements have been displayed in Table 2.

Table 2. Alternative validity and reliability measures of cricket specific movement patterns

Movement patterns	Distance (m)	SEE	CV	% of error
Walking	10.00	0.16	0.09	-0.03
	20.00	0.44	0.11	0.10
Jogging	10.00	0.24	0.14	-0.02
	20.00	0.42	0.11	0.10
Striding/Running	10.00	0.19	0.11	-0.06
	20.00	0.37	0.11	-0.07
Sprinting	10.00	0.21	0.13	-0.10
	20.00	0.61	0.19	-0.12
Trigger, step out and run	10.00	0.29	0.15	0.07
Curve running	20.0	0.26	0.07	-0.03
Run-a-three	17.68*3times	0.52	0.06	-0.09
Circuit	180.00	0.94	0.03	-0.02

The Pearson correlations (r) for real field distance and all measured cricket specific movements have been found to be ranging from 0.86 to 0.99 and with pooled data r has been found 0.998. Predicted best fit line of linear regression has been found as $y = 0.9722 X + 0.0046$ (where y = observed value, X = real field distance). The coefficient of determination ($R^2 = 0.996$) indicates homoscedasticity by nature, which indicates that as the number of measurements increase, only trivial measurement differences arise. The percentage of mean differences of observed pooled data against real field distances has been found to be $-2.20 \pm 13.17\text{m}$ in B&A plot (Figure 2).

The data suggest that on average polar V800 smart watches underestimate by 2.20% for the distance than the real field measurements. The limits of agreement mean ± 1.96 SD has been found -23.61 m to 28.01 m . From figure 2 it could be understood that a major portion of pooled data lies between the confidence limits, only a few data points lay outside the limits. As more than 95% (approx.) data were lying inside of the limit, it indicates that there is a strong agreement between the tests. All the data converted in percentile

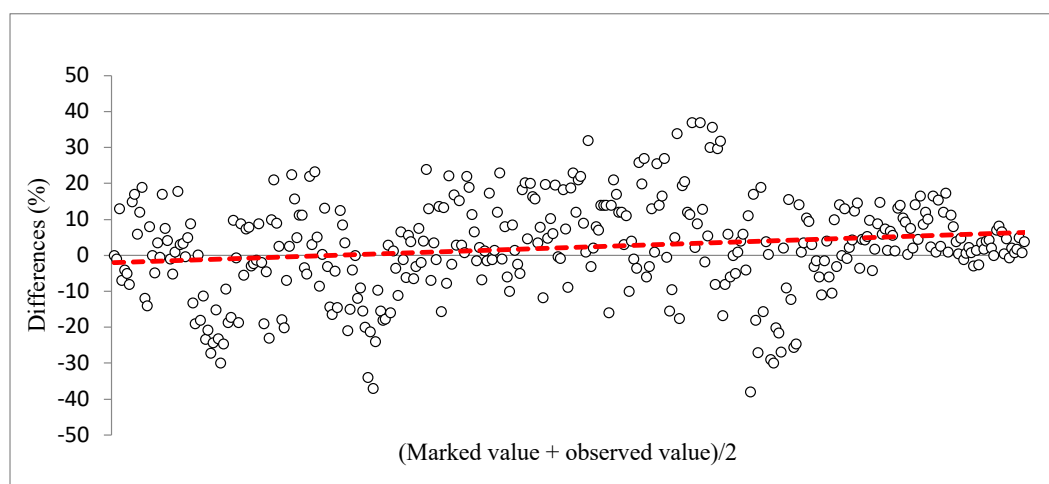


Figure 2. The Bland-Altman Plot

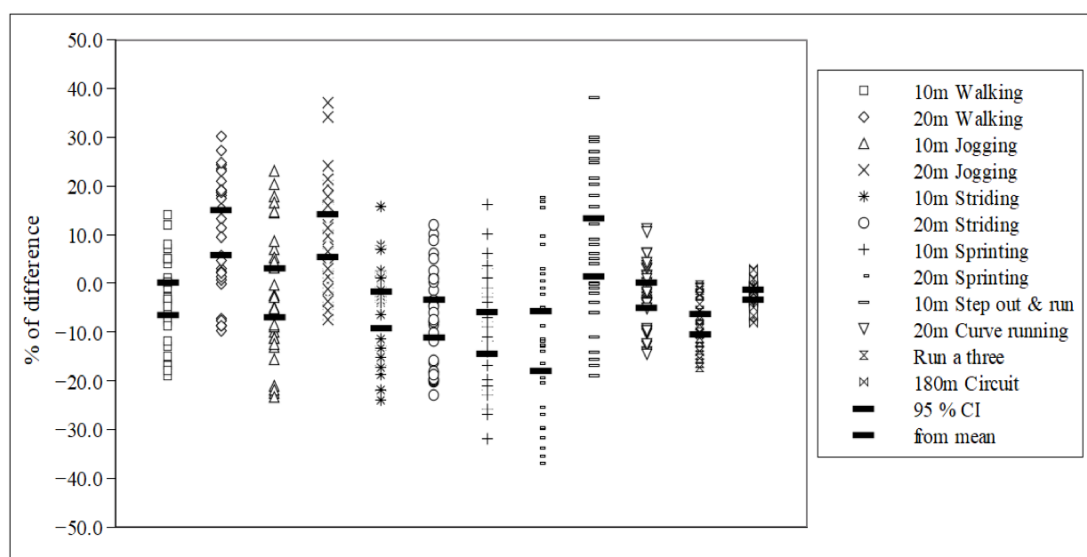


Figure 3. Graphical representation of bias with 95% confidence intervals

score and one way single factor ANOVA followed by Tucky's post hoc test were performed to uncover specific differences among groups.

The observed 20m walking, 20m jogging, 10m sprinting, 20m sprinting and run a three movements shows maximum significance difference with others observed movements but medium magnitude of differences (-0.43, -0.42, 0.44 and 0.36 respectively) has been observed with real field distance. The percentage of least significant difference has been observed 5.49 and the majority of the data set did not display significant difference with real field distance.

Bias was determined by subtracting the real field distance from the GPS estimated distance and evidence of bias has been observed in Figure 3.

The 95% CI of bias for all movements has been found to range from -3.15 to 14.84. All the data were pooled and compared with real field distance and no significant difference has been observed. Mean with SD, SEE and 95% CI for pooled data has been found to be 97.80 ± 13.17 , 0.69, 96.44-99.17 respectively. The distribution pattern of the data

clearly exposes random errors which come from an internal and external property of GPS, polar V800 smart watch and human locomotion error.

Discussion

One minute standing position was monitored to understand the static error of the smart watch. Due to natural error of GPS readings or inherent property of polar V800 a mild displacement (> 1.0 m/min, maximum speed > 0.9 km/h) has been found. Polar V800 smart watch has the ability to update the distance calculation in real time along with tracking a wide variety of activities (PEO, 2013, p. 56 & 97-98). There is an inherent error in the GPS location calculation, but under optimal conditions, the error can be minimized. Errors happen due to clock drift of the satellites and signal propagation delay in the upper atmosphere (Benjamin, 2018). Another source of error is a multipath delay, which occurs when the signal bounces off objects (building, big tree) before arriving at the receiver (Aughey, 2011; Benjamin, 2018). During

low intensity activities such as walking, jogging a tendency of overestimating distance covered has been observed. This finding also supports the finding of Benjamin Bennett (2018), four alternative methods used to explore observed data such as raw GPS data, GPS speed data, average GPS data and line of best fit. Both raw GPS data and line of best fit methods overestimate the total distance with low variance. With a high variance, GPS speed method misjudged the total distance traveled for all types of activity. During trigger-step out and run movement a tendency of overestimation real field distance has been observed might be due to across step out by the volunteer. As the speed increases a clear picture of underestimation of real field distances has been observed in the study. This finding was also supported by Coutts and Duffield (2010); and Jennings, Cormack, Coutts, Boyd, and Aughey (2010). In real time experience during walking and jogging one second backlog time has been found in exported data but as the speed increases backlog time also increases up to four seconds. So it can be misleading to measure speed. During low and moderate intensity activity speed can be measured through exported data but when speed increases it could be quite complex to measure accurate data because of the limitation of 1Hz GPS monitor. Cricket specific run-a-three movements also underestimate real field distance (Petersen, Pyne, Portus, & Dawson, 2009), due to quick changes of direction (>1 sec) the watch is unable to estimate real position. During run-a-three movement conditions, the volunteer runs in a slight curvilinear pathway instead of straight line that means the volunteer covered more than real field distance but observed data did not exhibit this. A small quartile range has been observed in the 180m cricket specific circuit which clearly indicates as the distance increases the reliability also increases to measure specific distance. Polar V800 smartwatch updates latitude and longitude in every second and sets distance accordingly. So as the duration of time and distance increases the accuracy of measurement also increases but when it's about speed the coaching expert should focus on the number of high intensity bouts instead of maximum speed (distance covered/ time) and train accordingly. The reliability of polar V800 to measure locomotion patterns was found better in longer distances and larger time periods. As the locomotion speed increases the reliability decreases. This outcome is a replica (reduced reliability with increased movement velocities) finding of Benjamin (2018); Coutts and Duffield (2010) and Petersen, Pyne, Portus, & Dawson (2009). Although a good reliability score was observed in cricket specific movement circuits. As per the theoretical agreement of Polar V800 manual, the smart watch demonstrated a good level of accuracy for the actual measured distance in various movement patterns (GAGPORW, 2018; PEO, 2013, p. 97). Some error has been observed between actual and measured distance and that is also supported by previous research (Benjamin, 2018; Coutts & Duffield, 2010; Petersen, Pyne, Portus & Dawson, 2009). A good overall significant intra-model reliability has been observed in distance measure through split-half reliability methods. The B&A plot, CV and 95% CI also reflect the statement. It also found, as the distance decreases and speed increases the SEE and CV become relatively larger. A limitation of this study is peak speed was not directly measured. As we know, cricket is an intermittent sport, long periods of low-moderate intensity activity (standing, walking, jog-

ging) interspersed with short bursts of high-intensity (striding, sprinting) activity with brief maximal accelerations. The sampling rate of Polar V800 smart was at 1-Hz which may not provide accurate information regarding speed trails (high-intensity activities) in nonlinear pathways, but as the inherent property of the smart watch it could give quite accurate distance measurement.

Effective training schedules largely depend on physiological demands and movement patterns of certain sports (Aughey, 2011). From this point of view, effective evaluation of cricket specific movements is important to prescribe fitness and condition programs. The accuracy of polar V800 has been observed -3.8 to 3.1 for measuring real field distance which also indicates random errors. A major finding of this investigation is to underestimate the distance covered in short sprint effort as well as run-a-three movements. The magnitude of errors associated with random errors should be clearly understood because no consistency of positive or negative errors has been observed in measuring true value. Sometimes it underestimates the true value and sometimes overestimates. Although when it is about precision (95% CI) then we can observe it includes true value or very close to true value. A tendency of under-reporting of high-intensity activity and the over reporting of low-intensity activity has been observed. The range of typical error has been observed 0.63 to 3.65 and relatively high typical error has been observed in circuits followed by run-a-three and short high intensity movement patterns.

Theoretically, it is possible because the number of GPS signals is lower during shorter sprints (GPS Accuracy, n.d.), so the distance of these sprints is underestimated and has reduced reliability. One study (Jennings, Cormack, Coutts, Boyd & Aughey, 2010) reported validity results for measured distance at lower intensity activity same as our current results (typical errors 1.51 ± 0.87). They found typical errors increased with short duration and high-intensity efforts. GPS monitoring is useful to track cricket specific movement patterns both in game situations and practice sessions to modify type of physical activity, duration of training and intensity of conditioning sessions. The reliability of estimating longer distances is acceptable for game and training applications. However, the underestimation bias displayed with the GPS units studied here during sprinting may mean that total game sprint distance is underreported, whereas the total game distance may represent true distance with a little change. So, coaches should focus on variations in game to game total distance cover and high intensity workload should be prescribed according to the number of high intensity efforts.

Conclusions

The study reveals that Polar V800 smart watch has an acceptable accuracy, reliability and validity for measuring basic locomotion and cricket specific movements. Although due to the inherent property of polar V800 smart watch (maximum sample rate 1Hz in high accuracy mode) it has a tendency to underestimate speed but due to continuous latitude and longitudinal update it can measure distance effectively. From this point of view, we can conclude that, although there are some certain limitations to measured speed oriented specific movements but when we wish to measure distance of all crickets specific movement patterns together then Polar V800 smart watch may be a good choice.

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Conflict of interest

The authors declare no conflict of interest.

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ТЕХНІЧНА ПРИДАТНІСТЬ І НАДІЙНІСТЬ СМАРТ-ГОДИННИКА POLAR V800 ДЛЯ ВИМІРЮВАННЯ ПРИТАМАННИХ КРИКЕТУ РУХІВ

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Метою дослідження було проведення оцінки надійності та технічної придатності смарт-годинника Polar V800 у процесі вимірювання різних притаманних крикету рухів.

Матеріали та методи. З метою скорочення до мінімуму індивідуальної похибки та усунення міжсуб'єктної варіабельності для виконання всіх притаманних крикету рухів було відібрано лише одного тренованого чоловіка-волонтера. Показники відстані, одержані за допомогою Polar V800, порівнювали з фактичними відмітками на полі.

Результати. Використовували статистичний метод перевірки надійності тесту шляхом співставлення окремих його частин, і було встановлено, що показник «г» для здійснених вимірювань дорівнює 0,93. Довірчі інтервали 95% також відбивають досить високий показник достовірності. Для визначення валідності цього набору даних використовували метод критеріальної валідності. Було встановлено, що коефіцієнти кореляції Пірсона (r) перебувають у діапазоні від 0,86 до 0,99. Було встановлено, що прогнозована найкраща емпірична крива лінійної регресії описується формулою $y = 0,9722 X + 0,0046$ (де y = виміряне значення, X = фактична відстань на полі). Однофакторний дисперсійний аналіз із наступним апостеріорним тестом Тьюкі, проведені стосовно виміряних значень рухів бігу на 10 м, бігу на 20 м та потрійного бігу вздовж усього пітча з двома поворотами на 180°, показують максимальну статистично значущу різницю з іншими притаманними крикету рухами. Установлено, що середня відсоткова похибка вимірювання стосовно всіх притаманних крикету рухів становить $-2,20 \pm 13,17$.

Висновки. Результати дослідження показують, що смарт-годинник Polar V800 має прийнятну точність, надійність і технічну придатність для вимірювання різних притаманних крикету рухів із певними обмеженнями.

Ключові слова: Polar V800, GPS, надійність, технічна придатність, притаманні крикету рухи.

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THE CORRELATION ANALYSIS BETWEEN SUBJECTIVE AND OBJECTIVE INDICATORS OF PHYSICAL DEVELOPMENT OF STUDENTS OF 5TH AND 9TH GRADES

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Abstract

The study purpose was to investigate the correlation between the objective results of measurements of somatometric and physiometric indicators of physical development and the subjective indicators of its self-description for students of 5th and 9th grades.

Materials and methods. The study was conducted in Lutsk secondary school 17 involving 120 secondary school students (aged 10 and 15) as participants. Research methods: analysis of data of scientific and methodical literature, normative-legal documents, programs on physical culture, pedagogical testing of physical fitness, methods of mathematical statistics, E.V. Bochenkova test-questionnaire "Self-description of physical development".

Results. The correlation analysis between the results in mobility tests for strength, endurance, coordination and flexibility and self-assessment of these indicators by students of 5th and 9th grades shows that they differ. The 9th graders evaluate their physical abilities more objectively. This is due to gaining practical experience in physical education classes. The inadequacy of self-assessment of physical abilities shows that insufficient attention is paid to substantiating the importance of pedagogical control of physical fitness of students during the physical education classes.

Conclusions. The study demonstrates the inadequacy of self-assessment of physical fitness by students, which indicates the importance of theoretical presentation and practical implementation in physical education classes of pedagogical control and self-control of physical fitness, which should be an incentive for boys and girls' self-improvement in physical education.

Keywords: students, middle school age, physical development, motor fitness tests, self-assessment, adequacy.

Introduction

Taking into consideration the psychological and pedagogical aspects of health, first of all, it is necessary to note the importance of the emotional and evaluative components of this phenomenon (Krutsevich, Pangelova, & Trachuk, 2019a,b). The value of society's attitude to health is a guarantee not only of maintaining the current statistical level of diseases but also of reducing it. Work aimed obviously the

promoting a healthy lifestyle among school children as one of the key factors in improving the health of the population is absolutely impossible with insufficient development of the structure of understanding the value of health and its impact on the holistic psychological system of the self-concept (Bakiko, Radchenko, Faydevich, Chizh, & Konstankevich, 2003; Collins, Micheli, Yard, & Comstock, 2008; Trussell, 2009). The basic thesis of the theory of the self-concept formation in general, and the development of adequate-realistic self-esteem, in particular, in the context of the holistic development of individuality and personality were reflected and concretized in numerous investigations (Rogers, 1994; Fromm, 1994; Tangney, Baumeister, & Boone, 2004). It is

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considered that the self-concept is a set of human ideas about themselves, which is formed ontogenetically, including - and on the basis of human ideas about their body (Bakiko, Savchuk, Dmytruk, & Kovalchuk, 2021; Dedukh, 2018; Krasota, Olkhovyi, & Romanchuk, 2014). This concept reflects the aggregate idea of a human about the body, sensory, cognitive aspects of the body in human consciousness, unconscious aspects of the body, the physiological equivalent of the body, as well as a number of categories of subjectivity of the body existence.

The level of physical fitness and physical development can determine certain components of the self-understanding of the individual. This is due to one's own conscious reflection and the experiences associated with that reflection. It is possible to study human self-esteem among such components. In the case understand this phenomenon comprehensively, it is appropriate to study not only the psychological aspects of self-assessment of physical development of students, but also to determine the adequacy of self-assessment of their physical fitness by comparing actual self-assessment of students with self-assessment of physical development and health (Bakiko, & Cherkashin, 2021; Bakiko, Dmitruk, & Nikolaev, 2021; Bakiko, Savchuk, Dmytruk, & Kovalchuk, 2021).

The study of the properties of self-esteem, its adequacy, self-awareness, structure and functions of the image of self-understanding is not only theoretical but practical interest in connection with the formation of life position of students studying in secondary schools. Nowadays specialists focus a lot of attention at physical culture and sports to improve the control of physical development of students in the process of physical education (Bakiko, Kovalchuk, & Ivanova, 2021; Fedorenko, 2011; Dorsch, Smith, & McDonough, 2009). However, self-assessment of physical development in terms of physical fitness of students is a lack of scientific work.

The aforementioned provisions indicate the relevance of the research topic related to the solution of the issue, which is of significant theoretical and practical importance for improving the system of physical education of schoolchildren.

Self-esteem is an element of self-knowledge, reflection, which is characterized by emotionally rich assessment of oneself as a person, one's capabilities, critical attitude to oneself and thus affects the effectiveness of human activity. Self-esteem is formed during the development of children and adolescents under the influence of society and can reflect their value orientations, which stimulate or suppress activities aimed at self-development (Maevsky, 2016, 2019; Marchenko, 2018).

Marchenko conducted the research with 5-11 grades. It has been determined that in middle school age students have an overestimated self-esteem with low physical activity, but later the general level of self-esteem becomes more realistic and critical of their own health and appearance. However, the author did not conduct a correlation analysis between objective indicators of mobility test results and subjective indicators of self-assessment of the mobility for respondents (Krutsevich, Marchenko, Trachuk, Priymak, Panhelova, & Kholodova, 2021; Moskalenko, Yakovenko, Sidorchuk, & Marchenko, 2019).

The need to study the self-assessment of physical condition and comparison with the actual performance of students arose along with the need to examine the readiness

of 5th and 9th grades for self-control and self-improvement through physical education and is important for determining the effectiveness of pedagogical control of physical fitness at school, which should be an incentive to exercise both in and in curricular and extracurricular forms (Barnett, 2008; Olkhovyi, & Finohenov, 2015; dos Santos, Nevill, Buranaruga, Pereira, Gomes, Reyes, Barnett, & Maia, 2018).

From the point of view of the scientists of age psychology, there is an intensive formation of self-awareness in school age to reorient external evaluation, adult opinion, academic success on internal evaluation, on themselves, on their own personal qualities. There is the emergence of psychological discoveries, a system of values, orientation, priorities, goals, relationships with adults and peers. These changes affect various aspects of adolescents' lives, including the process of professional self-determination and psychological readiness for independent living (Barnett, Lubans, Timperio, Salmon, & Ridgers, 2018; Barnett, Telford, Strugnell, Rudd, Olive, & Telford, 2019; Bolger, Bolger, O'Neill, Coughlan, O'Brien, Lacey, Burns, & Bardid, 2021).

The purpose of the study is to investigate the relationship between the objective results of measurements of somatometric and physiometric indicators of physical development and subjective indicators of its self-description in students of the 5th and 9th grades.

Materials and Methods

Study participants

The research was conducted in Lutsk secondary school 17 with the participation of middle school students in the amount of 120 (5th grades – 60 (boys – 30, girls – 30), 9th grades – 60 (boys – 30, girls – 30). Their ages are 10 and 15 years. Informed consent was obtained from all students to participate in this experiment.

Study organization

The following research methods were used to solve this goal: analysis and generalization of data from scientific and methodological literature, legal documents, physical education programs; Bochenkova's test questionnaire "Self-description of the physical development"; physical fitness testing, anthropometric research methods, Rufier's, Robinson's index and Martine-Kushelevsky functional test indicators; correlation analysis; methods of mathematical statistics.

To study the individual profile of the physical self-understanding of the individual, Bochenkova's test questionnaire "Self-description of the physical development" was used (Bochenkova, 2000). The proposed questionnaire consists of 70 statements related to the field of physical development. During the answers, students express their attitude to statements about health assessment, coordination of movements, physical activity, slimness, athletic ability, global physical self-understanding, appearance, strength, flexibility, endurance and overall self-esteem using one of six answer options.

The following somatometric indicators were used for correlation analysis: body length (BL), body weight (BW), vital capacity of the lungs (VCL), wrist dynamometry, body mass index (BMI), vital index (VI), strength index (SI). Anthropometric examinations of children were performed with

standard equipment according to the generally accepted and unified method.

Physiometric parameters included measurements of resting heart rate (RHR), blood pressure (SBP and DBP), Robinson's index (RI), Rufier's test, Martine-Kushilevsky functional test (MK test) and physical fitness: 30 meters running (5th grades), 60 meters running (9th grades), 500 meters steady run (5th grades), 1500 meters (9th grades), flexion and extension of the arms emphasis lying down, lifting the torso to sit for 1 minute, long jump from a place, tilt the torso from a sitting position, "Flamingo test".

Statistical analysis

Mathematical processing of factual material was carried out in order to interpret the results of pedagogical experiments. The following mathematical procedures were performed:

- estimation and characteristics of variational series of parameters of representatives of different age and gender groups, namely – the sum (Σ), arithmetic mean of the variational series ($\bar{x}$);
- comparison and determination of the significance of differences between individual groups using Student's t-test at a level of significance not lower than 0.05;
- a pairwise correlation analysis between self-assessment of physical development and somatometric and physiometric indicators was carried out, on the basis of which the indicators with the highest degree of correlation were identified (r).

All data obtained during the study were processed using statistical software packages "STATISTIKA 7.0" and EXCEL.

The research procedure was conducted in accordance with the ethical standards of the responsible human rights committee with the approval of the Department of Education and Science of the Lutsk City Council and the written consent of school principals and parents of respondents, as evidenced by relevant documents.

Results

We notice the differences between the levels of correlations between boys and girls of different ages were found out in the comparison of the actual indicators of physical development with the indicators of the test-questionnaire "Self-description of physical development".

The study of the correlations between self-esteem of respondents of different ages and genders revealed some differences in the interdependence of physical qualities, health status, assessment of appearance and global self-understanding of the students.

In this case the 5th grade boys have the greatest correlation with the strength index (SI) with self-esteem ($r = 0.50$, $p < 0.01$). Correlation matrix SI with indicators of health, coordination, strength, body shape, appearance is at an average correlation level within ($r = 0.23-0.41$).

The 5th grades cannot adequately assess their coordination skills. The concept of sufficient "physical activity" for boys is associated with the perception of their physical strength ($r = 0.34$, $p < 0.05$) and the number of attempts to perform the "Flamingo" test ($r = -0.34$, $p < 0.05$). The boys

feel their "athletic ability" depending on their body length ($r = 0.34$, $p < 0.05$), the higher is the stronger, the forces of the right and left hands ($r = 0.37$, $p < 0.05$; $r = 0.33$, $p < 0.05$) and "Flamingo" test ($r = -0.36$, $p < 0.05$).

Strength abilities in self-assessment are related to the results of the Martine-Kushilevsky functional test ($r = 0.30$, $p < 0.05$), strength index ($r = 0.29$, $p < 0.05$) and negative correlation with the number of flexions and extensions of the arms in the emphasis lying down ($r = -0.32$, $p < 0.05$), however, with a low objective result in the test, self-assessment of strength training is inflated. Physical abilities such as flexibility and endurance have no significant correlation with mobility test results.

In general, the "self-assessment" of the physical development of the 5th grade boys is based on the indicators of the life index ($r = 0.42$, $p < 0.01$) and a strength index ($r = 0.50$, $p < 0.01$). The highest average correlation coefficients between self-esteem and actual indicators of physical development do not exceed $r = 0.19$, $p > 0.05$ (self-esteem) $r = 0.17$, $p > 0.05$ (slender of the body and athletic ability) (table 1).

Thus, fifth-grade girls demonstrated the highest level of correlation of the parameters studied was recorded between the Rufier Index, which characterizes physical performance and assesses the functional state of the cardiovascular and respiratory systems and the following indicators of the questionnaire "Self-description physical development": "self-esteem" ($r = 0.49$, $p < 0.01$), "body slenderness" ($r = 0.49$, $p < 0.01$), "appearance" ($r = 0.45$, $p < 0.01$), "movement coordination" ($r = 0.37$, $p < 0.01$), "strength" ($r = 0.33$, $p < 0.05$), "flexibility" ($r = 0.31$, $p < 0.05$) and "health" ($r = 0.28$, $p < 0.05$).

According to the adequacy of self-assessment of physical fitness of 5th grade girls, we did not find significant correlations between indicators of self-description of physical development and real indicators of physical fitness of girls.

"Movement coordination" for the 5th grade girls was compared with the results of motor tests: short distance run 4x9 m and "Flamingo" test, however, no significant correlations were found between them, indicating some difficulty in assessing one's own coordination abilities. Girls feel their athletic ability only through the Robinson's index ($r = 0.37$, $p < 0.01$), which was used to assess the functional state of the cardiovascular system. Indexes "strength" ($r = 0.33$, $p < 0.05$) and "flexibility" ($r = 0.31$, $p < 0.05$) have a moderate correlation with the results of the Rufier functional test. This fact can not indicate the adequacy of self-esteem, because the higher the Rufier index, the lower the physical capacity. "Endurance" is correlated with body length ($r = 0.33$, $p < 0.05$) and negative correlation with the Martine-Kushilevsky test ($r = -0.29$, $p < 0.05$).

The highest average correlation coefficients between self-esteem and actual indicators of physical development do not exceed $r = 0.18$, $p > 0.05$ (body slenderness and appearance) and $r = 0.15$, $p > 0.05$ (coordination of movements, strength and self-esteem), which indicates a low level of adequacy of self-esteem of physical development of the 5th grade girls (table 2).

Thus, we can say that the lack of significant correlations with the results of motor tests and functional indicators, indicates the low importance of pedagogical control of physical fitness in the process of physical education of 5th grade students.

Table 1. Correlation coefficients of self-assessment of physical development and somatometric and physiometric indicators of the 5th grade boys (n = 30)

Phys. train.	Self-esteem Health	Movement coord	physical activity	Body slender ness	Athletic abilities	Global self esteem	Appearance	Strength	Flexibility	Endurance	Self-esteem
BL	0.12	0.19	0.11	0.14	0.34	0.09	0.20	0.09	0.23	0.23	0.06
BW	0.10	-0.01	0.18	-0.18	0.07	0.03	0.02	0.18	-0.14	0.14	0.04
RHR	0.08	-0.06	0.04	-0.22	-0.09	-0.08	-0.18	0.05	-0.18	-0.13	0.12
SBP	0.22	0.10	0.31	0.15	0.29	0.14	0.12	0.14	-0.04	-0.07	0.35
DBP	0.07	0.16	0.23	0.15	0.27	0.13	0.21	0.22	0.06	0.21	0.18
VCL	-0.11	-0.14	-0.23	-0.22	-0.20	-0.21	-0.19	-0.26	0.02	-0.11	-0.24
Rufier's test	-0.10	0.08	-0.08	0.14	0.13	-0.02	0.11	-0.02	0.22	0.17	-0.05
MK test	0.19	0.17	0.26	0.21	-0.07	0.19	0.20	0.30	0.03	0.12	0.23
BMI	0.07	0.10	-0.02	-0.09	0.08	0.05	0.05	-0.02	0.01	0.21	-0.25
VI	0.13	0.28	0.15	0.36	0.02	0.15	0.19	0.16	0.10	-0.16	0.42
SI	0.23	0.27	0.11	0.41	0.20	0.22	0.32	0.29	-0.01	-0.04	0.50
Robinson's index	0.20	0.02	0.07	0.06	0.13	-0.06	0.03	0.03	-0.24	-0.13	0.19
30 metres run	-0.07	-0.04	-0.10	-0.11	-0.19	-0.04	-0.10	0.02	0.03	0.09	-0.13
steady running	0.05	0.04	0.04	0.14	0.15	0.01	0.10	-0.08	0.01	-0.12	0.09
Flexion and extension of the arms	-0.35	-0.34	-0.24	-0.24	-0.25	-0.23	-0.22	-0.32	-0.01	-0.05	-0.34
right hand strength	0.24	0.16	0.34	0.19	0.37	0.20	0.33	0.10	0.12	0.20	0.13
left hand strength	-0.01	0.06	0.21	-0.01	0.33	0.11	0.14	-0.04	0.21	0.22	-0.16
Lifting the torso	-0.13	-0.01	-0.08	0.07	-0.08	-0.12	-0.02	0.00	-0.03	-0.06	0.15
Distance jump	-0.25	-0.19	-0.18	-0.24	-0.10	-0.18	-0.15	-0.10	-0.03	0.08	-0.25
Short dist run	-0.21	-0.02	0.03	-0.21	0.12	-0.14	-0.10	-0.04	0.10	0.14	-0.10
Tilt the torso	-0.01	0.17	-0.02	0.14	0.05	-0.04	0.03	0.01	-0.03	-0.19	0.21
"Flamingo" test	-0.06	-0.17	-0.34	-0.22	-0.36	-0.19	-0.29	-0.14	-0.16	-0.23	-0.14
Total Σ	3.0	2.96	3.37	3.9	3.89	2.63	3.3	2.61	2.01	3.1	4.33
r arithmetic mean	0.13	0.13	0.15	0.17	0.17	0.11	0.15	0.11	0.09	0.14	0.19

Notice: $r_{(p=0.05)} = 0.2731$; $r_{(p=0.01)} = 0.354$

The correlation results of ninth-graders' testing show the highest number of correlations (table 3). To start with the analysis of the value of "health", which in the imagination of students is significant and a priority. In particular, a positive correlation was found between self-assessment of "health" and the results of the following tests: vital index (VI), ($r = 0.38$, $p < 0.01$), strength index (SI) ($r = 0.38$, $p < 0.01$) and long jump from a place ($r = 0.37$, $p < 0.01$), and a negative correlation with the Robinson's index ($r = -0.41$), RHR ($r = -0.32$), which suggests that with age, the adequacy of self-esteem "health" becomes more real and in their imagination is associated with the development of strength and functionality of the human body, which is a positive factor to form a healthy lifestyle. An analysis of the negative correlations between subjective assessment of "health" and body weight, length, and body lift shows that young men do not associate these indicators with the impact on their health.

The next indicator of self-description of physical development, which has strong correlations with many indicators, is "coordination of movements". There is a positive correla-

tion 3: SBP ($r = 0.31$, $p < 0.05$), DBP ($r = 0.44$, $p < 0.01$), right hand strength ($r = 0.31$, $p < 0.05$), lifting the torso to sit ($r = 0.31$, $p < 0.05$) and tilt the torso forward from a sitting position ($r = 0.56$, $p < 0.01$). But from these indicators we can not judge the adequacy of self-assessment of this quality. Negative correlation is observed in short distance running 4x9 m ($r = -0.51$, $p < 0.01$), Rufier's test ($r = -0.40$, $p < 0.01$), steady running ($r = -0.37$, $p < 0.01$), which is objective, because the lower these indicators, the better the result in the tests.

The self-description of "physical activity" is significant for 9th graders, as it is also closely correlated with many test results.

There is a positive correlation with body weight (MT, $r = 0.44$, $p < 0.01$), body mass index (BMI) ($r = 0.41$, $p < 0.01$), tilt the torso ($r = 0.50$, $p < 0.01$), negative correlation with the Rufier test result ($r = -0.45$, $p < 0.01$), short distance running (4x9 m) ($r = -0.46$, $p < 0.01$), which can be considered an adequate result of physical activity. But such positive correlations 3 RHR ($r = 0.46$, $p < 0.01$), Robinson's (RI) ($r = 0.51$, $p < 0.01$). Negative correlation with vital and strength in-

Table 2. Correlation coefficients of self-assessment of physical development and somatometric and physiometric indicators of the 5th grade girls, (n = 30)

Phys. train.	Health	Movement coord	physical activity	Body slender ness	Athletic abilities	Global self esteem	Appearance	Strength	Flexibility	Endurance	Self-esteem
BL	0.19	0.15	0.17	0.21	0.04	0.34	0.31	0.23	0.20	0.33	0.23
BW	-0.06	-0.09	-0.01	0.03	0.08	-0.06	0.06	-0.13	-0.12	-0.06	0.06
RHR	0.04	-0.27	-0.09	-0.11	-0.06	-0.04	-0.15	-0.16	-0.11	-0.03	-0.17
SBP	-0.15	-0.34	-0.16	-0.34	-0.08	-0.01	-0.27	-0.23	-0.23	0.02	-0.35
DBP	0.08	0.05	0.06	-0.02	-0.02	0.19	0.02	0.11	0.07	0.15	-0.02
VCL	-0.31	-0.17	-0.14	-0.32	0.03	-0.15	-0.04	-0.22	-0.23	-0.13	-0.25
Rufier's test	0.28	0.37	0.22	0.49	0.03	0.21	0.45	0.33	0.31	0.23	0.49
MK test	-0.12	-0.17	-0.03	-0.34	-0.04	-0.23	-0.27	-0.22	-0.20	-0.29	-0.13
BMI	0.06	0.03	0.05	0.22	-0.08	-0.03	0.16	0.17	0.00	0.04	0.20
VI	-0.13	-0.09	0.04	-0.37	0.16	-0.19	-0.24	-0.29	-0.14	-0.31	-0.12
SI	-0.07	-0.23	0.05	-0.32	0.17	-0.10	-0.22	-0.23	-0.08	-0.13	-0.12
Robinson's index	0.07	0.08	0.20	-0.08	0.37	-0.04	-0.08	0.04	0.11	-0.16	0.02
30 metres run	0.03	0.08	0.09	0.02	0.05	0.20	0.15	0.12	0.11	0.19	0.06
steady running	0.00	-0.05	-0.06	0.05	-0.04	-0.14	-0.07	-0.09	-0.09	-0.13	0.02
Flexion and extension of the arms	-0.04	-0.24	-0.08	-0.21	-0.06	0.07	-0.17	-0.13	-0.14	0.06	-0.22
right hand strength	0.02	-0.05	-0.02	0.08	-0.02	0.01	0.11	0.00	0.03	0.09	0.07
left hand strength	-0.02	-0.04	-0.03	0.01	0.04	-0.09	0.06	-0.03	0.05	-0.03	0.01
Lifting the torso	-0.07	-0.25	-0.17	-0.15	-0.14	-0.12	-0.20	-0.17	-0.15	-0.03	-0.19
Distance jump	-0.04	0.16	0.02	0.09	-0.21	-0.07	0.18	0.16	0.07	0.15	0.16
Short dist run	0.15	-0.10	0.07	-0.13	0.15	-0.12	-0.21	0.03	-0.06	-0.15	-0.16
Tilt the torso	0.01	0.22	-0.01	0.25	-0.13	0.09	0.29	0.16	0.15	0.16	0.24
"Flamingo" test	0.04	-0.20	-0.05	-0.16	0.06	-0.06	-0.26	-0.14	-0.17	-0.12	-0.18
Total Σ	1.98	3.38	1.83	4.0	2.06	2.56	3.97	3.39	2.82	2.99	3.47
r arithmetic mean	0.09	0.15	0.08	0.18	0.09	0.11	0.18	0.15	0.12	0.13	0.15

Notice: $r_{(p=0.05)} = 0.2731$; $r_{(p=0.01)} = 0.354$

dexes, hand strength, long jump indicate that physical activity loses its meaning when the all these indicators with low results become more important instead.

The 9th grades athletic ability is more adequately associated with the relationship with the Rufier test ($r = -0.308$, $p < 0.05$), 60 m running ($r = -0.24$, $p < 0.05$), hand strength ($r = 0.26$, $p < 0.05$), lift the torso ($r = 0.32$, $p < 0.05$), short distance running (4×9 m) ($r = -0.66$, $p < 0.01$), tilt the torso ($r = 0.26$, $p < 0.05$).

Self-esteem of young people's strength qualities has a positive correlation with distance jump ($r = 0.32$, $p < 0.05$), and left hand strength ($r = 0.29$, $p < 0.05$).

Researchers claim that boys' self-assessment of physical development is directly related to their strength and physical activity, girls – to their appearance and coordination of movements (Danish, Forneris, Hodge, & Heke, 2004). In this research, we also observe the fact of the self-esteem for girls while becoming adult, which is influenced by the appearance and slenderness of the body, becomes especially important (table 4).

Self-assessment of "body slenderness" in girls correlates with body length (BL) ($r = 0.30$, $p < 0.05$), the higher, the slimmer girl, according to Martine-Kushelevsky test ($r = -0.41$, $p < 0.01$) indicating physical fitness. They associate appearance with the Martin-Kushelevsky test ($r = -0.33$, $p < 0.05$) and Robinson's index ($r = 0.30$, $p < 0.05$). Such data is not informative for us and, unfortunately, we can not determine the adequacy of girls' self-esteem on the indicators: "appearance".

Girls' strength abilities correlate only with body length ($r = 0.30$, $p < 0.05$). No significant correlations were found in the self-assessment of physical qualities such as "flexibility", "endurance". Self-esteem of physical development correlates with VCL ($r = 0.30$, $p < 0.05$) and there is a negative correlation with the 60 m running ($r = -0.30$), tilt the torso forward ($r = -0.34$, $p < 0.05$) and a balance exercise ($r = -0.37$, $p < 0.01$).

The 9th graders demonstrated such indicators of self-description of physical development as: "coordination of movements", "physical activity", "sports ability" do not have

Table 3. Correlation coefficients of self-assessment of physical development and somatometric and physiometric indicators of 9th grade boys, (n = 30)

Self-esteem	Health	Movement coord	physical activity	Body slender ness	Athletic abilities	Global self esteem	Appearance	Strength	Flexibility	Endurance	Self-esteem
Phys. train.											
BL	-0.50	0.15	0.19	0.02	-0.13	-0.37	0.10	-0.14	0.23	0.27	0.00
BW	-0.31	0.17	0.44	-0.11	0.07	-0.20	0.20	0.15	0.05	0.41	0.09
RHR	-0.32	0.19	0.46	-0.25	0.04	0.20	0.13	0.38	-0.23	0.35	0.13
SBP	0.18	0.31	0.28	-0.21	0.26	0.24	0.11	-0.09	-0.04	0.18	-0.12
DBP	0.06	0.44	0.17	-0.44	0.34	0.32	0.06	-0.04	0.00	0.24	0.07
VCL	-0.24	0.14	-0.16	-0.05	-0.25	-0.16	0.13	-0.38	0.19	0.04	-0.02
Rufier's test	0.53	-0.40	-0.45	0.44	-0.38	-0.09	-0.06	0.01	0.04	-0.12	0.27
MK test	-0.14	-0.21	-0.24	-0.01	0.05	-0.10	-0.23	-0.27	0.23	-0.31	0.17
BMI	-0.19	0.14	0.41	-0.13	0.12	-0.10	0.20	0.21	0.00	0.37	0.12
VI	0.38	-0.22	-0.36	0.19	-0.03	0.07	-0.18	-0.22	0.06	-0.35	-0.20
SI	0.38	-0.06	-0.33	0.12	-0.13	0.16	-0.12	-0.09	-0.07	-0.37	-0.07
Robinson's index	-0.41	0.19	0.51	-0.12	-0.11	-0.01	-0.04	0.21	-0.09	0.30	-0.13
30 metres run	-0.11	-0.01	0.03	0.02	-0.24	-0.26	-0.01	0.10	0.10	0.22	-0.26
steady running	0.00	-0.37	-0.16	0.21	-0.04	-0.04	0.00	0.29	-0.05	-0.23	0.08
Flexion and extension of the arms	-0.13	-0.13	-0.09	0.30	-0.15	-0.38	0.05	-0.09	0.20	-0.03	0.07
right hand strength	-0.54	0.31	0.14	-0.39	0.26	0.18	0.09	-0.03	0.15	-0.12	-0.17
left hand strength	0.26	-0.35	-0.30	0.24	-0.04	0.09	0.00	0.29	0.02	-0.08	0.14
Lifting the torso	-0.37	0.31	0.17	-0.19	0.32	0.06	0.16	0.04	0.21	0.16	-0.14
Distance jump	0.37	-0.35	-0.31	0.17	-0.05	0.22	-0.04	0.32	-0.07	-0.07	0.14
Short dist run	0.11	-0.51	-0.46	0.32	-0.26	-0.06	-0.05	0.14	0.08	-0.42	0.18
Tilt the torso	-0.48	0.56	0.50	-0.37	0.26	-0.06	0.10	-0.21	0.05	0.23	-0.23
"Flamingo" test	-0.05	0.11	0.20	0.04	-0.12	-0.28	-0.03	-0.26	-0.06	0.07	-0.04
Total Σ	6.06	5.63	6.36	4.34	3.65	3.65	2.09	3.96	2.22	4.94	2.84
r arithmetic mean	0.27	0.25	0.28	0.19	0.16	0.16	0.09	0.18	0.1	0.22	0.12

Notice: $r_{(p=0.05)} = 0.2731$; $r_{(p=0.01)} = 0.354$

any significant correlation with any indicator of physical fitness. The highest correlation coefficients between self-esteem indicators and actual indicators of physical development do not exceed $r = 0.15$, $p > 0.05$.

Discussion

The results of the research demonstrate the self-assessment of physical development with the physical fitness of the 5th grade boys did not reveal any significant correlations between such indicators as: "health", "coordination of movements", global self-understanding, "Appearance", "flexibility" and "endurance". "Physical activity" correlates with boys' strength abilities and has a negative correlation with statistical balance. This means that the stronger the guy, the more physically active he is. Balance is not a priority for boys. Self-assessment of strength abilities has a correlation with the Martine-Kushelevsky test, strength index and flexion and extension of the arms while emphasis lying down.

The 5th grade girls demonstrated the highest correlation between the Rufier index and the following Physical Development Self-Test Questionnaire: "health", "coordination", "body slenderness", "appearance", "strength" and "self-esteem". Girls are more demanding of "body slenderness" and their appearance.

The largest number of correlations in 9th grade boys fell on the value of "health", which is reflected in the following indices: Rufie, vital and strength, as well as speed and strength exercise. This fact demonstrates a positive guarantee of maintaining and leading a healthy lifestyle among schoolchildren. There is an inflated self-esteem among young people in the "coordination of movements". The indicator of self-description "physical activity" is significant for the 9th grade students, but "body slenderness" is not a priority.

The highest average correlation coefficients between self-esteem and actual indicators of physical development do not exceed $r = 0.28$, $p < 0.05$ (physical activity), $r = 0.27$, $p < 0.05$ (health) & $r = 0.25$, $p < 0.05$ (coordination of move-

Table 4. Correlation coefficients of self-assessment of physical development and somatometric and physiometric indicators of 9th grade girls, (n = 30)

Phys. train.	Health	Movement coord	physical activity	Body slenderness	Athletic abilities	Global self-esteem	Appearance	Strength	Flexibility	Endurance	Self-esteem
BL	0.04	-0.02	-0.06	0.30	0.11	0.00	0.21	0.30	0.16	0.12	-0.12
BW	0.04	0.05	0.03	-0.08	-0.16	0.00	-0.08	-0.13	-0.05	-0.06	0.03
RHR	0.07	-0.03	-0.02	0.05	-0.16	0.04	0.09	0.03	0.07	0.02	0.16
SBP	-0.09	0.07	0.09	-0.23	-0.02	0.06	-0.15	-0.10	-0.09	0.03	0.12
DBP	-0.16	0.18	0.08	0.03	-0.06	0.11	-0.16	-0.05	-0.02	-0.06	0.19
VCL	0.10	-0.14	-0.13	-0.26	0.15	0.21	-0.08	-0.14	0.01	0.04	0.30
Rufier's test	-0.18	0.12	-0.01	-0.07	0.03	0.20	-0.20	-0.24	-0.11	-0.17	0.09
MK test	-0.19	0.05	0.13	-0.41	0.00	0.06	-0.33	-0.24	-0.20	-0.07	-0.10
BMI	-0.01	0.04	0.06	-0.24	-0.16	0.00	-0.19	-0.27	-0.13	-0.12	0.09
VI	-0.06	0.02	0.01	0.01	0.12	0.00	0.03	-0.07	-0.08	-0.06	-0.23
SI	-0.03	-0.04	-0.03	0.03	0.14	-0.01	0.06	0.04	0.01	0.01	0.00
Robinson's index	0.17	-0.05	-0.11	0.34	-0.04	-0.03	0.30	0.16	0.16	0.03	0.10
30 metres run	-0.11	0.12	0.24	-0.22	-0.06	-0.25	-0.15	-0.22	-0.18	-0.13	-0.30
steady running	-0.17	0.13	0.17	0.00	-0.06	-0.04	-0.16	-0.02	-0.09	0.01	0.09
Flexion and extension of the arms	0.03	-0.01	-0.02	0.21	-0.04	-0.08	0.11	0.08	0.06	-0.06	-0.20
right hand strength	0.06	-0.16	-0.06	-0.16	0.08	0.05	0.08	0.06	0.01	0.06	-0.24
left hand strength	0.01	-0.08	-0.01	-0.12	0.02	0.07	0.04	0.09	0.04	0.05	-0.13
Lifting the torso	0.01	0.05	-0.11	0.22	0.00	0.04	0.08	-0.11	0.05	-0.17	0.02
Distance jump	0.15	-0.20	-0.15	0.01	0.14	0.04	0.17	0.02	0.09	0.03	-0.02
Short dist run	-0.21	0.19	0.22	0.06	-0.15	-0.23	-0.13	-0.22	-0.19	-0.17	-0.09
Tilt the torso	-0.02	0.01	0.10	-0.12	-0.09	-0.15	0.03	0.15	-0.09	0.11	-0.34
"Flamingo" test	-0.09	0.13	0.09	0.06	-0.15	-0.20	0.03	-0.01	-0.13	-0.07	-0.37
Total Σ	2.0	1.89	1.93	3.23	1.94	1.87	2.86	2.75	2.02	1.65	3.33
r arithmetic mean	0.09	0.08	0.08	0.14	0.08	0.08	0.13	0.12	0.09	0.07	0.15

Notice: $r_{(p=0.05)} = 0.2731$; $r_{(p=0.01)} = 0.354$

ments), indicating a low level of adequacy of self-esteem of physical development of the 9th grade students. Self-esteem of appearance and slenderness of the body becomes especially important for girls while becoming adult.

Thus, the adequacy of self-assessment of physical development in terms of physical fitness becomes more objective.

The results of our study of age and gender characteristics of students' attitudes to their physical self-understanding coincide with the results of Bochenkova's research E. B. (Bochenkova, 2000). The author also studied the self-esteem of young men and women. Boys rate their physical abilities higher than girls. But the general self-esteem of girls is inflated. While studying the age characteristics of self-description of physical development (Krutsevich & Bakiko, 2020) we can notice for boys of middle school age in comparison to boys of senior school age the value of self-description is higher in 8 out of 11 indicators. Boys grades 5-7 have higher self-esteem scores than boys grades 10-11 (grades 10-11). At the same time, the general self-esteem of boys is higher

than that of girls. This result of the study coincides with the data of Ilin (2013). The author notes that boys in the 5th and 9th grades are generally more satisfied with their appearance and give it a higher grade than girls. Sitnikov also claims that boys rated their physical characteristics much higher than girls. They attach great importance to their own physical self-understanding (Sitnikov, 2001). But such scientists as Stepanova (2012) and Federikin et al. (2021), according to the results of studies of students' self-description, claim that self-esteem and the level of harassment do not have a gender difference in middle school age. They also argue that children's physical development does not significantly affect self-esteem. This contradicts the results of our previous research.

The adequacy of self-assessment of physical development is associated with gaining practical experience in physical education lessons. Inadequacy indicates that in physical education lessons insufficient attention to substantiating the importance of pedagogical control of physical fitness of students. Performing mobility test in physical education

lessons is used by the teacher in general to assess, and not to determine the progress of student achievement in the development of physical qualities in the process of specially organized mobility. Therefore, students do not see the correlation between the results of specific exercises and the development of their physical abilities, ie pedagogical control does not become an incentive for their self-development and self-improvement. This explains the fact that scientists (Tsybullska, 2019; Tkachenko, 2020) determine in their research the lack of children's motivation to increase physical fitness in physical education.

Conclusion

Thus, the correlation analysis between the results in mobility test for strength, endurance, coordination and flexibility and self-assessment of these indicators by students of the 5th and 9th grades are differ. The 9th graders evaluate their physical abilities more objectively.

Studies have shown the inadequacy of self-assessment of physical fitness of students, which indicates the importance of theoretical coverage and practical implementation in physical education classes of pedagogical control and self-control of physical fitness, which should be an incentive for self-improvement of boys and girls in physical education.

Conflict of interest

The authors declare that there is no conflict of interest.

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АНАЛІЗ ВЗАЄМОЗВ'ЯЗКІВ СУБ'ЕКТИВНИХ І ОБ'ЄКТИВНИХ ПОКАЗНИКІВ ФІЗИЧНОГО РОЗВИТКУ ШКОЛЯРІВ 5-ИХ ТА 9-ИХ КЛАСІВ

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Авторський вклад: А – дизайн дослідження; В – збір даних; С – статаналіз; D – підготовка рукопису; Е – збір коштів

Реферат. Стаття: 10 с., 4 табл., 34 джерела.

Мета: дослідити взаємозв'язок між об'єктивними результатами вимірів соматометричних і фізіометричних показників фізичного розвитку та суб'єктивними показниками його самоопису у школярів 5-их та 9-их класів.

Матеріал і методи. Дослідження проводились у загальноосвітній школі № 17 м. Луцька за участю учнів середнього шкільного віку у кількості 120 учнів (вік 10 та 15 років). Методи дослідження: аналіз даних науково-методичної літератури, нормативно-правових документів, програми з фізичної культури, педагогічне тестування

фізичної підготовленості, методи математичної статистики, тест-опитувальник Є.В. Боченкової «Самоопис фізичного розвитку».

Результати. Проведений кореляційний аналіз між результатами у рухових тестах на силу, витривалість, координацію і гнучкість та самооцінкою цих показників учнями 5-их та 9-их класів відрізняються. Більш об'єктивно оцінюють свої фізичні здібності школярі 9-го класу. Це пов'язано з набуттям практичного досвіду на уроках фізичної культури. Неадекватність самооцінки фізичних здібностей свідчить, що на уроках фізичної культури недостатньо уваги приділяється обґрунтуванню значення педагогічного контролю фізичної підготовленості школярів.

Висновки. Проведені дослідження виявили неадекватність самооцінки фізичної підготовленості учнів, що свідчить про важливість теоретичного висвітлення і практичного впровадження в уроки фізичної культури школярів розділу педагогічного контролю і самоконтролю фізичної підготовленості, який має бути стимулом для самовдосконалення хлопців і дівчат в процесі фізичного виховання.

Ключові слова: учні, середній шкільний вік, фізичний розвиток, рухові тести, самооцінка, адекватність.

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ORIGINAL SCIENTIFIC ARTICLE

TWELVE WEEKS OF AEROBIC TRAINING TO INCREASE VO₂max IN SEDENTARY YOUNG MALES

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Abstract

Study purpose. The aim of this study was to verify the effect of three sessions of aerobic training, for a period of 12 weeks, on VO₂max and on the distance covered during the test.

Materials and Methods. Fifteen sedentary males were recruited in this study. VO₂max was investigated using Cooper test. Aerobic intervention lasted for 12 weeks. The exercise the subjects were performing for the first 6 weeks was supervised aerobic training, 3 times per week at 60-75% of heart rate max (HRmax) (The first two weeks at 60-65% HRmax, third and fourth week at 65-70% HRmax, fifth and sixth week at 70-75% HRmax). Afterwards, the subjects continued supervised aerobic training for 6 weeks until the twelfth week at 70-75% HRmax.

Results. After 8 weeks of aerobic training, a significant increase in distance covered during the Cooper test ($p < 0.001$) and a significant increase in VO₂max ($p < 0.001$) were observed.

Conclusions. In this study, it was found that 12 weeks of aerobic training have a positive impact on VO₂max improvement and, therefore, completing 3 sessions of this type of training per week has a positive impact on aerobic parameters.

Keywords: aerobic exercise, aerobic training, VO₂max, Cooper test, aerobic program.

Introduction

The aerobic exercise is frequently used to promote cardiorespiratory and musculoskeletal fitness, and it is now also well-established that it exerts powerful effects on the brain (Mang et al., 2016, Kramer et al., 2018; Cirillo et al., 2009). These aerobic exercise effects on the brain include an impact on neuroplasticity and have been investigated in terms of chronic effects related to with long-term aerobic exercise training (Cotman et al., 2002; Moscatelli et al., 2016).

The inherent advantages of physical exercise stem from an increase in cardiac output and an enhancement of the

innate ability of muscles to extract and utilize oxygen from the blood. This benefit is further compounded by the benefit physical exercise has on high-density lipoprotein cholesterol (HDL-C) (Williams et al., 1996), adipose tissue distribution (Schwartz et al., 1991), increased insulin sensitivity (Rosenthal et al., 1983), improved cognitive function (Spirduso 1980), enhanced response to psychosocial stressors (McDonnell et al., 2013), as well as a deterrent of depression. With the benefit of physical exercise well established, the question remains which type of exercise provides the most effective and efficient means to help deter CV disease.

The American College of Sports Medicine (ACSM) defines aerobic exercise as any activity that uses large muscle groups, can be maintained continuously and is rhythmic in nature (Haskell et al., 2007). As the name implies, muscle groups activated by this type of exercise rely on aerobic metabolism to extract energy in the form of adenosine

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triphosphate (ATP) from amino acids, carbohydrates and fatty acids. Examples of aerobic exercise include cycling, dancing, hiking, jogging/long distance running, swimming and walking. These activities can best be accessed via the aerobic capacity, which is defined by the ACSM as the product of the capacity of the cardiorespiratory system to supply oxygen and the capacity of the skeletal muscles to utilize oxygen (Ludyga et al., 2016). The criterion measure for aerobic capacity is the peak oxygen consumption (VO_2), which can be measured either through graded exercise ergometry or treadmill protocols with an oxygen consumption analyzer or via mathematical formulas. The value of peak VO_2 can be appreciated by a study performed by Vaitkevicius et al. (1993), in which the $\text{VO}_{2\text{max}}$ was calculated along with other dimensions, to conclude that higher physical conditioning status was directly correlated with reduced arterial stiffness. It is now customary to attend equipped sports centers about three times a week, therefore the aim of this study was to verify the effect of three sessions of aerobic training, for a period of 12 weeks, on $\text{VO}_{2\text{max}}$ and on the distance covered during the test.

Material and Methods

Participants

Fifteen male were recruited in this study (Age: 24.5 ± 2.1 years; Height 175.1 ± 3.2 cm; Body mass 73.2 ± 3.3 Kg). The subjects involved in the study were students of the University of Foggia (Italy). All subjects were sedentary, which was defined as engaging in ≤ 60 min of exercise/week. The local Institutional Ethics Committee approved the study. Participants were provided both written and oral information regarding the possible risks and discomforts and were ensured that they were free to withdraw from the study at any time.

Aerobic Cooper's test

The $\text{VO}_{2\text{max}}$ can be measured in different ways and is generally detected through the use of indirect tests such as the 12-minute Cooper (CRT) run test. This is one of the most popular tests and only takes one meter to determine the distance traveled in 12 minutes (Bandyopadhyay 2015) India, to bypass the exhaustive and complicated protocol of direct estimation of $\text{VO}_{2\text{max}}$. Eighty-eight sedentary male university students recruited by simple random sampling from the University of Calcutta, Kolkata, were randomly assigned to the study group ($N = 58$). The test was performed on a 400 meter track and the subject underwent a test before becoming familiar with the nature of the experiment a few days before the actual day of the test. Subjects who lost part of the procedure were asked to cover the maximum possible distance by walking / running for 12 minutes.

After 12 minutes the subjects were asked to stop running / walking immediately. Thus the total distance in meters covered after 12 minutes by the experimental subjects was recorded. $\text{VO}_{2\text{max}}$ was predicted using the following formula: $\text{VO}_{2\text{max}} (\text{ml} / \text{kg} / \text{min}) = (22,351 \times \text{distance traveled in kilometers}) - 11,288$.

The evaluation of $\text{VO}_{2\text{max}}$ was performed before training (T0) and after 4 weeks (T1), 8 weeks (T2) and after 12 weeks (T3) respectively.

Aerobic training protocol

Aerobic intervention lasted 12 weeks. The exercise subjects were completed with a 6 weeks supervised aerobic training, 3 times per week at 60-75% of heart rate max (HRmax) (The first two weeks at 60-65% of HRmax, third and fourth week at 65-70% of HRmax, fifth and sixth week at 70-75% of HRmax). After that, the subjects continued supervised aerobic training for 6 weeks until the twelfth week at 70-75% of HRmax. Each session started by 10 min of warm up, 30-40 min of aerobic exercise and 5-10 min of cool down activity. Aerobic exercises included running on flat surface with no slope. The intensity of the activity of any person was controlled using the Polar heart rate tester (made in the US). The training was carried out at the Sports Medicine Center of The University of Foggia (Italy).

Statistical analysis

The statistical analysis were performed used R Project for Statistical Computing software (version 3.1.0). Means and SDs were calculated for each of the analyzed variables and statistical significance was set at $p < 0.05$. The Shapiro-Wilk test was used to verify the normal distribution of variables. Data collected from the participants were compared by means of one-way repeated measure ANOVA, followed by Tukey's multiple comparison post hoc test and linear regression analysis.

Results

The ANOVA show significant differences in Cooper's test (m) ($F_{(3, 56)} = 17.16$; $p < 0.001$). The distance covered by the subjects changed from a starting mean value of 1993.26m (± 257.60) before the beginning of the aerobic training, to a mean value of 2274.70m (± 178.25) after 4 weeks of aerobic training, to a mean value of 2359.30m (± 199.75) after 8 weeks of aerobic training, to a mean value of 2525.10m (± 184.80) after 12 weeks of aerobic training (Fig. 1).

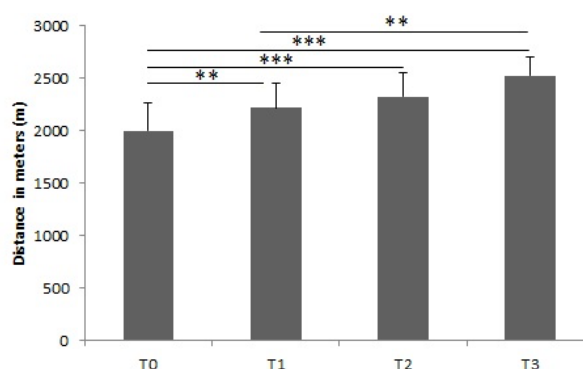


Fig. 1. Distance covered by the subjects during cooper's test: m = meters; T0= before the beginning of the aerobic training; T1 = after 4 weeks of aerobic training; T2 = after 8 weeks of aerobic training; T3 = after 12 weeks of aerobic training; ** $p < 0.01$; *** $p < 0.001$.

The ANOVA show significant differences in $\text{VO}_{2\text{max}}$ ($F_{(3, 56)} = 17.16$; $p < 0.001$). The $\text{VO}_{2\text{max}}$ changed from a starting mean value of 33.26 (ml/kg/min) (± 5.76) before the beginning

of the aerobic training, to a mean value of 39.55 (ml/kg/min) (± 4.00) after 4 weeks of aerobic training, to a mean value of 41.45 (ml/kg/min) (± 4.45) after 8 weeks of aerobic training, to a mean value of 45.10 (ml/kg/min) (± 4.15) after 12 weeks of aerobic training (Fig. 2).

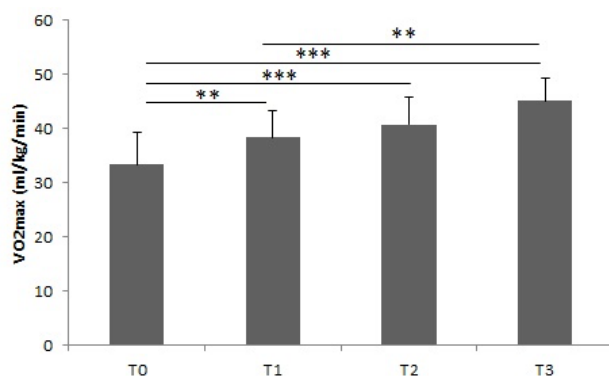


Fig. 2. VO₂max calculated after Cooper's test: T0 = before the beginning of the aerobic training; T1 = after 4 weeks of aerobic training; T2 = after 8 weeks of aerobic training; T3 = after 12 weeks of aerobic training; **p < 0.01; ***p < 0.001.

Discussion

The results of this study show that aerobic training done at a frequency of three times a week has a positive impact on the improvement of VO₂max and the distance covered during the Cooper test. These results show that it is enough to carry out 3 training sessions to have positive effects on the level of physical efficiency and, consequently, an improvement in health conditions with a reduction of risk factors related to physical inactivity. Our results are in line with the guideline by the World Health Organization (WHO) that provided activity recommendations based on three different age groups: Ages 5-17, 18-64, and > 64 years of age. In the age group of 5-17 years, individuals should accrue at least 60 min of moderate activity daily. Those in the group of 18-64 years should perform at least 150 min of moderate activity or at least 75 min of vigorous activity throughout the week. Finally, individuals above the age of 65 years are recommended similar length and intensity exercise programs as the prior group, but with a focus on activities to help enhance balance and to prevent falls. The inherent advantages of physical exercise stem from an increase in the cardiac output and an enhancement of the innate ability of muscles to extract and to utilize oxygen from the blood. This benefit is further compounded by the benefit physical exercise has on high density lipoprotein cholesterol (HDL-C) (Williams 1996).

An important meta-analysis showed a decrease in the risk of all cardiovascular (CV) outcomes and diabetes mellitus incidence with increasing levels of physical activities (Whaid et al., 2016). Another meta-analysis suggested that high level of leisure time physical activity had a beneficial effect on CV health by reducing the overall risk of incident CHD and stroke among men and women by 20% to 30%, while moderate level of occupational physical activity might reduce 10% to 20% risk of CVD (Li et al., 2012). Furthermore, cardiac rehabilitation, which is physical exercise based (Mampuya et al., 2012; Kaminsky et al., 2013; Messina et al

2015; Monda et al., 2017) is a promising field which showed a favorable outcome among patients with heart failure and post CVD events (Moscatelli et al., 2021; Monda et al., 2017; Moscatelli et al., 2020).

Conclusion

In conclusion, our data seem to show that aerobic training carried out regularly three times a week can have a positive impact on the improvement of the physical efficiency of sedentary subjects and, consequently, there can be significant reductions in risk factors related to sedentary lifestyle.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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ДВНАДЦЯТЬ ТИЖНІВ АЕРОБНИХ ТРЕНУВАНЬ ДЛЯ ПОКРАЩЕННЯ ПОКАЗНИКА МАКСИМАЛЬНОГО СПОЖИВАННЯ КИСНЮ (VO₂max) В МОЛОДИХ ЧОЛОВІКІВ, ЯКІ ВЕДУТЬ МАЛОРУХЛИВИЙ СПОСІБ ЖИТТЯ

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Авторський вклад: А – дизайн дослідження; В – збір даних; С – статаналіз; D – підготовка рукопису; Е – збір коштів

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Мета дослідження. Метою дослідження було перевірити вплив аеробних тренувань протягом 12 тижнів, по 3 заняття на тиждень, на показник максимального споживання кисню (VO₂max) та на відстань, яку долають учасники під час тесту.

Матеріали та методи. До участі в цьому дослідженні було залучено 15 чоловіків, які ведуть малорухливий спосіб життя. Показник VO₂max досліджували за допомогою тесту Купера. Аеробне втручання тривало протягом 12 тижнів. Вправами, які учасники виконували протягом 6 тижнів, були контрольовані аеробні тренування, 3 рази на тиждень за інтенсивності 60-75% максимальної ЧСС (HRmax) (перші два тижні – за інтенсивності 60-65% максимальної ЧСС, третій і четвертий тиждень – за інтенсивності 65-70% максимальної ЧСС, п'ятий і шостий тиждень – за інтенсивності 70-75% максимальної ЧСС). Після цього учасники продовжували контрольовані аеробні тренування протягом 6 тижнів до двадцятого тижня за інтенсивності 70-75% максимальної ЧСС.

Результати. Після 8 тижнів аеробних тренувань спостерігалось значне збільшення відстані, яку учасники долали під час проведення тесту Купера ($p < 0,001$), і суттєве зростання показника максимального споживання кисню VO₂max ($p < 0,001$).

Висновки. За результатами цього дослідження було встановлено, що 12 тижнів аеробних тренувань позитивно впливають на покращення показника максимального споживання кисню VO₂max, а отже, виконання тренувань цього типу по 3 заняття на тиждень позитивно впливає на аеробні показники.

Ключові слова: аеробні вправи, аеробні тренування, максимальне споживання кисню (VO₂max), тест Купера, програма аеробних тренувань.

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ORIGINAL SCIENTIFIC ARTICLE

DISTANCE LEARNING: DOES IT HAVE AN IMPACT ON THE READINESS OF PHYSICAL EDUCATION TEACHERS IN COASTAL AREAS?

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Abstract

Study purpose. The purpose of this study was to determine whether there is an effect of distance learning on the readiness of physical education teachers in coastal areas.

Materials and methods. This study used an experimental method with one group pre-test-post-test design. The research participants were physical education teachers in junior high schools in coastal areas ($n = 60$). Primary data collection to measure teacher readiness was the Online Teaching Readiness Survey consisting of 41 questions with a validity level of 0.76 and a reliability of 0.91. Secondary data collection was performed using literature study.

Results. The results of the paired sample t-test showed $0.754 > 0.01$, indicating the data variance was the same. By looking at the assumed equal variances, the significance result shows that $0.000 < 0.01$ (confidence interval = 99%), then H_0 is rejected. Based on the data, there are 10 teachers or 16% who are ready to carry out distance learning, 36 teachers or 60% are not ready, and 14 teachers or 24% are unprepared.

Conclusions. There is an impact of distance learning on the readiness of PE teachers in coastal areas. The effect in question shows the unpreparedness of PE teachers in implementing distance learning. The recommendation from the findings is that teachers need virtual learning training and adequate support to succeed in distance learning.

Keywords: physical education, coastal areas, distance learning, readiness, teaching.

Introduction

In the Special Province of Yogyakarta, there are 3 regencies with coastal areas, namely Gunungkidul with 8 coastal villages, Kulonprogo there are 4 coastal areas and Bantul has 2 coastal area (Khakhim et al., 2021). Coastal areas are identical with limited educational infrastructure, especially in implementing distance learning due to the COVID-19 pandemic (Nurhayati, Aisah & Supriatna, 2020). Qualified human resources and technology are needed for the smooth running of distance learning programs. For this reason, it is important to know the readiness of each region in implementing distance learning, including in coastal areas. The

Indonesian government itself has officially determined that education is carried out by distance learning (Kemendikbud, 2020). Teachers are faced with the reality of adapting teaching in a short period of time regardless of their readiness.

For physical education (PE) teachers who teach physical activity, the virtual teaching burden becomes greater (González-Calvo et al., 2020). PE lessons are identical to direct teaching, namely by physical interaction within the framework of physical activity between teachers and students (Koutaya, 2020). Indeed, this condition is a challenge for both teachers and students in carrying out the new order of education (Burki, 2020). But the obstacles faced are certainly very large related to the readiness of teachers to implement virtual learning. So it is very necessary to see how prepared teachers are in carrying out distance learning, especially in coastal areas with limited infrastructure and other factors that do not support. Based on this, PE teach-

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ers need to have the readiness of both technology and new competencies to face distance learning (Hortigüela-Alcalá, Hernando-Garijo & Pérez-Pueyo, 2021).

For the implementation of distance learning, the problems that arise are not only related to “unusual” learning, but also technical matters such as teachers who are not prepared when dealing with educational technology and servers that are overwhelmed when study hours are at peak load so that access becomes difficult. slow. Not to mention the element of motion that must be considered and corrected directly by the teacher becomes constrained because it has to go through technology first (Calabuig-Moreno et al., 2020). PE becomes a complicated lesson when run remotely even with the help of technology (Kirk, 2020). This condition will certainly make it difficult to acquire basic skills and good physical fitness as the goal of PE, lifelong fitness (Hordvik, MacPhail & Ronglan, 2019). However, distance learning will not run optimally, especially in the development of motor aspects which is the main domain of PE (Richards et al., 2020). Learning objectives have experienced a shift from the motor domain to the cognitive domain (MacPhail & Lawson, 2020). In the aspect of PE facilities as learning support it is impossible for each individual to provide (Azhari & Fajri, 2021).

Because to be able to carry out distance learning requires qualified supporting facilities (Schneider & Council, 2021). Good learning should provide adequate learning facilities, both study rooms, lighting, and complete equipment (Crawford et al., 2020). So in this case, distance learning facilities are everything that should be available. However, not all areas have adequate facilities, including in coastal areas (Samadi & Lestariningsih, 2018). This is supported by the survey results that 29% of the Indonesian population does not have a mobile phone. As many as 28% of the population have ordinary cellphones but cannot support the implementation of e-learning, and only 42% have smartphones (Koesnandar, 2020). The problem of lack of electronic device ownership facilities for e-learning was also reported to be only 40.5% (Kemendikbud, 2020). With many learning barriers, especially in the application of learning applications such as zoom, google class, google meet, of course the disadvantaged are the students (Adedoyin & Soykan, 2020; Alea et al., 2020).

Coastal areas that are far from the city center and far from the reach of provider networks will certainly be hampered in learning (Firman & Rahayu, 2020; Rashid et al., 2020). This problem is experienced by many teachers who are in coastal areas. Thus learning activities do not run smoothly (Moorhouse, 2020). According to Burges’ concentric theory of urban spatial structure, the coastal area is an area along the coast which is the center of fishery, production, service activities and not as an educational area (Wirawan & Tambunan, 2018). By paying attention to the theory of urban spatial structure, it can be understood that access to education in coastal areas is much different from that in downtown areas. In this study, the coastal areas referred to are districts located on the coast and far from access to the city center.

Materials and methods

Participants

The research participants were 60 PE teachers from junior high schools who carried out distance learning in coastal

areas with details of 30 teachers from Gunungkidul Regency, 20 teachers from Kulonprogo Regency and 10 teachers from Bantul Regency. All teachers are members of teacher associations in each district. The research sample was selected by cluster random sampling. The experimental test of the implementation of distance learning will be carried out in February-July 2021 (Table 1).

Table 1. Distance learning intervention activities in experimental test

Session	Variable	PE Scope	Materials	Platform
1			Pretest	
1	Readiness	Gymnastics	Floor exercise	Zoom
2	Readiness	Game	Soccer	Zoom
3	Readiness	Athletics	Long jump	Zoom
4	Readiness	Rhythmic gymnastics	Aerobic gymnastics	Zoom
5	Readiness	Development activities	Physical fitness	Zoom
6	Readiness	Aquatic	Breaststroke swimming	Google meeting
7	Readiness	Martial arts	Pencak silat	Google meeting
8	Readiness	Health	Personal health	Google meeting
9	Readiness	Game	Basketball	Google meeting
10	Readiness	Athletics	Relay run	Google meeting
2			Posttest	

Research design

The research design used was an experimental one group pre-test & post-test without a control group. The intervention provided was in the form of distance learning for junior high school PE materials for 12 weeks. The instrument used to measure teacher readiness is the Readiness for Online Teaching Survey which consists of 41 questions with a validity level of 0.76 and a reliability of 0.91. Table 2 shows the research design and intervention.

Table 2. Research designs and intervention

Experiment	Paired sample t-test
Pre-test	Questionnaire with 41 questions
Intervention	12 weeks distance learning
Post-test	Questionnaire with 41 questions
Participants	30 coastal PE teachers from Gunungkidul Regency 20 coastal PE teachers from Kulonprogo Regency 10 coastal PE teachers from Bantul Regency

Data Collection

Collecting data in the form of a questionnaire as the main data and literature study as secondary data. The data collection procedure is by selecting PE subject matter in the

Table 3. Teacher readiness questionnaire in distance learning

Variable	Factor	Indicator
Readiness	Technical skills	Skills to use internet network
		Skills in using software and applications
		Skills in using social networks such as twitter, facebook
		Skills in using learning platforms such as zoom, google.
	Experience with teaching and distance learning	Distance learning planning skills
		Distance learning management skills
		Distance learning assessment skills
	Attitude towards distance learning	Attitude of trust towards the success of distance learning
		Provide support for the continuation of distance learning
		Get comfortable with distance learning
	Time management and time commitment	Time management skills
		Time commitment skills

8th grade junior high school curriculum taught in the zoom meeting or google meeting. Furthermore, the researchers conducted a trial of PE subject matter to non-respondents and corrected invalid instruments. These interventions include: (1) Giving directions to the teacher for filling out the questionnaire; (2) Measurement of the initial test of teacher readiness for approximately 30 minutes. (3) Implement distance learning for 12 weeks. (4) Measurement of the final test of teacher readiness for 30 minutes. The teacher readiness questionnaires are as follows (Table 3).

Data analysis

Analysis of the data with paired sample t-test to see the difference between the results of the initial test score and the final test score through the significance value on the t-test, prerequisite tests in the form of normality and homogeneity tests, and hypothesis testing.

Results

This research was conducted during February – August 2021 involving 60 participants from three districts in the coastal area consists of 38 male and 22 female teachers (Table 4).

Table 4. Data on the distribution of PE teachers in coastal areas

No	Regency	Male	Female	Total
1	Gunungkidul	20	10	30
2	Kulonprogo	12	8	20
3	Bantul	6	4	10
N		38	22	60

This study uses an experimental method on teachers in coastal areas with an intervention in the form of distance learning PE subject matter for eighth grade junior high school students. Table 5 displays the results of the mean scores of the initial and final tests. The teacher's readiness before being given the intervention showed 5.4 or the low

category and the average teacher readiness after the intervention was 6.8 or the medium category. Increased teacher readiness in distance learning by 1.4 or 20.1%.

Table 5. The mean score and significance of teacher readiness in coastal areas

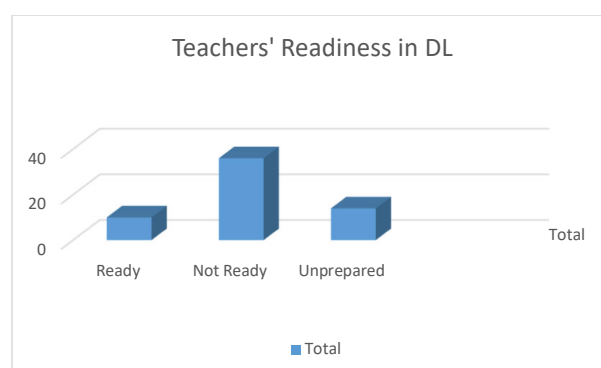
Group	Pre-test	Post-test
	Mean score	Mean score
Coastal	5.4*	6.8*

*p < 0.5 (significantly different); **p < 0.1 (very significantly different)

Based on the data in Table 6, there are 10 teachers who are ready to carry out distance learning or 16%, 36 teachers are not ready or 60%, and 14 teachers are unprepared or 24%.

Table 6. Categorization of teacher readiness for distance learning

No	Category	Criteria	Total	Percentage
1	Ready	150-175	10	16%
2	Not ready	90-149	36	60%
3	Unprepared	< 90	14	24%
N			60	

**Fig. 1.** Categorization of teacher readiness for distance learning

Hypothesis testing

The hypothesis formulated in this research is: H0: There is no impact of distance learning on the final score of teacher readiness in coastal areas. H1: There is an impact of distance learning on the final score of teacher readiness in coastal areas. In Table 7, the results of the paired sample hypothesis test show $0.754 > 0.01$, then the variance of the data is assumed to be the same. The next step is to see how the paired sample t-test can answer the formulated hypothesis. By looking at the equal variances assumed, the significance results show that $0.000 < 0.01$ (confidence interval = 99%) then H0 is rejected. Thus it is proven that there is an impact of distance learning on teacher readiness in coastal areas.

Table 7. Analysis of paired sample test results

		Paired Differences			t	df	Sig. (2-tailed)
		Mean	SD	SE			
Pair 1	Pre test-post test Coastal	-7.137	5.385	0.983	-7.540	59	0.000

SD = Standart Deviasi, SE = Standart Error of Mean

Normality test

The results of the Kolmogorov-Smirnov Test distribution showed a significance of $0.541 > 0.005$ and $0.0577 > 0.05$ so that the data variance was declared normally distributed (Table 8).

Table 8. Normality test results

Experiment group	Kolmogorov-Smirnov Test	P-value	Distribution
Coastal Pre	0.541	>0.05	Normal
Coastal Post	0.577	>0.05	Normal

Homogeneity test

The results of the Levene test distribution show a significance of $0.540 > 0.05$ and $0.612 > 0.05$ so that the data variance is assumed to be homogeneously distributed (Table 8).

Table 9. Homogeneity test result

Experiment group	Levene Statistic	Probability	Varian
Coastal Pre	0.540	>0.05	Homogen
Coastal Post	0.612	>0.05	Homogen

Discussion

The main objective of this study was to determine the impact of a 12-week distance learning intervention on PE lessons. The intervention was in the form of PE subject matter consisting of floor exercise, soccer, basketball, long jump, aerobic exercise, physical fitness, breaststroke swimming, Pencak silat, and personal health. This material is in accordance with the curriculum used for junior high school students (Richards et al., 2020). The results of this study support the hypothesis that there is an impact of distance learning on teacher readiness in coastal areas. These results are consistent with research on teacher readiness which is influenced by regional structure (Manasia, Ianos & Chicioreanu, 2020).

Teacher readiness is also influenced by the competencies they have whether they have updated their knowledge or not (Tyan, Rahman & Sarvestani, 2020). Do you often attend training related to virtual learning or not. In addition, achieving PE goals is also influenced by the availability of supporting sports facilities (Barney & Kahaialii, 2020). The distance learning that is currently being carried out is hampering the achievement of the PE goals. Because it has traditionally been considered a practical and "direct" lesson in schools, where closeness and physical contact are common between teachers and students, so learning becomes more alive (Jeong & So, 2020). Meanwhile, distance learning in PE lessons is actually constrained by the presence of technology (Fernández & Espada, 2021).

The impact of distance learning on the readiness of PE teachers in coastal areas can be seen at least in four aspects of readiness, namely: technical skills of teachers in using technology, teaching experience of teachers in distance learning, attitudes towards distance learning, and management & time commitment (Welsh & Swain, 2020). In the aspect of teacher technical skills, it was found that most of the teachers did not have technical skills in using technology to support distance learning. Some steps that have been taken by the school is to provide training in the use of technology. However, the training is considered less effective. Most of the respondents felt that the training carried out in schools did not go well. The impact of this is that the training is not able to improve the skills of teachers in using various media that support distance learning, so that it also has an impact on student ignorance. Another fact is that most of the coastal areas have not been reached by telecommunications providers so that distance learning is not fully implemented (Warren & Venzant, 2020). The implementation of learning runs less than optimally due to the non-functioning of the teacher's role as an instructor in directing the movement functions of students (Alea et al., 2020). So that the development of motion or physical activity becomes complicated because there is no role model. Another finding is that not all teachers and students have learning technology devices such as smartphones, PCs, or laptops, including internet networks. It is undeniable that there are teachers who have not been able to utilize learning media or learning platforms properly (Kok et al., 2020). Judging from the competence of teacher graduates in coastal areas, the average status of graduates is undergraduate.

In the aspect of teaching experience, it was found that almost all of the respondents did not have distance teaching experience. So that distance learning is something that is completely new and has almost never been done before (Legowo et al., 2019; Abidin, Hudaya & Anjani, 2020). Moreover, PE lessons are full of motor and physical functions that require special attention in teaching practice (Muhtar & Dalyono, 2020). This is in line with the expert opinion that PE lessons are lessons that traditionally have direct closeness between teachers and students (McEvilly, 2022). Teachers in coastal areas are accustomed to teaching PE with direct practice without the help of learning technology. This direct learning model is preferred by teachers to virtual learning. Another finding shows that teachers lack confidence in conveying emotional expressions in virtual media so that the message that will be conveyed to students does not arrive (Irmansyah et al., 2021). This low self-confidence interferes

with teachers in interacting with students virtually so that it can affect the learning process (Fiorilli et al., 2020; Nolan & Molla, 2017).

In the aspect of teachers' attitudes towards distance learning, it was found that most of the teachers had a flat attitude and even tended to be less cooperative (Susanto, Sukoco & Suharjana, 2020). This is reflected in the lack of learning platforms used, apart from using the zoom platform and google meeting, teachers only rely on giving assignments via messages on WhatsApp. The ability of teachers to have the initiative to take responsibility for their work or duties is still relatively low. In other words, aspects of awareness, teaching strategies, evaluation, and interpersonal skills are still low. In this study, it was found that the teacher's attitude was a weak indicator that affected the distance learning process. It is undeniable that teachers in teaching need complete and honest feedback from students, which is not found during distance learning (Pribudhiana, Bin Don & Bin Yusof, 2021; Savolainen, Malinen & Schwab, 2020).

In the aspect of management and time commitment, there are several indicators that show the weak commitment of teachers in managing time because they have to teach from home, are distracted by other online activities, do not have optimism in using virtual learning applications, and are unable to enjoy new challenges at work. In other words, teachers are not ready for the new order of education (Zhang & Sun, 2020). This aspect also contributes to the low readiness of teachers in implementing distance learning.

Researchers also analyzed teacher readiness related to four teacher competencies, namely: pedagogy, professional, social, and personality. Teacher readiness in pedagogic competence is readiness in terms of teacher abilities or skills in managing the learning process or teaching and learning interactions occur with students (Adrian & Agustina, 2019; Deligiannidou et al., 2020). Readiness in the pedagogical competence of teachers in coastal areas should appear in the ability of teachers to explain the material, implement learning methods, ask questions, answer questions, manage classes, and carry out structured and responsible learning evaluations. However, this has not been seen during the distance learning process.

Teacher readiness in professional competence is readiness in terms of skills, abilities, knowledge and skills possessed by an educator, teacher, student mentor in the teaching and learning process (Chiva-Bartoll, Capella-Peris & Salvador-García, 2020; Fachrurrazi, 2017). Groups of teachers in coastal areas do not yet have professional competence in terms of mastery of PE material, mastery of other science materials, and linkages with the subject matter of certain subjects. For example, a teacher who teaches the subject of gymnastics is not enough to master material related to basic gymnastic skills, but also has to master and understand the rules of the games (Susanto et al., 2021). It seems that there are still few teachers who improve their scientific material, related to physical education material and sports science (Raibowo, Nopiyanto & Muna, 2019). So that the professional competence of teachers in coastal areas is still stagnant.

Teacher readiness related to social competence is the readiness of teachers in terms of individual abilities to work together, build social interactions with the surrounding environment by using knowledge and being able to communicate well with empathy (Mustofa, 2020; Flory & Wylie,

2019). The readiness of the social competence of teachers in coastal areas is shown in terms of the position of the teacher who is still an elite figure in the community who is considered to have considerable moral authority. One consequence of this role is that teachers are trusted in their environment (Cheung & Lee, 2010). Of course this is a plus for the social competence of teachers in coastal areas.

Teacher readiness related to personality competence is personal readiness that reflects a steady, stable, mature, authoritative, exemplary, and noble personality (Meilia & Murdiana, 2019; Cheung & Lee, 2010). The personality competencies of teachers in coastal areas appear in terms of teachers who are patient, calm, responsible, democratic, sincere, intelligent, respectful of others, friendly, assertive, and creative (Burdina, Krapotkina & Nasyrova, 2019). In distance learning physical education material, the personality competence of teachers in coastal areas is quite good.

Conclusion

Distance learning is proven to have an impact on the readiness of PE teachers in coastal areas. However, the intended impact shows the unpreparedness of PE teachers in carrying out distance learning. The influencing aspects are the technical skills of teachers in using technology are still low, the teaching experience of teachers in distance learning is still small, attitudes towards distance learning that tend to be flat, and time management is not good. Furthermore, the recommendation of this finding is that virtual learning training and sufficient support are needed for success in distance learning.

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Conflict of interest

No potential conflict of interest was reported by the authors.

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ДИСТАНЦІЙНЕ НАВЧАННЯ: ЧИ ВПЛИВАЄ ВОНО НА ПІДГОТОВЛЕНІСТЬ УЧИТЕЛІВ ФІЗИЧНОГО ВИХОВАННЯ В ПРИБЕРЕЖНИХ ЗОНАХ?

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Авторський вклад: А – дизайн дослідження; В – збір даних; С – статаналіз; D – підготовка рукопису; Е – збір коштів

Реферат. Стаття: 8 с., 9 табл., 1 рис., 25 джерела.

Мета дослідження. Метою цього дослідження було визначити, чи впливає дистанційне навчання на підготовленість учителів фізичного виховання в прибережних зонах.

Матеріали та методи. У цьому дослідженні використовували експериментальний метод із планом дворазового попереднього та підсумкового тестування на одній групі. Учасниками дослідження були вчителі фізичного виховання 7–9 класів середніх шкіл у прибережних зонах ($n = 60$). Збір первинних даних для вимірювання підготовленості вчителів здійснювали за допомогою онлайн-опитування на тему підготовленості до проведення навчання, яке містило 41 запитання з рівнем достовірності 0,76 та надійності 0,91. Для збору вторинних даних використовували дослідження літератури.

Результати. Результати аналізу даних із використанням t -критерію Стюдента для парних вибірок показали $0,754 > 0,01$, указуючи на однакову дисперсію даних. Розглядаючи припущені рівні дисперсії, результат визначення рівня значущості показує, що $0,000 < 0,01$ (довірчий інтервал = 99%), отже нульову гіпотезу (H_0) відкидають. На підставі цих даних отримуємо, що із загального числа учасників дослідження 10 учителів, або 16%, готові проводити дистанційне навчання, 36 учителів, або 60%, не готові, а 14 учителів, або 24%, недостатньо підготовлені.

Висновки. Дистанційне навчання впливає на підготовленість учителів фізичного виховання в прибережних зонах. Вплив, про який ідеться в цій роботі, показує недостатню підготовленість учителів фізичного виховання в процесі реалізації дистанційного навчання. На підставі результатів дослідження рекомендується забезпечити підготовку вчителів до проведення навчання у віртуальному середовищі та їх належну підтримку для досягнення успішних результатів у дистанційному навчанні.

Ключові слова: фізичне виховання, прибережні зони, дистанційне навчання, підготовленість, навчання.

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ORIGINAL SCIENTIFIC ARTICLE

ASSOCIATION BETWEEN MEDIAL LONGITUDINAL ARCH WITH STATIC AND DYNAMIC BALANCE AMONG RECREATIONAL BADMINTON PLAYERS

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Abstract

The study purpose was to examine the association between the Medial Longitudinal Arch (MLA) and balance among recreational badminton players.

Materials and methods. Total of 48 recreational badminton players aged 18-40 (24 males and 24 females) were recruited. Navicular Drop Test (NDT), Single Leg Stance Balance Test (SLSBT) and Modified Star Excursion Balance Test (mSEBT) were assessed on both dominant and non-dominant leg. Participant's foot type was categorized using NDT scores according to difference of navicular height in weight bearing and relax sitting; static balance was grouped based on the time (seconds) the players were able to maintain balance during the SLSBT; and dynamic balance was grouped based on the percentage of distance reached in mSEBT.

Results. The study results revealed a significant association between the MLA of dominant ($p < 0.05$) and non-dominant leg ($p = 0.02$) with static balance among recreational badminton players. However, there is no significant association between the MLA of dominant (Anterior: $p = 0.39$; Posteromedial: $p = 0.34$; Posterolateral: $p = 0.98$) and non-dominant leg (Anterior: $p = 0.39$; Posteromedial: $p = 0.54$; Posterolateral: $p = 0.07$) with dynamic balance.

Conclusions. The current study concludes that there is a significant association between the MLA and static balance. However, no changes were seen in dynamic balance. Thus, coaches and trainers may look into the MLA of players to improve their static balance, which can further improve their sports performance. Future studies are recommended to examine the effects of dynamic balance in more depth with increased sample size.

Keywords: recreational badminton players, balance, medial longitudinal arch, dominant leg arch, non-dominant leg arch.

Introduction

Badminton as a contactless sport requires quick motion of the body where players have to lunges, jump and react to changes in position during the game (Marchena-Rodriguez et al., 2020). Badminton involves defending and shooting strategies which require many skills like net shot, jump smashes, overhead strokes, effective serving and defending (Paup & Fernhall, 2017). Besides having good skills to dominate the opponent, the ability to maintain their own static

and dynamic balance is also very necessary for badminton players in order to have a better performance (Masu et al., 2014). Static balance refers to the ability to maintain a stable posture; whereas dynamic balance is our ability in respond to various alteration of our body position (Tsigilis, 2001). In terms of motor and movement functions, coordinating variables such as static and dynamic balances; foot anatomy and movement; and response time plays a significant role in the badminton sports (Hamed Ibrahim Hassan, 2017). In a previous study, amateur badminton players were found to have serving accuracy, but lack of static and dynamic balance (Wong et al., 2019). Moreover, as badminton is a unilateral sport, the dominant limb's motions are more accurate and faster than those of the non-dominant limb, predisposing

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players to acquire certain imbalances (Manolova, 2018). Asymmetry between the sides of the body can increase the chance of injury and negatively impact a player's effectiveness (Manolova, 2018).

The medial longitudinal arch (MLA) is one of the main factors that affect our balance while static standing and moving around (Salvastore & Nur Khairunisa Abu Talip, 2020). The MLA is supported by plantar ligaments, muscles, and tendons and consists of the tarsal (talus, calcaneus, navicular, and three cuneiform bones) and metatarsal bones of the big toe (Babu & Bordoni, 2021). MLA offers the plantarflexors sufficient mechanical advantage in raising our bodyweight during stance phase and assist in absorbing the increased shock during upright standing (Justine et al., 2016). Hence, our body posture may appear to be disturbed if the biomechanical changes in this supporting structure are disrupted and our foot quality will be dramatically impaired by its design (Hashimoto et al., 2010; Justine et al., 2016).

A causal link between arch formation and musculoskeletal injury trends is indicated as low arch foot due to the changes of head of talus position from the navicular causes the MLA to drop and lengthen the tendon as well as the surroundings ligaments (Justine et al., 2016). As a result, if the neuromuscular system could not meet the demands of maintaining postural balance, musculoskeletal injury would possibly occur (Justine et al., 2016). On the other hand, the high arch foot with a rigid lever is less efficient to work as a shock absorber (Justine et al., 2016). When sustaining postural balance, the high arch foot was unable to equally carry the body weight, shifting the centre of pressure laterally and as a result, people with high arches acquire pain and foot injuries frequently (Justine et al., 2016). Furthermore, both high and low foot arch have been linked to an increased risk of lower limb injuries, and have been recognized as prone to the occurrence of stress fractures in the foot and lower leg (Hollander et al., 2019; Justine et al., 2016).

Due to the nature of badminton sports, the majority of badminton players suffer ankle injuries as a result of instability while landing (Herbaut et al., 2018). Recent studies conducted on the effects of MLA on static and dynamic balance has been conducted only among female healthy athletes (Salvastore & Nur Khairunisa Abu Talip, 2020) and male collegiate athletes involving sports such as volleyball, basketball, handball (Hasan et al., 2017). There is a paucity of research that have been conducted on MLA and balance among badminton players owing to the nature of the sports of quick and strong jump smashes and very swift reflex exchanges.

Thus, the current study aimed to examine the association between MLA and balance (static and dynamic balance) among the recreational badminton players. We hypothesize that the different heights of MLA (low and high arch) affect the static and dynamic balance of the badminton players.

Materials and methods

Study participants

The current study recruited 48 recreational badminton players (24 males and 24 females) (Age: 24.17 ± 4.07). The following inclusion and exclusion criteria were used to recruit participants. Participants in this study ranged in age from 18 to 40 years old, played badminton at least once a week, and did not compete in any badminton tournaments

or any other sports. Participants were excluded from the study if they reported any health issues, any pre-existing lower limb injury, or if they had previously participated in physical training. Prior to participation in the study, all individuals were informed about the testing procedures and completed a written consent form. The study was approved by the Research and Ethics Committee from INTI International University (approval no. INTI-IU/FHLS-RC/BPHTI/7NY12020/006).

Study organization

This was a quantitative experimental study to determine the association between the MLA and balance. The test was completed in a single session. Prior to the physical examination, participants were given a consent form and PARQ+ 2021 to complete. After the introduction and briefing, the participants performed the Navicular Drop Test (NDT), Single Leg Stance Balance Test (SLSBT) and Modified Star Excursion Balance Test (mSEBT).

Medial Longitudinal Arch (MLA) assessment. The MLA of the participants was measured based on the following procedure below:

1. The dominant leg of a participant was determined by asking them which leg they jump and lift off the ground when completing a jump smash (Hamed Ibrahim Hassan, 2017).
2. The participants were then instructed to relax and sit on the bench/chair with their bare feet on the ground.
3. A marker pen was used to palpate and label the prominent navicular tuberosity. A ruler was placed next to the navicular tuberosity on the medial part of the foot. The distance between the prominent navicular tuberosity and the floor was measured in millimetre (mm) s to determine the height of the navicular tuberosity.
4. The subject was then instructed to stand up on one leg, completely weight bearing on the assessed foot only.
5. The assessor palpated the talar dome with his thumb (positioned antero-inferior to the medial malleolus) and index finger (placed at antero-inferior of fibula). The height of the navicular tuberosity was measured once more by measuring the distance in millimetres (mm) between the prominent navicular tuberosity and the floor.
6. The distance between the prominent navicular tuberosity and the floor was measured during relaxed sitting and single-leg weight bearing. The same steps were taken for both the dominant and non-dominant limb. Each side is measured three times, and the average height difference is calculated.
7. Participants are divided into three groups based on the height of the navicular prominent from the floor during weight bearing and relaxed sitting: high arch (navicular drop less than or equal to 4 mm), normal arch (navicular drop between 5 mm - 9 mm), and low arch (navicular drop more or equal to 10 mm) (Cote et al., 2005; Langley et al., 2016).

Static Balance: Single Leg Stance Balance Test (SLSB). The participants' static balance was evaluated using the following procedure (ATEŞ, 2017; Tsai et al., 2006):

1. SLSBT was performed with participants standing barefoot on an even floor with both feet. Students were requested to begin the SLSBT with either their dominant or non-dominant leg at random.
2. During the assessment, participants performed with eyes closing, both hands crossed in front their chest and the tested leg straighten while the non-tested leg was bent 90° in the air. They will need to maintain in the single leg standing position motionless as long as possible.
3. A digital stopwatch was used to time the duration (seconds) of the three Single Leg Standing test trials. When any of the following errors happened, time was halted:
 - The non-tested foot touched the floor or the tested leg.
 - Participant's tested foot off the testing surface.
 - Participant's hand left its position from their chest.
 - Participant opened their eyes.
 - Participants able to maintain and stand in position for more than 50 seconds.
4. The same steps were performed on both the dominant and non-dominant leg. The time for SLSBT was measured three times for both the dominant and non-dominant leg, and the average was calculated.
5. For each leg, the average time that the participant should sustain the necessary single-leg stance on the floor surface was calculated and was rated on a scale of 1 (poor), 2 (fair), 3 (average), 4 (good) and 5 (excellent).
6. The SLSBT scoring for the age range 18-40 years old was classified as follows:

Scoring	Age groups	
	18-29 years	30-40 years
50 + seconds	Excellent	Excellent
40-50 seconds	Good	Good
25-39 seconds	Average	Good
10-24 seconds	Fair	Fair
5-9 seconds	Poor	Poor

(ATEŞ, 2017; Emery, 2003; Tsai et al., 2006)

Dynamic Balance: modified Star Excursion Balance Test (mSEBT). The modified SEBT involves the uses of three tapes connecting to each other from the anterior, posteromedial and posterolateral direction. The following is the method used for measuring dynamic balance among the participants:

1. Participants were instructed to start the test by randomly putting their heel of either dominant or non-dominant leg at the intersection 'X' of the inverted 'Y'.
2. Participants were required to extend as far as they could towards the three directions of anterior (ANT), postero-medial (PM), and postero-lateral (PL) using the tips of their free leg's big toes without losing their balance with hands on the waist. Trials were halted if any of the participants committed one of the following errors:
 - Their foot off the intersection of the inverted 'Y'.
 - Participants unable to maintain balance.
 - The free leg touches ground when reaching to ANT, PM or PL.
 - Hands off from their iliac.

3. The participants were then instructed to repeat the three directions three times before switching legs.
4. The reach out distances was measured in centimetres (cm) and the average was calculated for both dominant and non-dominant leg.
5. Following the test, the participant's true limb length in supine position was assessed. The measurement started at their anterior superior iliac spine (ASIS) and ended at the distal end of their medial malleolus, with both feet 20 cm apart. The measurement was done in centimetres (cm).
6. The test results were then determined by taking the average of the reaching out distance and standardising it on the limb length.
7. To eliminate inaccuracy due to limb length disparities, a formula of (average reaching value/limb length) $\times$ 100 was employed. As a result, the normalised data were calculated as percentages of the excursion distance and their relationship to limb length. (ATEŞ, 2017; Bulow et al., 2019; Hamed Ibrahim Hassan, 2017; Hyong & Kang, 2016).

Statistical analysis

The data were analyzed using IBM SPSS Statistics version 28.0. The Shapiro-Wilk normality test was used, and all of the data were found to be normally distributed. To present the values of each variable, descriptive analysis was used to compute the mean, standard deviation, frequencies, and percentages. The chi-square was used to examine the association between the arch group and recreational badminton players' static and dynamic balance. In all analyses, the significance level was set at 0.05 with a 95% confidence level.

Results

In the current study, forty-eight participants were recruited. The baseline demographics details of the participants were presented in Table 1.

Table 1. Demographic characteristics of the participants

Demographic variables	Subcategory	Mean $\pm$ SD	Frequency (%) (N = 48)
Gender	Male		24 (50)
	Female		24 (50)
Age (year)		24.17 $\pm$ 4.07	
	18-25		37 (77.1)
	26-30		4 (8.3)
	31-35		7 (14.6)
BMI (kg/m ²)		21.42 $\pm$ 3.99	
	Under weight		14 (29.2)
	Normal weight		23 (47.9)
	Over weight		9 (18.8)
	Obesity		2 (4.2)

SD – standard deviation

In dominant leg, the mean $\pm$ SD of the MLA was 6.79 $\pm$ 3.33 mm. Majority of them are categorized in the normal arch group. Whereas, in non-dominant leg, the mean $\pm$ SD of the MLA was 7.00 $\pm$ 3.51 mm as mentioned in Table 2.

Table 2. MLA among recreational badminton players.

Type of arch	Dominant Leg (N = 48)		Non-Dominant Leg (N = 48)	
	Frequency (%)	Mean $\pm$ SD	Frequency (%)	Mean $\pm$ SD
Low arch	15 (31.3)		17 (35.4)	
Normal arch	18 (37.5)	6.79 $\pm$ 3.33	15 (31.3)	7.00 $\pm$ 3.51
High arch	15 (31.3)		16 (33.3)	

In dominant and non-dominant leg, majority of the participant's static balance was 'Fair' in table 3 that represents the static balance of the recreational badminton players. Majority of the participants score 'Excellent' in both dominant leg and non-dominant leg when reaching out towards the three directions (ANT, PM and PL) in the modified SEBT as in Table 3.

There is a significant association between dominant leg ($p < 0.05$) and non-dominant leg ($p < 0.05$) MLA and static balance as in Table 4.

There is no significant association between medial arch of dominant leg (ANT: $p = 0.39$; PM: $p = 0.34$; and PL: $p = 0.98$) and non-dominant leg (ANT: $p = 0.39$; PM: $p = 0.54$; PL: $p = 0.07$) with dynamic balance as in Table 5.

Discussion

The current study aimed to examine the association between medial longitudinal arch with static and dynamic balance among recreational badminton players. The find-

Table 3. Static and dynamic balance among recreational badminton players.

Balance	Dominant Leg (N = 48)		Non Dominant Leg (N = 48)	
	Frequency (%)	Mean $\pm$ SD	Frequency (%)	Mean $\pm$ SD
Static balance		19.19 $\pm$ 10.31		18.96 $\pm$ 12.66
Poor	10 (20.8)		14 (29.2)	
Fair	25 (52.1)		22 (45.8)	
Average	11 (22.9)		8 (16.7)	
Good	1 (2.1)		2 (4.2)	
Excellent	1 (2.1)		2 (4.2)	
Dynamic balance				
ANT		94.37 $\pm$ 0.12		92.79 $\pm$ 13.21
Poor	7 (14.6%)		7 (14.6%)	
Excellent	41 (85.4%)		41 (85.4%)	
PM		90.33 $\pm$ 10.72		87.92 $\pm$ 10.37
Poor	5 (10.4%)		11 (22.9%)	
Excellent	43 (89.6%)		37 (77.1%)	
PL		88.78 $\pm$ 11.35		86.93 $\pm$ 12.53
Poor	10 (20.8%)		13 (27.1%)	
Excellent	38 (79.2%)		35 (72.9%)	

SD – standard deviation; ANT – Anterior; PM – Posteromedial; PL – Posterolateral

ings of the current study support our hypothesis that the static balance of badminton players with low and high MLA has been affected. However, no association has been found between the height of MLA and dynamic balance. Thus, the hypothesis that stated the influence of low and high MLA on dynamic balance has been rejected.

Table 4. Association between MLA and static balance among recreational badminton players

Static Balance	Dominant Leg				Non Dominant Leg			
	Frequencies (n)			P value	Frequencies (n)			P value
	Low arch	Normal arch	High arch		Low arch	Normal arch	High arch	
Poor	3	0	7		6	1	7	
Fair	10	10	5		8	5	9	
Average	2	6	3	<0.05	3	5	0	<0.05
Good	0	1	0		0	2	0	
Excellent	0	1	0		0	2	0	
Total	15	18	15		17	15	16	

Table 5. Association between MLA and dynamic balance among recreational badminton players

Dynamic balance		Dominant Leg				Non-Dominant Leg			
		Frequencies (n)			P value	Frequencies (n)			P value
		Low arch	Normal arch	High arch		Low arch	Normal arch	High arch	
ANT	Poor	3	1	3	0.39	4	1	2	0.39
	Excellent	12	17	12		13	14	14	
PM	Poor	1	1	3	0.34	5	2	4	0.54
	Excellent	14	17	12		12	13	12	
PL	Poor	3	4	3	0.98	5	1	7	0.07
	Excellent	12	14	12		12	14	9	

The MLA of the dominant and non-dominant legs was found to be significantly associated with static balance in recreational badminton players. Static balance issues were more common in participants with low and high arches than in those with normal arches, with the majority falling into the “Poor” or “Fair” category. When standing statically on the ground, the smaller plantar contact area reduces sensory afferent input, which may explain why participants with high arches had more difficulty maintaining static balance than those with normal arches (Hertel et al., 2002; Tsai et al., 2006). The sensory afferent input in the plantar surface is crucial as it enhances the postural control (Hertel et al., 2002). Besides, the proprioceptive feedback during ankle movement comprises divergent information from skin, articular, and muscular mechanoreceptors in addition to sensory information from joint receptors (ligament and capsule) (Cote et al., 2005; Riemann & Lephart, 2002). Reduction of surface area between plantar region and contact surface results in lack of sensory information to be sent to the central nervous system (Hasan et al., 2017). Hence, when there are changes in postural instability during standing (displacement of compression centre of pressure), the static balance decrease respectively (Hasan et al., 2017). The findings of this study are consistent with other previous studies stating the individuals with high arch will have less effective methods to maintain an upright posture during single leg standing balance (Cote et al., 2005; Hertel et al., 2002; Tsai et al., 2006).

The current study also showed that participants in the low arch group presented with greater difficulties in maintaining static balance when comparing with the normal arch group. Despite the fact that the lower arch foot has a larger surface area in contact with the surface, which allows more information to reach the skin, deep, subcutaneous, and articular sensory receptors, resulting in better static balance, the low arch group still has poorer static balance than the normal arch group. This might be due to the difference of foot structure and biomechanics (physiologic limitation of the range of motion of subtalar and midtarsal joint) (Hasan et al., 2017; Hertel et al., 2002).

The findings from this study demonstrated the dynamic balance of recreational badminton players was not affected by the MLA in both dominant and non-dominant leg. Majority of the participants in all arch groups had ‘Excellent’ (>0.80) in the three directions reaching (ANT, PM, and PL), Modified SEBT test. The nature of badminton, especially during lunges and quick reactive movement encompassing the entire court, may explain why majority of the players were able to score ‘Excellent’ on this exam (Desai & Gandhi, 2020). The findings of the current study correspond to other studies in which the dynamic balance of the dominant and non-dominant legs was not affected by the types of MLA (Hasan et al., 2017; Hyong & Kang, 2016; Justine et al., 2016; Kim et al., 2015). The investigations indicated a lack of association between the arch and dynamic balance as a result of foot muscles such as the peroneus longus and tibialis anterior compensating for postural adaptation (Hyong & Kang, 2016; Kim et al., 2015).

However, past research has suggested that in people with a low arch, the medial side of the foot drops, reducing the lateral and posterolateral reaching distance (Cote et al., 2005). The collapsed medial part of foot has an impact on

the length-tension relationship of the foot intrinsic muscles as the prolong lengthen of muscles and soft tissues causes the low arch foot to fatigue easily compare to other foot type (Kulkarni & Thosar, 2020; Chen et al., 2016; Justine et al., 2016). Contrarily, reduction of ankle dorsiflexion and the shortening of gastrocnemius in high arch foot also negatively affects the performance when maintaining dynamic stability (Justine et al., 2016). Therefore, foot posture modifications may lead to additional changes in musculoskeletal characteristics and joint flexibility, increasing the risk of accidents and falls (Justine et al., 2016; Kulkarni & Thosar, 2020).

The main limitation of the current study is the participants with asymmetrical of foot were not excluded from the study. Other than that, confounding variables like lower limb rotational deformities such as Q-angle and tibia torsion were not included in the current study.

Conclusions

This study had shown that there is a significant association between the MLA of dominant and non-dominant leg with static balance among recreational badminton players. However, there is no significant association between dominant and non-dominant leg MLA and dynamic balance in anterior, posteromedial and posterolateral reaching. Recreational badminton players should enhance their ability to maintain postural balance so that they can move in a stable stance and react quickly to incoming shuttlecocks in order to avoid injury. Future studies may be conducted with a larger sample size among the elite badminton players for further understanding.

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Conflict of interest

The author(s) declare(s) that there is no conflict of interest.

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ЗВ'ЯЗОК МІЖ МЕДІАЛЬНИМ ПОЗДОВЖНИМ СКЛЕПІННЯМ СТОПИ ТА СТАТИЧНОЮ ТА ДИНАМІЧНОЮ РІВНОВАГОЮ В БАДМІНТОНІСТІВ-ЛЮБИТЕЛІВ

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Метою дослідження було вивчення зв'язку між медіальним поздовжнім склепінням стопи (МПСС) та рівновагою в бадмінтоністів-любителів.

Матеріали та методи. У дослідженні брали участь загалом 48 бадмінтоністів-любителів віком від 18 до 40 років (24 чоловіки та 24 жінки). На домінуючій і на недомінуючій нозі було проведено тест на опущення човноподібної кістки стопи (NDT), тест на збереження статичної рівноваги стоячи на одній нозі (SLSBT) та модифікований тест на збереження динамічної рівноваги стоячи на одній нозі та рухаючи другою, намагаючись дістати нею якомога далі у восьми напрямках подвійного перехрестя у формі «зірочки» на підлозі (mSEBT), і виконано оцінку результатів тестування. Було проведено класифікацію типу стопи кожного учасника з використанням оцінок у тесті NDT відповідно до різниці висоти човноподібної кістки стопи в стані вагового навантаження на ногу та в стані розслабленого сидіння; показники статичної рівноваги класифікували за часом (у секундах), протягом якого гравці були здатні зберігати рівновагу під час виконання тесту SLSBT; показники динамічної рівноваги класифікували за відсотковою часткою відстані, досягнутої під час виконання тесту mSEBT.

Результати. За результатами дослідження в бадмінтоністів-любителів виявлено суттєвий зв'язок між МПСС домінуючої ($p < 0,05$) і недомінуючої ($p = 0,02$) ноги та статичною рівновагою. Проте суттєвого зв'язку між МПСС домінуючої (передня частина: $p = 0,39$; задньомедіальна частина: $p = 0,34$; задньолатеральна частина: $p = 0,98$) і недомінуючої (передня частина: $p = 0,39$; задньомедіальна частина: $p = 0,54$; задньолатеральна частина: $p = 0,07$) ноги та динамічною рівновагою не виявлено.

Висновки. На підставі результатів цього дослідження зроблено висновок про наявність суттєвого зв'язку між МПСС та статичною рівновагою. Проте жодних змін стосовно динамічної рівноваги не спостерігалось. Таким чином, тренери та інструктори можуть вивчати МПСС гравців із метою покращення їхньої статичної рівноваги, що може додатково покращити їхні спортивні показники. Рекомендується проведення подальших досліджень для більш поглибленого вивчення властивостей динамічної рівноваги зі збільшеним обсягом вибірки.

Ключові слова: бадмінтоністи-любителі, рівновага, медіальне поздовжнє склепіння стопи, склепіння стопи домінуючої ноги, склепіння стопи недомінуючої ноги.

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EFFECT OF THE EIGHT-WEEK SAND SURFACE EXERCISE, WATER SURFACE EXERCISE, AND POWER LEG MUSCLES TRAINING METHODS TOWARD AGILITY OF BASKETBALL PLAYERS FOR ADOLESCENT PLAYERS

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Abstract

Study purpose. Agility plays an essential role in basketball so increased agility needs to be a concern in the physical conditioning exercises of basketball players. To achieve the best results possible with an exercise, the type and manner of the exercise must be considered. The more varied is the training model offered to athletes, the more will it further encourage athletes not to feel exhausted while training. However, the training model used is still limited to hard textured courts. Though the use of textured fields such as water and sand has an impact other than power load, it lowers the rate of injury.

Materials and methods. The method used in this study was a 2×2 factorial design experiment. This study involved 36 men's basketball athletes ages 16-18. The leg power instrument used a vertical jump, agility assessment used an agility test, and analysis of this study data used the ANOVA test.

Results. (1) the sand exercise method shows higher results than the water exercise method; (2) athletes who have high limb power are better in agility testing than athletes who have low limb power; and (3) there is an interaction of water exercise and sand exercise methods and power of the limbs against agility.

Conclusions. The results of this study could prove that sand exercise methods are more effectively used in increasing agility to be an alternative for coaches.

Keywords: sand exercise, water exercise, agility, basketball, adolescent.

Introduction

The perfect ability must support the game of basketball. A good player is a player who can display consistent performance from start to finish in every quarter. Basketball is an aerobic-based anaerobic activity that includes both high-intensity activities like jumping (for rebounds, blocks, and shots), turns, dribbles, sprints, and screens, as well as low-intensity movements like walking, stopping, and jogging (Alemdaro lu, 2012; Delextrat, Anne and Cohen, 2009). Agility is a very complicated talent that correlates with other elements such as coordination, strength, speed,

explosiveness, endurance, and balance (Sekulić et al., 2013; Milenkovic, 2022). Agility can present itself in a variety of ways, ranging from the movement of a single body part to the rapid movement of the complete muscle system in a specific direction (Sopa & Pomohaci, 2016). The players in the game of basketball require a very high level of agility, some form of on-court activity that involves skill when dribbling the ball quickly towards the basketball hoop past several opponents who are guarding around the ring with certain formations.

Basketball is a fast-paced team sport that combines physical, mental, technical, and tactical elements. Basketball players must have superior motor skills and athletic ability to succeed in matches and tournaments (Ostojic et al., 2006). Basketball necessitates agility and high jumping ability (Bal et al., 2011) so that in the game of basketball, an athlete

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must have good agility, it is very useful when displaying a range of physical performance attributes for both specific movement patterns (dribbling, shooting, passing, throwing, rebounding, and blocking) and fundamental movement (running, jumping, change of direction). Agility has been characterized as the capacity to depart rapidly, stop, and change direction, or the capacity to rapidly and precisely change direction (Domenico et al., 2019). Basketball players' performance is influenced by various elements, including strength, speed, agility, endurance, and mobility (Ozen et al., 2020). Agility is an ability performed in a constantly changing environment. Responding to unforeseen inputs, such as opponents' movements, places a greater demand on the athlete's perceptual and decision-making abilities and the capacity to react rapidly (Kovacikova et al., 2021).

The utilization of the exercise model must also be adjusted to the training media to be used so that the results of the exercise will be more optimal. The development of a uniform system of accounting training loads is a critical prerequisite for effective training process management (Koryahin et al., 2021). Conditioning coaches vary the content and style of agility training in various ways to produce maximum gains in agility performance (Kovacikova et al., 2021). Some critical activities must be completed before effective management of the training process of basketball players can be executed (Koryahin, Blavt, Dorodhenko & Stadnyk, 2020). The more diverse the training model offered to athletes will further stimulate athletes not to feel saturated while training. Water exercise is not only used for various swimming techniques (crawl, backstroke, breaststroke, or butterfly); exercises with water media offer many other movement possibilities such as walking, jogging, or jumping. Water is a unique exercise medium because it provides a reduced-gravity environment that reduces impact pressures on joints while creating resistance to movement (Anista et al., 2018). This will stimulate the metabolic and neuromuscular systems, followed by physiological adaptation processes (Torres-Ronda & Schelling I Del Alcázar, 2014). Some studies show that jumping in water can help you get stronger, reach higher peak torque, and jump higher; speed and agility can also improve (Colado et al., 2010), and a study from (Anista et al., 2018) shows a considerable gain in skill and strength among preadolescent boys due to water exercise.

The sand reduces pressure or resistance caused by hard footings, such as when training on a hard textured field. Sand also challenges athletes to push their anaerobic thresholds to the maximum. Running and jumping on sand produce faster results than the same actions on any other surface (Vinoth & Nageswaran, 2015) and demand more force and a greater range of motion from your ankles and hips (Kapoor & Sharma, 2017). Exercises in the sand can also be one medium in implementing strength, speed, endurance, or power training. Soft foundations such as those in sand or water have properties like resistance. In addition to being useful to reduce pressure, it also provides an effect as a load to be useful in practice. According to research from (Binnie, 2013), ten weeks of agility training on a sand surface led to significant gains in agility performance on both sand and firm ground surfaces, implying that the physiological and biomechanical changes associated with sand training may potentially benefit solid-ground agility performance. Sand training is a fantastic way to improve strength and power, in-

crease lower body muscle, and generate competition-specific adaptations (Sultana, 2014).

However, many athletes aged 16-18 years in basketball clubs in Sleman district, Yogyakarta, still have low agility. This is evidenced by the number of traveling violations caused by lack of mastery during speed changes many fouls due to a slow slide defense motion. Based on match statistics, the turnover rate of athletes is very high, above 30 times in one match. Turnover itself consists of several elements: improper passing, traveling violation, and exposed steal. The dominant thing that occurs is traveling violation, told to steal due to the inability of athletes to pass opponents so that athletes tend to make mistakes. There is a gap between the coach's instructions to the intended target and the results of athletes' execution on the field. This study aimed to examine the effect of 8 weeks of sand exercise and water exercise on leg muscle power in adolescent basketball athletes using an agility training method. Our other aim is to prove that training models using sand or water media can improve the agility of teenage basketball players to be a choice for coaches.

Materials and methods

Study participants

The 36 basketball athletes were taken using random sampling techniques to divide the group in the limb power test. This test is used to determine the power level of the leg muscles owned by the athlete. After the limb muscle power data is collected, an analysis is then conducted to identify the group of athletes with high and low leg muscle power using the overall test score of the limb muscle power possessed by the athlete by ranking. Based on these rankings are further determined 27% of the upper group and 27% of the lower group of test results (Miller, 2008). Thus the grouping of samples were taken from athletes who had high leg muscle power as much as 27% and athletes who had low leg muscle power as much as 27% of the data that had been summarized. Based on this, 10 athletes have the high leg muscle power, and 10 have low leg muscle power. Then each of the data is divided into two groups by random and obtained. Each of the 5 athletes with high leg muscle power is treated with water and sand exercise methods. The same is also done for athletes with low leg muscle power.

Study organization

This study uses experimental methods with research design in 2x2 factorial. The factorial experiment is almost or all the levels of a factor combined or crossed with all levels of every other aspect present in the investigation. The design can be seen in table 1:

Table 1. Factorial Design

Leg Power Muscle (B)	Training Method (A)	
	High (A1)	Low (A2)
High (B1)	A1. B1	A2. B1
Low (B2)	A1. B2	A2. B2

- A1B1: Groups of athletes with high category leg power are given the treatment of leg training methods with water exercise.
- A2B1: Groups of athletes with high category leg power are given leg training methods with sand exercise.
- A1B2: Groups of athletes with low category leg power are given the treatment of leg training methods with water exercise.
- A2B2: Groups of athletes with low category leg power are given leg training methods with sand exercise.

Two types of data must be collected following the variables studied: the limb muscle power test and the agility test. Concentration data collection techniques and limb muscle power tests, and agility tests use tests and measurements. The leg muscle power instrument uses the Sargeant Vertical Jump Test. Sargeant Vertical Jump Test with the validity of 0.978 and reliability of 0.989. In contrast, the agility test uses an agility test with a validity of 0.947 and a reliability of 0.973.

Statistical analysis

The analysis technique used by ANOVA was two ways (two ways ANOVA) at the significance level of significance $\alpha = 0.05$. Before the variance analysis technique is used, the analysis prerequisite test is first carried out, including the normality and homogeneity tests. The normality test uses the Kolmogorof-Smirnov test. The variance homogeneity test uses Levene's test. To test the hypothesis using a two-way ANOVA (ANOVA two-way), and if there is evidence of interaction, a follow-up test will be carried out, namely the Tukey test, using the SPSS version 20.0 for windows software program with a significance level of 5% or 0.05.

Results

Descriptive pretest statistics and posttest agility test results on male basketball club athletes in Sleman County are presented in Table 2:

Table 2. Descriptive Statistics Pretest and Posttest Agility Test

Leg Power Muscle	Statistic	Pretest	Posttest
High (A1B1)	Jumlah	71.07	64.23
	Rerata	14.2140	12.8460
	SD	0.41241	0.46522
Low (A1B2)	Jumlah	70.45	66.90
	Rerata	14.0900	13.3800
	SD	0.41707	0.21249
High (A2B1)	Jumlah	68.73	59.96
	Rerata	13.7460	11.9920
	SD	0.32493	0.59162
Low (A2B2)	Jumlah	70.97	67.23
	Rerata	14.1940	13.4460
	SD	0.34681	0.16227

Prerequisite Test Results

Normality test

The data normality test in this study used the Kolmogorov Smirnov method. Normality test results presented in Table 3:

Table 3. Normality test

Data	P	Notes
Pretest A1B1	0.601	Normal
Posttest A1B1	0.699	Normal
Pretest A2B1	0.621	Normal
Posttest A2B1	0.636	Normal
Pretest A1B2	0.952	Normal
Posttest A1B2	0.877	Normal
Pretest A2B2	0.979	Normal
Posttest A2B2	0.768	Normal

Based on table 3 above, all pretest and posttest data were obtained from the normality test results of the data significance value $p > 0.05$, which means the data is a normal distribution.

Homogeneity Test

The homogeneity test is intended to test the similarity of variants between pretest and posttest. The homogeneity test in this study was the Levene Test. Homogeneity test results are presented in Table 4:

Table 4. Homogeneity test

Group	Sig.	Notes
Pretest	0.955	Homogen
Posttest	0.084	Homogen

Based on table 4, the pretest obtained a significance value of $0.307 \geq 0.05$ and in posttest received a significance value of $0.216 \geq 0.05$. This means that in the data group, there are homogeneous variants.

Hypothesis Test Results

Research hypotheses are tested based on data analysis and two-track ANOVA (ANOVA two-way) analysis interpretation. Hypothesis Test Results are presented in table 5:

Table 5. ANOVA Test

Source	Type III Sum of Squares	F	Sig.
Training method	0.776	4.867	0.042
Leg Power	4.940	30.976	0.000
Training method *Leg Power	1.058	6.634	0.020

The first hypothesis reads, "There is a difference in the influence between the method of exercise (water exercise and sand exercise) on agility." From the results of the ANOVA test, it can be seen that $F_{hitung} = 4,867$, while the significance value p is 0.042. Since the significance value p is $0.042 < 0.05$, H_0 is rejected. Thus there is a significant difference in influence between the exercise method (water exercise and sand exercise) on agility. Based on the analysis results, it turned out that the sand exercise method was higher (good) with a posttest average value of 12,719 seconds compared to the water exercise method with a posttest average value of

13,113. This means that the research hypothesis that there is a significant difference in influence between water exercise methods (water exercise and sand exercise) on agility has been proven.

The second hypothesis reads, "There is a difference in agility ability between athletes who have high leg muscle power and low leg muscle power." From the results of the ANOVA test, it can be seen that $F_{\text{calculate}} = 30,976$, while the significance value p is 0.000. Since the significance value p is $0.000 < 0.05$, H_0 is rejected. Based on this, there is a significant difference in agility ability between athletes with high leg muscle power and low leg muscle power. Based on the analysis results, athletes with high leg muscle power are higher (good) with a posttest average value of 12.419 seconds compared to athletes who have low limb muscle power with a posttest average value of 13.413 seconds. This means that the research hypothesis has been proven that there is a significant difference in agility ability between athletes with high leg muscle power and low leg muscle power.

The third hypothesis reads, "There is an interaction between the exercise method (water exercise and sand exercise) power of the limb muscles (high and low) to agility." From the results of the ANOVA test, it can be seen that $F_{\text{calculate}} = 6.634$, while the significance value p is 0.020. Since the significance value p is $0.020 < 0.05$, H_0 is rejected. Based on this, the hypothesis that there is an interaction between the exercise method (water exercise and sand exercise) and the power of the leg muscles (high and low) to agility has been proven.

A Diagram of the results of the interaction between the exercise method (water exercise and sand exercise), power of the leg muscles (high and low) to agility can be seen in Figure 1:

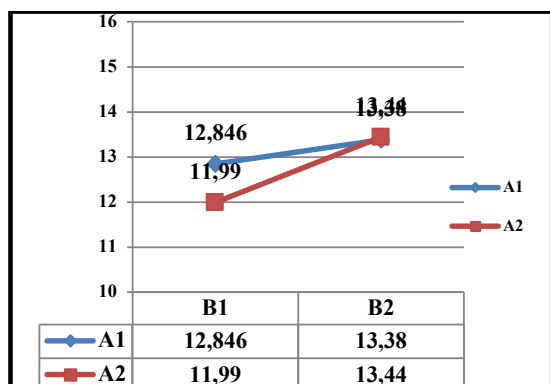


Fig 1. Results of Interaction Between Exercise Methods (Water Exercise and Sand Exercise) with Leg Muscle Power (High and Low)

After testing, there is an interaction between the exercise method (water exercise and sand exercise), power of the limb muscles (high and low) to agility. Then, it is necessary to do further tests using the Tukey test. The results of the additional test can be seen in table 6.

Based on table 6, Tukey test calculation results on asterisk marks (*) show that pairs that have interactions or pairs that differ markedly (significantly) are: (1) A1B1-A2B1, (2) A2B1-A1B1, (3) A2B1-A1B2, (4) A2B1-A2B2, (5) A1B2-

Table 6. Poshoc Test Results

Group	Interaction	Std. Error	Sig.
A1B1	A2B1	0.25257	0.018
	A1B2	0.25257	0.191
	A2B2	0.25257	0.122
A2B1	A1B1	0.25257	0.018
	A1B2	0.25257	0.000
	A2B2	0.25257	0.000
A1B2	A1B1	0.25257	0.191
	A2B1	0.25257	0.000
	A2B2	0.25257	0.993
A2B2	A1B1	0.25257	0.122
	A2B1	0.25257	0.000
	A1B2	0.25257	0.993

A1B1: Groups of athletes with high category leg power are given the treatment of leg training methods with water exercise.
A2B1: Groups of athletes with high category leg power are given leg training methods with sand exercise.
A1B2: Groups of athletes with low category leg power are given the treatment of leg training methods with water exercise.
A2B2: Groups of athletes with low category leg power are given leg training methods with sand exercise.

A2B1, (6) A2B2-A2B1. The other pairs are stated to be no different: pair (1) A1B1-A1B2, (2) A1B1-A2B2, (3) A1B2-A1B1, (4) A1B2-A2B2, (5) A2B2-A1B1, (6) A2B2-A1B2.

Discussion

Based on hypothesis testing, it is known that the method of exercise (water exercise and sand exercise) has a significant difference in influence on agility. Training in the sand can reduce stress on the skeletal muscle system (Binnie et al., 2014). Exercise can limit movement to minimize damage and related negative side effects such as increased muscle pain. So that sand exercise is another way to improve the ability of leg muscles and agility. The surface of the sand is also expected to reduce the frequency of steps even slightly because athletes maintain almost the same movement patterns and range of motion during stepping. The lower horizontal speed on the sand surface means that athletes take longer to make such movements, so they have a longer time when in contact with the sand surface. Sand's great shock absorption properties can also limit maximal movement speed in sprint training (Barrett et al., 1998) and jumping performance (Bishop, 2003).

Agility is required in sports that are game in nature. Agility is concerned with gestures involving footwork and rapid changes in body position. Agility in principle plays a role in activities that involve changing body movements while maintaining balance. An athlete or player with good agility will perform movements more effectively and efficiently.

Based on the results that have been put forward in this study, there is an interaction between the method of exer-

cise (water exercise and sand exercise), power of the limb muscles (high and low) to agility. From the results of the form of interaction, it appears that the main factors of the study in the form of two factors show significant interaction. In the results of this study, interactions mean that each group has a difference in the influence of each group that is paired. The interaction results showed that the group of athletes who had high leg muscle power was better treated with the sand exercise training method and the group of athletes who had low leg muscle power was better treated with the water exercise training method. The pairs that have interactions or significantly different partners are as follows: (1) The group of athletes with high leg power given the sand exercise training method is better than the group of athletes who have high leg power given the water exercise training method, with a significance value of $0.018 < 0.05$, (2) The group of athletes with high leg power who were given the sand exercise method was better than those who had low leg power who were treated with the water exercise method, with a significance value of $0.000 < 0.05$, (3) The group of athletes with high leg power was treated with the sand exercise method, which was better than the group of athletes with low leg power treated with the sand exercise method, with a significance value of $0.000 < 0.05$.

Conclusions

Based on the research results and the results of data analysis that has been done, the following conclusions were obtained: (1) There is a significant difference in the influence of exercise methods (water exercise with sand exercise) on agility. The sand exercise method is higher (good) than the water exercise method. (2) There is a significant difference in the influence of agility ability between athletes who have high leg muscle power with low leg muscle power. Athletes with high leg muscle power are higher (good) than athletes with low high leg muscle power. (3) There is a significant interaction between water exercise methods (water exercise and sand exercise) with the power of the limb muscles (high and low) to agility. The interaction results showed that the athletes with high leg muscle power were better treated with sand exercise methods. The athletes with low leg muscle power were better treated with water exercise methods. The implications of this study could prove that sand exercise methods are more effectively used in increasing agility to be an alternative for coaches. The results of the research can practically be used as consideration for coaches, as well as basketball coaches, in making appropriate training programs to improve agility. Thus the exercise will be effective and will result in what is expected by the coach.

Conflict of interest

The authors declare that there are no conflicts of interest.

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ВПЛИВ МЕТОДІВ ВИКОНАННЯ ВПРАВ НА ПІЩАНІЙ ПОВЕРХНІ, ВИКОНАННЯ ВПРАВ НА ВОДНІЙ ПОВЕРХНІ ТА СИЛОВИХ ТРЕНУВАНЬ М'ЯЗІВ НІГ ПРОТЯГОМ ВОСЬМИ ТИЖНІВ НА РОЗВИТОК СПРИТНОСТІ В БАСКЕТБОЛІСТІВ ДЛЯ ГРАВЦІВ ПІДЛІТКОВОГО ТА ЮНАЦЬОГО ВІКУ

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Авторський вклад: А – дизайн дослідження; В – збір даних; С – статаналіз; D – підготовка рукопису; E – збір коштів

Реферат. Стаття: 7 с., 6 табл., 1 рис., 23 джерела.

Мета дослідження. Спритність відіграє суттєву роль у баскетболі, тому підвищенню спритності потрібно приділяти окрему увагу у вправах із фізичної підготовки баскетболістів. Для досягнення якнайкращих результатів за допомогою певних вправ необхідно брати до уваги тип і спосіб виконання таких вправ. Що різноманітнішою буде модель тренувань, запропонована спортсменам, тим більше вона буде додатково сприяти відсутності в спортсменів відчуття виснаженості під час тренувань. Проте модель тренувань, яку використовують, досі обмежена майданчиками з твердою поверхнею. Хоча використання таких типів поверхні майданчика, як вода й пісок, має не такий вплив, як силове навантаження, воно знижує частоту випадків травматизму.

Матеріали та методи. У дослідженні використовували метод експерименту з факторним планом 2×2. У дослідженні брали участь 36 баскетболістів чоловічої статі віком 16-18 років. Для вимірювання сили ніг використовували стрибки у висоту, для оцінки спритності – тест на спритність, а для аналізу даних дослідження – дисперсійний аналіз.

Результати. (1) метод виконання вправ на піску показує кращі результати, ніж метод виконання вправ на воді; (2) спортсмени з високими показниками сили кінцівок показують кращі результати в тестуванні на спритність, ніж спортсмени з низькими показниками сили кінцівок; та (3) існує взаємозумовленість між методами виконання вправ на воді та виконання вправ на піску й силовими показниками кінцівок у зіставленні з результатами тестування на спритність.

Висновки. Результати цього дослідження можуть підтверджувати, що використання методів виконання вправ на піску є ефективнішим для покращення показників спритності та може бути альтернативним рішенням для тренерів.

Ключові слова: вправи на піску, вправи на воді, спритність, баскетбол, підліток.

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ORIGINAL SCIENTIFIC ARTICLE

AUGMENTED POKEMON GO IN TIMES OF COVID-19: DOES IT HAVE ANY EFFECT ON PROMOTING TEENAGERS' PHYSICAL ACTIVITY?

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Abstract

Study purpose. One of the main problems during the COVID-19 pandemic that needs to be considered is the decline in physical activity carried out by teenagers. The overall objective of this mixed method is to investigate the effects of the Pokemon Go intervention program to promote physical activity in teenagers during the COVID-19 crisis.

Materials and methods. This study was conducted through a mixed method approach. 94 teenagers in grades 10-12 from three high schools agreed to participate in this study. The subjects were divided into 2 groups, namely in the Pokemon Go intervention program group (N = 47) and a control group that did not get any physical activity (N = 47). The Pokemon Go intervention program was carried out for 7 weeks with an intensity of 3 times a week in physical education classes. After carrying out the Pokemon Go intervention program, the forty-seven subjects were interviewed. The quantitative instrument used to measure the physical activity level was IPAQ, while the qualitative instrument used in-depth interviews.

Results. The quantitative and qualitative (mixed) research confirms that the Pokemon Go intervention program showed to positively promote PA levels in teenagers to higher levels in the current COVID-19 crisis. The results of this study are in line with the previous studies which explained that Pokemon Go is an augmented reality game that requires players to travel to various locations in the real world where distances are relatively far.

Conclusions. Teenagers with the status of players, ex-players and non-players experienced a significant increase in physical activity level after participating the Pokemon Go intervention program for 7 weeks, and the majority of subjects considered that Pokemon Go had a positive effect to promote physical activity during the COVID-19 pandemic. After implementing the Pokemon Go intervention program for 7 weeks, the results of our study confirm that the physical activity levels of teenagers have gradually increased during the COVID-19.

Keywords: Pokemon Go, physical activity, COVID-19, mixed method.

Introduction

In this COVID-19 era, physical activity (PA) among teenagers until adults are drastically decline (Yan et al., 2020). Previous studies reported that physical activity has an important contribution in maintaining healthy body, fit and avoid chronic diseases, such as heart disease, obesity, cancer, diabetes (Dietz et al., 2016) and hypertension (Lee et al., 2021). Another study reported that, globally, more than a quarter of adults were physically inactive, caused 5 million deaths per

year (Ni et al., 2019). According to the study results by Xian et al. (2017), notwithstanding that exercise has been carried out and well documented, PA levels were still low in some countries. Based on this fact, innovative strategies to increase PA need to be promoted in current COVID-19 era.

Previous studies recommended Pokemon Go as a strategy to promote the low PA levels (Madrigras-Pana et al., 2019; Khamzina et al., 2020). Pokemon Go is an augmented reality game, a player has to find and get cartoon characters in real world or in the surrounding environment (e.g., house, yard, park, school) (Howe et al., 2016). According to Ma et al., (2018), this game created a condition as if players can catch and fight monsters (Pokemon) in the real world. Pokemon Go

has an advantage by utilizing the Global Positioning System (GPS) and compatible devices with cameras, so that players feel as if they are experiencing fantasy in the real world (Yan et al., 2020). Previous studies have reported that Pokemon Go had a positive effect on increasing PA levels (Ayers et al., 2016), because this game encourages people to walk or run to catch monsters (Pokemon), collect candy or hatch eggs (Wong, 2017; Wattanapisit et al., 2018). Although the benefits of Pokemon Go had been reported and documented, this game was claimed could cause traumatic injuries, for example the players were possible to fall, hit trees or walls, and even cause traffic injuries due to playing while walking, cycling or driving a vehicle. There were some data reported that the negative impact of playing Pokemon Go was serious injuries to players by 10.7% of all events and the most common side effect was musculoskeletal or skin injuries (68.0%) (Li et al., 2021). In addition, a study found that the long-term effects of Pokemon Go on increasing PA and health were not yet untested (An & Nigg, 2017). Based on the fact that there was found some gaps in previous studies, it was suggested that further research on Pokemon Go needs to be conducted and should be a major concern.

Previous studies on Pokemon Go have been reported internationally (Clark & Clark, 2016; Licoppe, 2016; Keogh, 2017). However, research on Pokemon Go as a strategy to increase PA levels through mixed methods has not been reported internationally. According to our knowledge, this is the first study that use a mixed method to investigate the effects of Pokemon Go during the COVID-19 crisis, because most of the previous research was conducted through Longitudinal, Cross-sectional, Experimental, Retrospective Cohort studies (Lee et al., 2021) and qualitative (Lindqvist et al., 2018). This study has the potential to explain the effectiveness of Pokemon Go in terms of quantitative and qualitative (mixed), so that it can provide accurate information to lecturers, students, athletes, public regarding the importance of the game Pokemon Go for increasing the PA level of teenagers during the current dangerous pandemic crisis. Thus, this study aims to investigate the effect of playing Pokemon Go on increasing PA levels during COVID-19.

Materials and Methods

Subject

The mixed method was used as an approach in this study. Mixed method is a research that combines quantitative and qualitative research. Thus, this study aims to obtain data in the form of numbers and descriptions of interviews results with subjects. The subjects in this study were teenagers who are currently undergoing education at the high school level in Cianjur City (Indonesia). Subjects were selected using Cluster Random, namely by sending messages via Whatsapps to all students from grades 10 to 12 from three schools regarding the purpose of this study and only 94 students responded and were willing to be subjects in this study. The characteristics of the subjects are presented in Table 1.

Measuring Instrument

Quantitative Instruments. International Physical Activity Questionnaire was used to measure a PA level. This

Table 1. Socio-demographic of Subjects

Variables		N(%)
Gender	Male	50(53.19%)
	Female	44(46.81%)
Age (y)	15	24(25.53%)
	16	32(34.04%)
	17	21(22.34%)
	18	17(18.09%)
Weight (kg)	50	19(20.21%)
	55	25(26.60%)
	60	36(38.30%)
	65	14(14.89%)
High (cm)	155	24(25.53%)
	160	39(41.49%)
	165	19(20.21%)
	170	12(12.77%)
School	Senior High School 1 Cipanas	29 (30.85%)
	Senior High School 2 Cianjur	41 (43.62%)
	Senior High School 1Ciranjang	24 (25.53%)
Class	10	59(62.77%)
	11	21(22.34%)
	12	14(14.89%)
Play Status	Players	30(%)
	Ex-Players	24(%)
	Non-Players	40(%)

instrument has been validated and has a validity value of 0.087 while the reliability was 0.77 and has been translated into Indonesian. IPAQ was used to measure three types of activities, namely high intensity PA, moderate PA and low PA (walking). These three PAs have different METs values, for example high PA = 8.0 METs, medium PA = 4.0 METs and low PA (running) = 3.3 METs. The total PA scores of the three activities between high, medium and low were combined and expressed in MET-min/week (Wong, 2017).

Qualitative Instruments. In qualitative research, researchers used in-depth interviews towards subjects about their experiences during the Pokemon Go program. Interviews were carried out by using Indonesian language with a duration of 10-15 minutes per day via online through Whatsapps platform. The interviews were recorded and noted in books, then analyzed by 3 experts who have Ph.D. degrees in physical education and sports.

Procedure

This research was conducted from November to December 2021 at Suryakencana University. This research has obtained permission from the Research Committee (N0:270.75/SP2H/UN64.10/LL/2021) Suryakencana University (Indonesia). In addition, this research has followed

the ethical guidelines of the World Medical Association (Helsinki Declaration) for human objects. In quantitative research, 94 subjects were divided into two groups, namely the experimental group (N=47) who received the Pokemon Go program and the control group (N=47) who only did daily activities at school or did not receive any physical activity program. The pre-test and post-test activities were carried out by sending IPAQ via Whatsapps to all subjects, so that they could fill out the questionnaire individually under the supervision of the research team. While the Pokemon Go program started from 08.00-09.00 AM during education classes and was carried out for 7 weeks with an intensity of 3 meetings a week. In addition, this study applied the COVID-19 health protocol, namely checking body temperature, providing hand sanitizer and vaccines to subjects.

As for qualitative research, all subjects were interviewed online by researchers regarding their experiences after participating in the Pokemon Go program for 7 weeks. The questions are as following: (a) The experience of intervention (Pokemon Go program), (b) the advantages of the Pokemon Go program and (c) the disadvantages of the Pokemon Go program.

Statistical analysis

Quantitative analysis. Quantitative data were processed to analyze descriptive statistics presented as mean, standard deviation (SD) and percentage. In addition, all data were checked for normal distribution using the Kolmogorov-Smirnov test. Meanwhile, the independent t-test was used for comparison between the experimental and control groups. Then the effect size (ES) was used to estimate the

significance of the group mean differences. All quantitative data were processed using IBM SPSS software (v25.0, SPSS Inc., Chicago, IL, USA) with a significance level of 0.05.

Qualitative analysis. Meanwhile, qualitative data were processed through thematic analysis. There were several steps in the thematic analysis that need to be taken, including: (a) Interviews were transcribed word for word. (b) The transcribed interview was read repeatedly by the researcher/expert to gain a broad understanding. (c) The data was sorted by categorization, coding, and highlighting based on their similarity (Rasmitadila et al., 2020). (d) Similar phrases were grouped and organized into themes (Ekström et al., 2017)

Results

The normality test in this study was normally distributed ($p = 0.246 > 0.05$). While the results of the quantitative study shows that there was a significant increase in total PA in teenagers with player status due to the impact of the Pokemon Go program (Table 2). The similar results also occurred in teenagers with ex-players status (Table 3) and non-players status (Table 4). Meanwhile, there was no increase in PA levels in the control group in all statuses.

The results of qualitative research through interviews with subjects are presented in three themes:

Theme 1: Experience of Intervention

The results of qualitative research through interviews with subjects are presented in three themes:

This first theme discusses the subjects' experience when participating in the Pokemon Go program for 7 weeks. Intervention experience is an important factor that needs to be

Table 2: Differences in Pokemon Go group and Control group values in Walking PA, Moderate PA, Vigorous PA of Players

Physical Activity	Pokemon Go Group (N = 15)				Control Group (N = 15)			
	Pre-Test	Post-Test	P	ES (d)	Pre-Test	Post-Test	P	ES (d)
	M(SD)	M(SD)			M(SD)	M(SD)		
Walking PA (METmin/week)	598.4(356.0)	558.8(342.1)	0.000	0.64	187.4(63.1)	173.8(61.7)	0.342	0.002
Moderate PA (METmin/week)	653.3(383.5)	664.8(362.7)	0.003	0.71	114.6(85.3)	101.3(79.8)	0.521	0.001
Vigorous PA (METmin/week)	629.3(367.2)	1024.0(433.1)	0.001	0.75	224.0(113.9)	208.0(89.7)	0.339	0.000
Total PA (METmin/week)	1881.1(456.1)	2246.8(742.4)	0.000	0.78	525.6(162.6)	483.1(128.5)	0.279	0.000

Table 3. Differences in Pokemon Go and Control group values in Walking PA, Moderate PA, Vigorous PA of Ex-Players

Physical Activity	Pokemon Go Group (N=12)				Control Group (N=12)			
	Pre-Test	Post-Test	P	ES (d)	Pre-Test	Post-Test	P	ES (d)
	M(SD)	M(SD)			M(SD)	M(SD)		
Walking PA (METmin/week)	533.5(369.3)	561.5(218.9)	0.000	0.69	203.5(44.1)	192.5(52.3)	0.221	0.000
Moderate PA (METmin/week)	733.3(331.3)	1063.3(288.1)	0.000	0.77	96.6(43.3)	90.0(38.6)	0.178	0.001
Vigorous PA (METmin/week)	466.6(278.8)	893.3(492.9)	0.000	0.72	186.6(104.2)	193.3(99.2)	0.264	0.001
Total PA (METmin/week)	1733.5(423.2)	2517.6(650.7)	0.001	0.80	486.8(100.0)	475.8(101.5)	0.380	0.002

Table 4. Differences in Pokemon Go and Control group values in Walking PA, Moderate PA, Vigorous PA of Non-Players

Physical Activity	Pokemon Go Group (N=20)				Control Group (N=20)			
	Pre-Test	Post-Test	P	ES (d)	Pre-Test	Post-Test	P	ES (d)
	M(SD)	M(SD)			M(SD)	M(SD)		
Walking PA (METmin/week)	506.5(252.0)	598.95(305.3)	0.000	0.64	196(43.4)	202.9(22.1)	0.321	0.000
Moderate PA (METmin/week)	642.0(398.8)	896.0(366.7)	0.000	0.71	98.0(39.9)	94.0(43.5)	0.201	0.001
Vigorous PA (METmin/week)	592.0(371.0)	1012.0(468.8)	0.000	0.78	200.0(105.4)	124.0(60.7)	0.111	0.001
Total PA (METmin/week)	1740.5(687.3)	2506.9(666.5)	0.001	0.79	494.3(98.8)	420.9(64.4)	0.108	0.002

known, in order to provide an overview of the effectiveness of the Pokemon Go program. The subjects give their opinion as following:

"I'm excited to be able to join the Pokemon Go program, because this game is very interesting and motivate me to walk."

"At the beginning of the intervention, I felt that this game was boring but after getting a lot of Pokemon monsters I liked the game."

"I've played this game previously, but I thought Pokemon Go can hurt me. But my opinion was changed because the location of the intervention in this study was carried out in an area on university that was far from the city center and there were no vehicles."

"Before taking part in this research, I have often played this Pokemon Go game and I confirm that this game is safe if it is done in a place far from vehicles, such as parks or hills. And I like this game, because it triggers me want to walk or run to find Pokemon monsters."

Theme 2: Pokemon Go Program Advantages

The second theme is about the advantages of the Pokemon Go game which is indeed an important factor and must be informed to everyone. The subjects argued that:

"I presume that the advantage of playing Pokemon Go is it can gradually increase our PA level. For example, before participating in the Pokemon Go intervention, I rarely did PA outside the house, especially during hot weather or the current pandemic situation. But, Pokemon Go has help me to have a much better PA level."

"In my opinion, Pokemon Go is one of the games that promotes PA in a positive way to teenagers in the current COVID-19 pandemic crisis. The advantage of this game can be played at any time, we just need to provide a smartphone with a mobile data."

"This game is incredibly fun, because it allows me to walk for an hour without feeling bored or tired. I will continue to play this game, even after the research has been completed."

"I believe that Pokemon Go can be one of the right strategies to increase PA levels during the current COVID-19 pandemic, because this game can be played individually and doesn't require many friends."

"I can't believe it!!, This Pokemon Go game trigger me to walk 1.2 km every day. This game is a great method for teenagers to increase their PA level even during a pandemic."

Theme 3: The disadvantages of Pokemon go program

This third theme discusses the shortcomings of the Pokemon Go game that must be investigated accurately, in

order to minimize the weakness. The subjects revealed their opinion that:

"Pokemon Go is indeed a game that can promote improvement in PA levels, but if the game is not played in a safe place, it can result in injury (e.g., falling, crashing into a tree or wall, being hit by a vehicle)."

"In my opinion, Pokemon Go has several weakness, such as : it requires a fairly large mobile data plan, we should have a smart phone with good quality in order to play this game."

"If the internet network is bad, then Pokemon Go cannot be used to increase our PA level. In addition, if the weather is raining, then we cannot walking outside the house. And the GPS signal sometimes gets interrupted, so players can't walk to search Pokemon monsters."

Discussion

In overall, the objective of this study was to evaluate the effects of the Pokemon Go game from a mixed method point of view on increasing PA levels during the COVID-19 period. In quantitative and qualitative (mixed) research confirm that the Pokemon Go program showed to positively promote PA levels in teenagers to higher levels in the current COVID-19 crisis. The results of this study are in line with previous studies which explained that Pokemon Go is an augmented game that requires players to travel to various locations in the real world which the distances was relatively far. Thus, after carried out this game, players can increase their PA level to be better than before (Althoff et al., 2016; Chaput & Leblanc, 2017; Ewell et al., 2020; Kosa & Uysal, 2022).

Teenagers with the status of players, ex-players and non-players who have participated in the Pokemon Go intervention program reported that they were able to walk 60 minutes in a day (Ni et al., 2019) and experiencing an increase in walking distance with an average of 1.5 km. Similarly, a study conducted in the US reported that the effects of Pokemon Go can lead to an average increase of 1473 runs in a day. While the research of Howe et al., (2016) noted that players experienced an increase of 955 steps per day (Wattanapisit et al., 2018).

In addition, this study refutes previous research that reported Pokemon Go was not effective if used in the long term to increase PA levels (An & Nigg, 2017). The fact is the Pokemon Go intervention program which was implemented for 7 weeks was effective for increasing PA levels in teenagers despite the current pandemic crisis. The main issue that is often found in previous studies is the safety or of players

(Wong, 2017; Marquet et al., 2017; Wattanapisit et al., 2018), but our research confirms that none of the teenagers got injured while playing Pokemon Go. This is because we had prepared a wide and safe environment for them to play.

Conclusions

This study becomes evidence that the Pokemon Go program is one of the strategies that has a positive effect in promoting PA among teenagers at high school level during the COVID-19 crisis. The scope of this study was limited in terms of the subject which comes from one area in Indonesia. Thus, future studies need to be carried out by targeting subjects from different ages including children, adolescents and adults in several regions in Indonesia or other countries.

Acknowledgement

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Conflict of interest

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

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ДОПОВНЕНА ГРА «РОКЕМОН GO» ПІД ЧАС ПАНДЕМІЇ COVID-19: ЧИ ВПЛИВАЄ ВОНА НА СПРИЯННЯ ФІЗИЧНІЙ АКТИВНОСТІ ПІДЛІТКІВ?

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Реферат. Стаття: 6 с., 4 табл., 26 джерел.

Мета дослідження. Однією з головних проблем під час пандемії COVID-19, яка потребує розгляду, є зниження фізичної активності підлітків. Загальною метою цього змішаного методу є вивчення впливу інтервенційної програми «Pokemon Go» на сприяння фізичній активності підлітків під час кризи, зумовленої COVID-19.

Матеріали та методи. Це дослідження проводили з використанням підходу на основі змішаного методу. Учасниками дослідження погодилися стати 94 підлітки-учні 10-12 класів із трьох середніх шкіл. Учасників розподілили на 2 групи, а саме: експериментальну групу, у якій учасники займалися за інтервенційною програмою «Pokemon Go» (N = 47), і контрольну групу, у якій учасники не здійснювали фізичної активності (N = 47). Інтервенційну програму «Pokemon Go» проводили на заняттях із фізичного виховання протягом 7 тижнів з інтенсивністю 3 рази на тиждень. Після завершення проведення інтервенційної програми «Pokemon Go» було проведено опитування 47 учасників. Засобом кількісної оцінки, який використовували для вимірювання рівня фізичної активності, була Міжнародна анкета з фізичної активності (IPAQ), а як засіб якісної оцінки використовували докладні інтерв'ю.

Результати. Кількісний і якісний (змішаний) аналіз підтверджує, що інтервенційна програма «Pokemon Go» показала позитивне сприяння зростанню рівнів ФА в підлітків до вищих рівнів під час нинішньої кризи, зумовленої COVID-19. Результати цього дослідження узгоджуються з попередніми дослідженнями, у яких було пояснено, що «Pokemon Go» – це гра доповненої реальності, яка вимагає від гравців пересуватися до різних локацій у реальному світі на відносно далекі відстані.

Висновки. Підлітки зі статусом гравців, колишніх гравців і не гравців зазнали значного підвищення рівня фізичної активності після участі в інтервенційній програмі «Pokemon Go» протягом 7 тижнів, і більшість учасників уважала, що гра «Pokemon Go» позитивно впливає на сприяння фізичній активності під час пандемії COVID-19. Після реалізації інтервенційної програми «Pokemon Go» протягом 7 тижнів результати нашого дослідження підтверджують, що рівні фізичної активності підлітків під час пандемії COVID-19 поступово зростали.

Ключові слова: Pokemon Go, фізична активність, COVID-19, змішаний метод.

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ORIGINAL SCIENTIFIC ARTICLE

EIGHT-WEEK FUNCTIONAL TRAINING WITH ASCENDING AMRAP MODEL AND FOR TIME CONSTANT LOAD MODEL TO INCREASE ABDOMINAL MUSCLE STRENGTH AND MAXIMAL OXYGEN CONSUMPTION LEVELS IN ADOLESCENT MALES

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

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Abstract

The study purpose was to investigate the effect of functional training with the ascending AMRAP model and with the FOR TIME constant load model on increasing abdominal muscle strength and maximal oxygen consumption ($\text{VO}_{2\text{max}}$) in adolescent males.

Materials and methods. This study used the True-Experimental method with the research design of the Randomized Control Group Pretest-Posttest Design. A total of 21 adolescent males aged 18-21, body mass index (BMI) 18.5-24.9 kg/m^2 , normal blood pressure, normal resting heart rate, normal oxygen saturation (SpO_2) participated in this study and were divided into three groups, namely CTRLG (n = 7; control group), FSTAG (n = 7; ascending AMRAP functional training group), and FSTFG (n = 7; FOR TIME constant load functional training group). Both the ascending AMRAP functional training and the FOR TIME constant load functional training interventions were carried out with a frequency of 3 times/week for 8 weeks. Statistical analysis used the one-way ANOVA test with the Statistical Package for Social Science (SPSS) software version 21.

Results. The results showed that there was a significant difference in the mean delta (Δ) increase in abdominal muscle strength ($p \leq 0.05$). The mean delta (Δ) increase in $\text{VO}_{2\text{max}}$ also showed a significant difference ($p \leq 0.05$).

Conclusions. Based on the results of the study, it was shown that the administration of functional training intervention with the ascending AMRAP model and functional training intervention with the FOR TIME constant load model which was carried out 3 times/week for 8 weeks increased abdominal muscle strength and maximal oxygen consumption levels.

Keywords: ascending AMRAP, FOR TIME constant load, abdominal muscle strength, $\text{VO}_{2\text{max}}$.

Introduction

Lack of physical activity can have serious implications for human health. Approximately 2 million deaths per year are associated with a lack of physical activity, prompting the WHO to issue a warning that an inactive lifestyle can be one of the top 10 causes of death and disability in the world (WHO, 2002). Sedentary behavior has wide-ranging adverse effects on the human body including an increase in all-cause mortality, such as death from cardiovascular disease, cancer risk, and the risk of metabolic disorders such as diabetes mellitus, hypertension, and dyslipidemia, musculoskeletal

disorders such as arthralgia and osteoporosis, as well as depression, and cardiovascular disorders. cognitive (Park et al., 2020). Physical fitness is one of the strongest predictors of a person's health status (Artero et al., 2012; Kodama et al., 2009). In addition, physical fitness is a prerequisite in achieving one's peak performance. Physical fitness is characterized by the ability to perform and maintain activities of daily living and exhibit traits or capacities associated with a low risk of early development of movement-related diseases and conditions (Winnick & Short, 2005). Physical fitness refers to the components of physical fitness related to health that are influenced by habits in physical activity, including cardiovascular endurance, muscle strength and endurance, body composition, and flexibility (Dunn & Leitschuh, 2006).

Balance and posture are important for most human movements (Winter, 1990). Postural control or balance can

be defined statically as the ability to maintain a base of support with minimal movement and dynamically as the ability to perform tasks while maintaining a stable position (Bresel, 2007). The main factor that affects balance is the function of skeletal muscles as an active means of movement, especially abdominal muscles (Örgün et al., 2019; Akuthota & Fredericson, 2008). This is because the abdominal muscles connect the upper body with the lower body, the level of abdominal muscle strength is very influential on the balance of the body. Core exercise is a popular term in athletics and rehabilitation fields (Örgün et al., 2019; Mok et al., 2015; Jamison et al., 2012; Hibbs et al., 2008). Low muscle mass (i.e. sarcopenia) can be defined as an age-related loss of lean tissue mass that usually results in decreased physical function, muscle strength, and mobility (Yang et al., 2018; Gray & Binns, 2016). An increase in muscle size is considered to be mechanically important for an increase in muscle function (Loenneke et al., 2019). Skeletal muscle plasticity is defined and characterized by dynamic functional and structural remodeling of muscle fibers (biochemistry and size). Changes can occur due to transfer of force loads (space travel, rear leg suspension, and bed rest) or due to increased load-bearing loads. Again, significant changes in the biochemistry of skeletal muscle fibers may occur as a result of high loads and high volume resistance training and low volume aerobic loads, thereby increasing oxidative capacity in certain subsets of the population. However, the exact contribution mechanism is uncertain (Khan, 2004). Physical fitness is currently considered to be one of the most important markers of health, as well as a predictor of morbidity and mortality from cardiovascular disease and other causes (Esmailzadeh & Ebadollahzadeh, 2012; Ortega et al., 2008). Cardiorespiratory fitness is positively related to cardiovascular health, academic achievement, and mental well-being in youth (Raghuvver et al., 2020).

Continuous and continuous development of physical condition training can improve athlete performance as well as an effort to advance Indonesian and international achievements. Through physical condition training programs, coaches can create additional training programs for athletes who have decreased physical condition and carry out advanced physical condition tests to achieve better physical conditions (Bompa, 2015). Achievement in every sport is something that is always a target to be achieved as much as possible. Therefore, it should be noted that in order to provide the best results in sporting achievements, it is necessary to establish achievement coaching in supporting the quality of professional athletes and coaches. This is because the coach must have the ability, including proper treatment related to physical conditions, techniques, tactics, and even psychology. Based on the above background, the purpose of this study was to prove the effect of functional training with the ascending AMRAP model and FOR TIME constant load on increasing abdominal muscle strength and maximal oxygen volume (VO_{2max}) in adolescent mens.

Materials and methods

Study participants

This study used the True-Experimental method with the research design of The Randomized Control Group

Pretest-Posttest Design. A total of 21 teenage boys, aged 18-21 years, body mass index (BMI) 18.5-24.9 kg/m², normal blood pressure, normal resting heart rate, normal oxygen saturation (SpO_2) participated in this study and divided into three groups, namely CTRLG (n = 7; control group), FSTAG (n = 7; functional training AMRAP ascending group), and FSTFG (n = 7; functional training FOR TIME constant load group). Prior to conducting the research, all subjects received information both orally and in writing about this research. All subjects filled out and signed informed consent before participating in the study.

Study organization

The training program is implemented and supervised by professional officers from the Department of Sports Coaching Education, Faculty of Sport Science, State University of Surabaya. The ascending AMRAP functional training intervention and the FOR TIME constant load functional training were carried out with a frequency of 3x/week for 8 weeks. Heart rate monitoring during ascending AMRAP functional training and FOR TIME constant load using Polar Heart Rate Monitor (Polar H10 Heart Rate Sensor, Inc., USA). This research was conducted at the International Youth Center Building, State University of Surabaya.

Body height was measured using a Stadiometer (Portable Seca® Stadiometer, North America), while body weight was measured using a digital scale (OMRON Model HN-289, Omron Co., Osaka, Japan). Body mass index (BMI) was measured by calculating body weight (kg) divided by TB (m²). Blood pressure was measured using an OMRON digital blood pressure meter (OMRON Model HEM-7130 L, Omron Co., Osaka, Japan) on the non-dominant arm 3 times in a row with a 1-2 minute rest interval between the two measurements. At the time of measurement of blood pressure the subject is in a sitting position. Resting pulse rate and SpO_2 were measured using a Beurer Pulse Oximeter (PO 30 Pulse Oximeter). The measurement of abdominal muscle strength was carried out using the Sit Up test for 30 seconds, while the measurement of VO_{2max} used the Multistage Fitness Test (MFT). Abdominal muscle strength and VO_{2max} were measured pre-exercise and 8 weeks post-exercise.

Statistical analysis

Statistical analysis using software Statistical Package for Social Science (SPSS) version 21 (SPSS Inc., Chicago, IL, USA). Shapiro-Wilk was used to test for normality, while Levene's test was used to test for homogeneity and the difference test used Paired Sample T-Test, One Way-ANOVA, followed by Tukey's Honestly Significant Difference (HSD) post hoc test. All data are displayed with Mean $\pm$ Standard Deviation (SD). All statistical analyzes used a significant level ($p \leq 0.05$).

Results

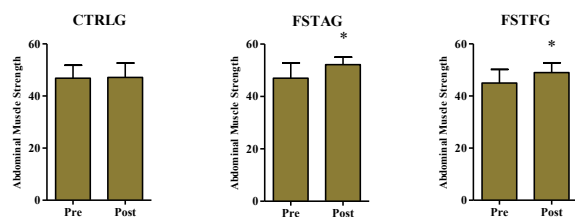
The results of the data analysis on the characteristics of the research subjects which included age, height, weight, body mass index, systolic blood pressure; diastolic blood pressure, resting heart rate, and oxygen saturation in each group are presented in Table 1.

Table 1. Results of data analysis on the characteristics of research subjects in each group

Parameter	n	Mean $\pm$ SD			p-values
		CTRLG	FSTAG	FSTFG	
Age (years)	7	19.71 $\pm$ 1.11	19.57 $\pm$ 1.27	19.86 $\pm$ 1.07	0.899
Body Height (m)	7	1.69 $\pm$ 0.04	1.64 $\pm$ 0.03	1.68 $\pm$ 0.06	0.273
Body Weight (kg)	7	62.00 $\pm$ 5.89	59.43 $\pm$ 5.06	58.29 $\pm$ 3.82	0.382
Body Mass Index (kg/m ²)	7	21.78 $\pm$ 1.27	21.97 $\pm$ 1.67	20.69 $\pm$ 0.79	0.164
Systolic Blood Pressure (mmHg)	7	116.86 $\pm$ 3.08	112.86 $\pm$ 9.51	115.71 $\pm$ 5.35	0.513
Diastolic Blood Pressure (mmHg)	7	76.86 $\pm$ 3.08	75.71 $\pm$ 5.35	75.71 $\pm$ 5.35	0.873
Resting Heart Rate (bpm)	7	66.71 $\pm$ 4.11	63.71 $\pm$ 4.68	70.86 $\pm$ 9.99	0.171
Oxygen Saturation (%)	7	97.57 $\pm$ 1.27	97.43 $\pm$ 1.52	97.43 $\pm$ 1.52	0.977

Description: CTRLG: Control group; FSTAG: Functional training AMRAP ascending group; FSTFG: Functional training FOR TIME constant load group. p-value was obtained using the one-way ANOVA test. Data is displayed with Mean $\pm$ SD.

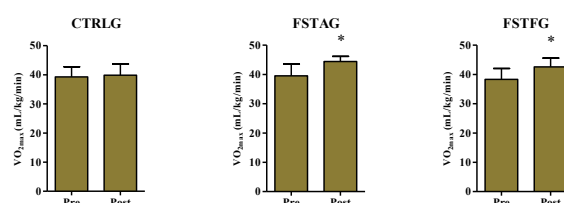
Based on Table 1, the results of the one-way ANOVA test showed that there was no significant difference in the data on the characteristics of the research subjects between the three groups ($p \leq 0.05$). The results of the analysis of the average abdominal muscle strength between pre-exercise vs. post-exercise in each group is presented in Figure 1.

**Fig. 1.** Average abdominal muscle strength between pre-exercise vs. post-exercise in each group

Description: CTRLG: Control group; FSTAG: Functional training AMRAP ascending group; FSTFG: Functional training FOR TIME constant load group. p-Values were obtained by using the different Paired Samples t-Test. (*) Significant vs. pre-exercise ($p \leq 0.05$). Data is displayed with Mean $\pm$ SD.

Based on Figure 1, it can be seen that the average abdominal muscle strength in CTRLG has the same tendency between pre-exercise and post-exercise, while in FSTAG and FSTFG it has a tendency to increase. The results of the different Paired Samples t-Test showed that there was no significant difference in the average abdominal muscle strength between pre-exercise and post-exercise at CTRLG (46.86 $\pm$ 4.95 vs. 47.14 $\pm$ 5.49 repetitions, (p -values=0.356)). While the average abdominal muscle strength between pre-exercise and post-exercise on FSTAG showed a significant difference (47.00 $\pm$ 5.80 vs. 52.14 $\pm$ 2.85 repetitions, (p -values=0.007)). Likewise, the FSTFG showed a significant difference in the average abdominal muscle strength between pre-exercise and post-exercise (45.00 $\pm$ 5.20 vs. 49.00 $\pm$ 3.74 repetitions, (p -values=0.017)). The results of the analysis of the average VO₂max levels between pre-exercise vs. post-exercise in each group is presented in Figure 2.

Based on Figure 2, it can be seen that the average VO₂max levels in CTRLG has the same tendency between pre-exercise and post-exercise, while in FSTAG and FSTFG it has a ten-

**Fig. 2.** Average VO₂max level between pre-exercise vs. post-exercise in each group

Description: CTRLG: Control group; FSTAG: Functional training AMRAP ascending group; FSTFG: Functional training FOR TIME constant load group. p-values were obtained by using the different Paired Samples t-Test. (*) Significant vs. pre-exercise ($p \leq 0.05$). Data is displayed with Mean $\pm$ SD.

dency to increase. The results of the different Paired Samples t-Test showed that there was no significant difference in the mean VO₂max levels between pre-exercise and post-exercise at CTRLG (39.29 $\pm$ 3.46 vs. 39.86 $\pm$ 3.88 mL/kg/min, (p -values= 0.236)). Meanwhile, the mean VO₂max levels between pre-exercise and post-exercise at FSTAG showed a significant difference (39.54 $\pm$ 3.99 vs. 44.41 $\pm$ 1.77 mL/kg/min, (p -values=0.004)). Likewise, the FSTFG showed a significant difference in the mean VO₂max levels between pre-exercise and post-exercise (38.34 $\pm$ 3.68 vs. 42.59 $\pm$ 3.02 mL/kg/min, (p -values=0.001)).

Based on Table 1, the results of the one-way ANOVA analysis showed that there was no significant difference in the mean pre-exercise and post-exercise muscle strength between the three groups ($p \geq 0.05$), while the delta mean (Δ) abdominal muscle strength showed a difference. significant ($p \leq 0.05$). The results of the Tukey's Honest Significant Difference (HSD) post-hoc test showed that there was a significant difference in average delta (Δ) muscle strength between FSTAG and CTRLG (p -values=0.011), FSTFG and CTRLG (p -values=0.043), while FSTAG and FSTFG did not show any significant difference ($p \geq 0.05$).

Based on Table 1, the results of the one-way ANOVA analysis showed that there was no significant difference in the mean VO₂max pre-exercise between the three groups ($p \geq 0.05$), while the average VO₂max post-exercise and delta (Δ) showed a significant difference ($p \leq 0.05$). The results of the Tukey's Honest Significant Difference (HSD) post-

Table 2. The results of the analysis of Abdominal Muscle Strength and VO₂max between the three groups

Parameter	n	Mean±SD			p-values
		CTRLG	FSTAG	FSTFG	
Abdominal Muscle Strength (Repetitions)					
Pre-exercise	7	46.86 ± 4.95	47.00 ± 5.80	45.00 ± 5.20	0.739
Post-exercise	7	47.14 ± 5.49	52.14 ± 2.85	49.00 ± 3.74	0.105
Delta (Δ)	7	0.29 ± 0.76	5.14 ± 3.44*	4.00 ± 3.21*	0.010
VO ₂ max (mL/kg/min)					
Pre-exercise	7	39.29 ± 3.46	39.54 ± 3.99	38.34 ± 3.68	0.819
Post-exercise	7	39.86 ± 3.88	44.41 ± 1.77*	42.59 ± 3.02	0.035
Delta (Δ)	7	0.57 ± 1.15	4.87 ± 2.88*	4.24 ± 1.73*	0.002

Description: CTRLG: Control group; FSTAG: Functional training AMRAP ascending group; FSTFG: Functional training FOR TIME constant load group. p-Values were obtained using the one-way ANOVA test followed by Tukey's Honestly Significant Difference (HSD) post hoc test. (*) Significant vs. CTRLG (p ≤ 0.05). Data is displayed with Mean ± SD.

hoc test showed that there was a significant difference in the average VO₂max post-exercise FSTAG with CTRLG (p-values=0.029), while FSTFG with CTRLG, FSTAG and FSTFG did not show any significant difference (p ≥ 0.05). The results of the Tukey's Honest Significant Difference (HSD) post-hoc test showed that there was a significant difference in the mean delta (Δ) VO₂max between FSTAG and CTRLG (p-values=0.003), FSTFG and CTRLG (p-values=0.009), while FSTAG and FSTFG did not show any significant difference (p ≥ 0.05).

Discussion

Based on the research, it was shown that the functional training intervention with the AMRAP model of functional exercise and FOR TIME model which was carried out 3x/week for 8 weeks to increased abdominal muscle strength and maximum oxygen volume level on petanque athletes. The explanation given by Fathir et al. (2021) functional training with AMRAP, FOR TIME, and EMOM increases strength, endurance, and speed on runners. However, of the three types, functional exercise with For Time is better at increasing strength, endurance, and speed, than AMRAP and EMOM functional exercises. However, the AMRAP model of functional exercise was more effective in increased abdominal muscle strength and maximum oxygen volume level than FOR TIME model. Previous research on functional training with 21-minute AMRAP can develop agility and balance for young basketball athletes (Wibowo et al., 2020). This explanation confirms that functional training with 21-minute AMRAP was effective in improving several components of physical condition. Functional training was the development of an interval training model or intermittent because it has the benefit of increasing the biomotor components, namely strength, endurance, flexibility, balance, speed, and agility so that activities always involve more than 3 muscle groups and involve the core muscles (Wibowo et al., 2021). However, the components of the physical condition of abdominal strength and maximum oxygen volume levels could be proven in this study. Abdominal muscle strength was the ability of the abdominal muscles to perform movements in standing, sitting, and walking. That abdomi-

nal muscle strength was the energy used to change the state of motion or shape by using the muscles of the lower extremities and core from starting to moving, stopping depending on the physical nature of the object and the magnitude of the force, fulcrum and direction of force. Therefore in the petanque sport, good abdominal muscle strength was needed to support good physical condition. This could be achieved by giving the AMRAP model of functional training (Brooks & Copeland, 2012).

Based on the results of this study that the AMRAP model of the functional exercise was effective in increasing abdominal muscle strength and maximum oxygen volume levels on petanque athletes. The AMRAP model aims to achieve the highest number of repetitions or rounds during the task (de-Oliveira et al., 2021). The strength exercises in AMRAP, the practitioner who must complete the maximum number of repetitions/rounds in the established time could perform each exercise at the highest possible execution velocity since the first repetition. Thus, those for whom the different absolute loads (body mass or external resistance) assume a lower relative intensity, in theory, will complete each exercise in less time. Besides, depending on the velocity loss they reach over the set time, they will perform a higher number of repetitions/rounds in the pre-defined total time. In this way, the subject who could initially perform better would be the one who trains with less relative intensity, being able to perform the exercises at a higher velocity and possibly with a lesser velocity loss in the set, compared to those who perform the same number of repetitions with the same absolute load, which represents a higher relative intensity (Silva-Grigoletto et al., 2020). The AMRAP method could produce a significant increased in maximal aerobic capacity, an increased in maximal oxygen consumption expressed as a function of body mass was significantly correlated with an increased in absolute oxygen consumption. As was generally understood, an increased in relative VO₂max can result from an increased in absolute oxygen consumption. Therefore, the main factors that could cause an increase in the value of VO₂max are due to the AMRAP method and an increase in absolute oxygen consumption.

In the model FOR TIME, the exercises are performed with the same absolute load, and the established number of

repetitions must be performed in the shortest possible time. In this way, the participants start each exercise with the same absolute load (except in the case of body mass), which will typically have different relative intensities. As the number of repetitions is established and fixed, the velocity loss for each subject may differ; therefore, the degree of fatigue achieved will be different in most cases. This variation in the character of effort made will mean that, in general, those who make a character of less effort will obtain a better result, which usually implies that the average velocity achieved will be higher, so that the average relative intensity will be lower in those who complete the rounds in less time. Once again, we are faced with a proposal that is impossible to know, with a certain degree of precision, the degree of effort developed by each participant (Silva-Grigoletto et al., 2020).

Based on the above discussion, the AMRAP model of functional training could be used as the right and effective type of exercise for petanque athletes in increasing abdominal muscle strength and maximum oxygen volume (VO_{2max}).

Conclusion

Ascending AMRAP model and functional training with the FOR TIME constant load model which was carried out 3x/week for 8 weeks increased abdominal muscle strength and maximum oxygen volume levels. However, functional training with the AMRAP model ascending is more effective in increasing abdominal muscle strength and maximum oxygen volume levels compared to functional training with the FOR TIME constant load model.

Conflicts of interest

The authors declare that they have no conflict of interest.

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ВОСЬМИТИЖНЕВЕ ФУНКЦІОНАЛЬНЕ ТРЕНУВАННЯ ЗА МОДЕЛЯМИ ЗМІННОЇ ТА СТАНДАРТНОЇ ВПРАВИ ДЛЯ ЗБІЛЬШЕННЯ СИЛИ М'ЯЗІВ ЧЕРЕВНОГО ПРЕСА ТА ПІДВИЩЕННЯ РІВНІВ МАКСИМАЛЬНОГО СПОЖИВАННЯ КИСНЮ В ЮНАКІВ

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Авторський вклад: А – дизайн дослідження; В – збір даних; С – статаналіз; D – підготовка рукопису; E – збір коштів

Реферат. Стаття: 7 с., 2 табл., 2 рис., 26 джерел.

Метою дослідження було вивчення впливу функціонального тренування за моделями змінної та стандартної вправи на збільшення сили м'язів черевного преса та підвищення рівнів максимального споживання кисню (VO_{2max}) у юнаків.

Матеріали та методи. У цьому дослідженні використовували метод істинного експерименту з планом дворазового попереднього та підсумкового тестування для двох рандомізованих груп із контрольною групою. У дослідженні брали участь загалом 21 юнак віком 18-21 рік, індекс маси тіла (IMT) 18,5-24,9 кг/м², нормальний кров'яний тиск, нормальна ЧСС у стані спокою, нормальне насичення артеріальної крові киснем (SpO_2), яких розділили на три групи, а саме: CTRLG (n = 7; контрольна група), FSTAG (n = 7; група функціонального тренування за моделлю «Виконати якомога більше раундів вправ за заданий час зі збільшенням кількості повторів у кожному наступному раунді») та FSTFG (n = 7; група функціонального тренування за моделлю «Виконати заданий обсяг вправ якомога швидше з постійним навантаженням»). Інтервенційні функціональні тренування за моделлю «Виконати якомога більше раундів вправ за заданий час зі збільшенням кількості повторів у кожному наступному раунді» та за моделлю «Виконати заданий обсяг вправ якомога швидше з постійним навантаженням» проводили з частотою 3 рази на тиждень протягом 8 тижнів. Для статистичного аналізу даних використовували однофакторний дисперсійний аналіз із застосуванням ПЗ Statistical Package for Social Science (SPSS) версії 21.

Результати. Результати показали наявність статистично значущої різниці в середньому значенні дельти (Δ) збільшення сили м'язів черевного преса ($p \leq 0,05$). Середнє значення дельти (Δ) підвищення рівнів VO_{2max} також показало статистично значущу різницю ($p \leq 0,05$).

Висновки. На підставі результатів дослідження було показано, що призначення інтервенційного функціонального тренування за моделлю «Виконати якомога більше раундів вправ за заданий час зі збільшенням кількості повторів у кожному наступному раунді» та за моделлю «Виконати заданий обсяг вправ якомога швидше з постійним навантаженням»,

яке проводили 3 рази на тиждень протягом 8 тижнів, забезпечило збільшення сили м'язів черевного преса та підвищення рівнів максимального споживання кисню.

Ключові слова: метод змінної вправи, метод стандартної вправи, сила м'язів черевного преса, максимальне споживання кисню ($\text{VO}_{2\text{max}}$).

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EFFECT OF TACTICAL GAME MODELS ON FORMATION OF BASIC TECHNIQUES IN HANDBALL PLAYERS: MIXED METHOD

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Abstract

Study purpose. This study aimed to evaluate the effect of a tactical game model program on improving formation of basic techniques in male handball players.

Materials and methods. This study adopted a mixed method (quantitative and qualitative). 20 students from Indonesian education universities were willing to be the subjects of this study. The experimental group (n=10) received treatment, namely the tactical game model program, and the control group (n=10) carried out daily training activities or did not receive any program. The tactical game model program was held 16 times with once a week meetings. After the tactical game model program was completed, 10 athletes were interviewed. The quantitative instrument in this study used a test for shooting, passing and dribbling. Meanwhile, the instrument for qualitative research used in-depth interviews about the experiences, strengths and weaknesses of the tactical game model program. Analysis of quantitative data was carried out using IBM SPSS, and analysis of qualitative data was carried out using thematic analysis.

Results. The results of this quantitative study showed that there was a significant effect of tactical game models on improving the formation of basic techniques in male handball players ($p < 0.05$), but the control group showed no significant effect ($p > 0.05$). Meanwhile, the results of qualitative research showed that the subjects provided positive and diverse perceptions about the tactical game model program.

Conclusions. This study confirms that the tactical game models program has proven to be an alternative teaching method for lecturers at the university level to improve the formation of basic techniques in male handball players.

Keywords: tactical game models, formation of basic techniques, handball, mixed method.

Introduction

In the current crisis of the COVID-19 pandemic, all sports activities are hampered, and temporarily banned (Grix, Brannagana, Grimesa & Neville 2021; Skinner & Smith, 2021; Fallatah, 2021). Even the Tokyo Olympics events that were supposed to take place in 2020 were canceled and rescheduled for 2021 (Wong et al., 2020). In addition, the national and international sports competitions must be carried out without spectators and require strict COVID-19 protocol standards (Parnell, Widdop, Bond & Wilson, 2022).

Handball is one of the sports that has been affected by COVID-19 (Hermassi, Hayes, Sanal-Hayes & Schwesig

2021). Data reports that during the COVID-19 pandemic, training activities could not be carried out in a long duration, due to social distancing, isolation, and lockdown regulations (da Silva Musa et al., 2021), thus causing many negative impacts on athletes. The formation of basic techniques possessed by beginner handball athletes are currently the focus of attention, because they have limited opportunity to exercise in the COVID-19 era (Mon-López, Riaza, Galán & Roman 2020), resulting in a gradual decline of basic techniques. Formation of basic techniques, including: passing, dribbling, shooting are important aspects for beginner athletes to support performance when competing (Manchado, García-Ruiz, Cortell-Tormo & Tortosa-Martínez, 2017; Debanne, 2018; Font et al., 2021; de la Rubia et al., 2021), and become a parameter of success for achieving high achievements (Wagner et al., Finkenzeller, Würth & van Duvillard, 2014; Gouveia et al., 2019). Therefore, in this new normal

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era requires proper training to improve the basic techniques of beginner handball athletes. One teaching model that is claimed to have an effect on improving the basic techniques of a sport is tactical game models.

Tactical game models provide a teaching concept that focuses on developing athlete skills through modified game situations (Smith et al., 2015; Gouveia et al., 2019). According to a previous study, tactical game models are a development of teaching games for understanding (Calábria-Lopes, Greco & Pérez-Morales, 2019; Harvey et al., 2020; Robles, Collado-Mateo, Fernández-Espínola, Viera & Fuentes-Guerra 2020; Nopembri et al., 2022), which have the similar framework, but more simplified, namely using modified games, with varying degrees of tactical complexity (Sgro, Coppola, Schembri & Lipoma 2020). Teaching through tactical game models must include small-side games to implement modified gameplay, in order to develop a more optimal athlete training experience (Hodges, Wicke & Flores-Marti, 2018). The modified game allows adaptation the original version of sport, in terms of the dimensions of playing area, number of players and rules (Nathan, 2016). Several previous studies have reported the benefits of using tactical game models (Gouveia et al., 2019; Sucipto, Yudianta, Hambali, Komariyah & Gumilar, 2021).

Although research on tactical game models has been extensively researched internationally (Sgro, Coppola, Schembri & Lipoma, 2020), however there have been no previous studies reporting the effects of tactical game models on improving basic handball techniques in male players during the COVID-19 crisis. In addition, this study offers different aspect from previous studies, namely assess the effects of tactical game models through a mixed method, which would provide a more accurate study about the effects of tactical game models as the analysis used quantitative and qualitative methods. This research has implications for the development of basic techniques in playing handball among male athletes at beginner level throughout the country and providing insightful knowledge for teachers, lecturers and other practitioners regarding the importance of using tactical game models during the current pandemic. Thus, this study aims to evaluate the effect of tactical game models on improving the formation of basic techniques for male handball players.

Materials and Methods

Participants

This study used a mixed method, which is a type of research that combines quantitative (experimental) and qualitative (in-depth interviews) method. Based on data from previous studies, the mixed method was effective for uncovering and overcoming a problem (Gani et al., 2022).

A total of 20 athletes in entry-level from the Indonesian Education University were involved in this study as subject research. The inclusion criteria of subject include: male gender, age 20-23 years, height 150-169 cm, weight 45-66. These subjects were selected by researchers via whatsapp messages contained about the information of this study to 25 athletes in beginner level and only 20 people were willing to participate in this study. These 20 subjects were later allocated to the experimental group ($n = 10$), which received

treatment of tactical game models and the control group ($n = 10$), which carried out daily learning or did not follow any program for 7 week.

Instruments

Quantitative Instruments. This battery test aims to measure the skills of athletes in performing basic handball techniques. There were 3 item test, namely:

Shooting Test. This first test item aims to measure the ability of athletes when shooting skills in handball games. Subjects performed flying shoot, dive shoot or fall shoot. The subject shoots at the goal with a distance of 9 meters aimed at the top left corner (zone 1), top right corner (zone 2), bottom left corner (zone 3) and bottom right corner (zone 4). If the ball enters zones 1 and 2, 2 points are awarded, while if the ball enters zones 3 and 4, it is awarded a value of 3. The subject is given 12 opportunities (Metan & Küçük, 2021).

Passing Test. This second test item aims to measure the ability of athletes when performing passing skills in a handball game. The subject stood behind the boundary line with a distance of 1 meter and held the ball in front of the chest, then the subject threw the ball at the wall and then caught it again (Saavedra, Halldórsson, Þorgeirsson, Einarsson & Guðmundsdóttir, 2020). The activity was carried out for 30 seconds. Each subject has 2 opportunities. Scoring was calculated from the total score of passing for 30 seconds.

Dribbling Test. This third test item aims to measure the athlete's ability when performing dribbling skills in handball games. The subject dribbles the ball through the cones. Scoring was calculated by counting the number of cones that have been successfully passed for 30 seconds (Saavedra, Halldórsson, Þorgeirsson, Einarsson & Guðmundsdóttir, 2020).

Qualitative Instruments. This qualitative research used in-depth interviews with all subjects about the experiences, advantages and disadvantages of the tactical game models program. In-depth interviews were conducted through theWhatsapps platform for 20-30 minutes and interviews were conducted in Indonesian (Gani et al., 2022).

Study organization

Before starting this research, all participants were asked to write a statement letter about their willingness to participate in all activities in this study. This study was approved by the Indonesian Education University (No: 1021/01/2022) and in accordance with the World Medical Association Code of Ethics (Helsinki Declaration for humans).

This mixed research was conducted from January to February 2022 in Indonesian Education University (Indonesia). There are several meetings to be held for quantitative research. The first meeting was held on January 1, 2022, involving 40 participants in the initial test of the basic techniques of playing handball. The second meeting on January 3, 2022, the treatment group carried out the tactical game models program until the 17th meeting (February 7, 2022). At the 18th meeting (10 February 2022), all subjects carried out a final test activity, namely a skill test of the basic techniques of playing handball. The tactical game models program was held in the morning at the stadium located at the Indonesian Education University. This study applied the

COVID-19 health protocol strictly, for example, all subjects and the research team were checked for body temperature, vaccines and used hand sanitizers before training. While the qualitative research was conducted on 12 and 13 February 2022, the treatment group was interviewed for 20-30 minutes each and the interviews were conducted using Bahasa language. The tactical game models program is presented in Table 1.

Table 1. Unit plans for the tactical game models instructional

Lesson	Tactical game models
1-3	Moving to the goal and shooting in situations of offensive advantage in 1 vs. 1 modification.
4-6	Decision making to shoot or passing in 1 vs. 1 modification.
7-9	Decision making to dribbling or shoot in 1 vs. 1 modification.
10-12	Decision making to passing, dribbling or shooting in 1 vs. 1 modification.
13-14	Team play 2 vs.2.
15-16	Team play 3 vs. 3.

Statistical analysis

Quantitative analysis

Data in quantitative research was analyzed using IBM SPSS version 25.0. The first step is to test the normality of the data using Shapiro-Wilk analysis. While the descriptive statistics ($M \pm SD$) and the difference in the pre-test and post-test basic handball techniques (shooting, passing, dribbling) scores of the tactical game models and control groups were tested using Paired Sample t-test analysis. The level applied in this study was $p < 0.05$, which means it is accepted as significant. The size of effect was calculated as follows: small d : < 0.5 , medium d : $0.5-0.79$ and large d : > 0.85 (Gani et al., 2022).

Qualitative analysis

The qualitative analysis in this study was thematic, the results of in-depth interviews were coded and categorized into three themes (Ekström, Ostenberg, Björklund & Alricsson 2017), namely: theme 1: Tactical game models experience, theme 2: benefits of tactical game models and theme 3: disadvantages of tactical game models (Gani et al., 2022).

Results

The normality test showed data were normally distributed ($p = 0.169 > 0.05$). While the statistical descriptive results of each group are presented in Table 2. Table 3 shows that the experimental group (tactical game models) had a significant effect on improving the basic handball technique ($p < 0.05$) which was shown by the large effect size on shooting ($d = 0.82$), and medium in passing ($d = 0.76$) and dribbling ($d = 0.71$). While the control group showed no improvement in the basic handball technique ($p > 0.05$), it was indicated by a small effect size (Table 3).

Table 2. Descriptive Statistics

Dependent Variable	EG (n = 10)		CG (n = 10)	
	Pre-Test	Post-Test	Pre-Test	Post-Test
	M(SD)	M(SD)	M(SD)	M(SD)
Shooting	14.85 (2.72)	17.75 (2.63)	12.95 (2.28)	12.35 (2.11)
Passing	9.30 (1.41)	14.60 (1.95)	9.40 (1.23)	9.70 (1.30)
Dribbling	5.60 (0.503)	7.20 (1.05)	4.90 (0.553)	4.80 (0.696)

Note. M; Mean, SD: Standard Deviation, EG: Experimental Group, CG: Control Group

Meanwhile, the results of qualitative research indicate that the subject provides various perceptions regarding the tactical game models program, for example:

Theme 1: Tactical game models experience

The first aspect that needs to be considered is the experiences of subjects when carrying out the tactical game models program. In this method, researchers obtained a lot of information regarding subjects' perception on tactical game models, whether their perception leads to positive or negative assumption. The subject revealed that:

"We have conducted the tactical game models program for 18 meetings and it was really fun and gave us a lot of movement experience, because during the program we learned some basic handball techniques in fun situations (S1, S4)."

Some subjects mentioned that: "We are very lucky to be able to participate in the tactical game models program, because through this training we can learn how to do

Table 3. Differences values in pre-test and post-test in the EG and CG groups

Dependent Variable	EG (n = 10)				CG (n = 10)			
	Pretest-Posttest		t	p	ES (d)	Pretest-Posttest		ES (d)
	M(SD)					M(SD)		
Shooting	2.900 (1.51)		8.542	0.000	0.82	0.600 (1.50)	1.788	0.090
Passing	5.300 (2.15)		11.001	0.000	0.76	0.300 (1.17)	1.143	0.267
Dribbling	1.600 (1.14)		6.263	0.000	0.71	0.100 (0.912)	0.490	0.629

Note. M; Mean, SD: Standard Deviation, EG: Experimental Group, CG: Control Group, p: Significance; ES (d): Effect Size (Cohen's d)

shooting, dribbling and passing techniques in the right way (S7, S10)."

"At the beginning of the tactical game models program, we were still confused about this training, but slowly we began to understand the concept of this training. We interested this training and we will continue to use it, even after this research has been completed (S5 and S2)."

"We got a lot of valuable experience after joining this program, for example (a) how to make a hard and targeted shooting movements, (b) Fast dribbling which difficult for opponents to stop it, and (c) directed passing (S3, S6)."

"We think that the valuable experience of the tactical game models program is it can add our knowledge about techniques and tactics in handball games (S8, S9)."

Theme 2: Advantages of tactical game models program

The second aspect that needs to be analyzed is the superiority of the tactical game model program. Excellence is an important point that must be known, so that it can provide information on the effectiveness of the tactical game models program. The subject revealed that:

"Tactical game models helped me the basic technique of playing handball better than before, because in the training process we played handball with modified rules, for example 2 vs 2. This model can help our basic technique gradually improve (S10, S1)."

"According to our opinion, the advantages of tactical game models were the application of game modifications, so that training was much more interesting than other training. This also keeps us motivated to join the tactical game models program (S4, S2)."

"The advantage is about tactics and techniques which applied in the training process, so that our abilities develop faster (S5, S9)."

"This game is interesting, not boring, encourage our motivation and rich in motion experience and modifiable games are the advantages of tactical game models (S3, S7)."

"The rules were able to modified, for example the game can be played with 2 vs 2 or 3 vs 2. The size of field that can be modified, for example playing handball with a smaller size of field than the actual size. This is the main advantage of tactical game models (S6, S8)."

Theme 3: Weaknesses of tactical game models program

This third theme is important to analyze based on the perceptions of the subjects, in order to minimize the weaknesses in the tactical game models program. Regarding this third theme, the subject argued that:

"We think that the weakness lies in the knowledge and how to use this model. If the teacher do not understand the stages of teaching, the material will not be delivered optimally (S2, S4, S7, S8, S10)."

"The application of tactical game models will be less effective, if the sports equipment at a university is inadequate (S1, S3, S5, S6, S9)."

Discussion

Our study aimed to evaluate the effect of the tactical game models program on the improvement formation of ba-

sic techniques for male handball players from mixed analyzes. The results of quantitative study show that the tactical game model program had a significant effect on improving the basic techniques of male handball athletes at beginner level. The increase occurred because the tactical game model provides training for athletes, they can be more active in moving, and they are required to play using basic technical skills (Sgro et al., 2020). In addition, the use of games such as 2 vs 2 or 3 vs 3 involving small groups is much more effective and they can play more actively, so that basic techniques can be learned optimally (Menezes, Ramos, Marques & Nunomura, 2018).

The tactical games model can be a method to emphasize exercises through a game, encourage athletes to solve problems in game situations and help athletes become better players (Nathan, 2016; Ward, Piltz & lehwald, 2018; Harvey et al., 2020). According to González-Espinosa, García-Rubio, Feu & Ibáñez, (2021) tactical game models have a training approach by focusing on a game, athletes were required to solve tactical problems in a game to gradually improve basic technique. The results of this study are in line with previous research which explains that game-centered teaching is an effective approach to improve basic techniques in handball (Menezes, Marques & Nunomura, 2017). While subsequent findings showed that athletes in the control group did not experience a significant increase.

While the qualitative findings in this study showed that most athletes had a positive perception towards the tactical game model program. The main strength of this training model is a tactical approach and oriented towards promoting technique in an invasion sport (Harvey & Jarrett, 2014; Gouveia et al., 2019).

Conclusions

Based on this study, it can be concluded that the tactical game model program is proven to have an effect on improving the formation of basic techniques for male handball players. The research has implications for providing information and scientific insight about the tactical game model for lecturers and this tactical game model can be applied to trigger the effectiveness of teaching techniques at the university level. Thus, the basic techniques (shooting, passing, dribbling) are possessed by male athletes. entry-level males can improve significantly. In terms of future works, it would be interesting to test the effect of tactical game models on the basic techniques of soccer, volleyball or other sports or can apply tactical game models to athletes at the professional level.

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Conflict of interest

All authors declare that there is no potential conflict of interest associated with this research, or publication of this manuscript.

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ВПЛИВ ТАКТИЧНИХ МОДЕЛЕЙ ГРИ НА ФОРМУВАННЯ ОСНОВНИХ ТЕХНІК У ГАНДБОЛІСТІВ: ЗМІШАНИЙ МЕТОД

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Авторський вклад: А – дизайн дослідження; В – збір даних; С – статаналіз; D – підготовка рукопису; E – збір коштів

Реферат. Стаття: 6 с., 3 табл., 31 джерело.

Мета дослідження. Метою цього дослідження була оцінка впливу програми тактичних моделей гри на покращення формування основних технік у гандболістів чоловічої статі.

Матеріали та методи. У цьому дослідженні використовували змішаний метод (кількісний і якісний). Стати учасниками дослідження погодились 20 студентів педагогічних університетів Індонезії. Експериментальна група (n = 10) виконувала спеціально призначену тренувальну діяльність, а саме – програму тактичних моделей гри, а контрольна група (n = 10) вела повсякденну тренувальну діяльність або не виконувала жодної програми. Програму тактичних моделей гри проводили 16 разів зі зборами раз на тиждень. Після завершення виконання програми тактичних моделей гри було проведено інтерв'ю з 10 спортсменами. Як засіб кількісного аналізу в цьому дослідженні використовували тест на кидок, передачу та ведення м'яча. При цьому як засіб якісного аналізу використовували докладні інтерв'ю з метою висвітлення вражень від програми моделей тактики гри та її переваг і недоліків. Аналіз кількісних даних проводили з використанням ПЗ IBM SPSS, а аналіз якісних даних проводили за допомогою тематичного аналізу.

Результати. Результати цього кількісного дослідження показали наявність значного впливу тактичних моделей гри на покращення формування основних технік у гандболістів чоловічої статі (p < 0,05), але контрольна група показала відсутність значного впливу (p > 0,05). При цьому результати якісного аналізу показали, що учасники дали програмі тактичних моделей гри позитивні та різноманітні суб'єктивні оцінки.

Висновки. Це дослідження підтверджує, що програма тактичних моделей гри зарекомендувала себе як альтернативний метод навчання для викладачів університетського рівня, спрямований на покращення формування основних технік у гандболістів чоловічої статі.

Ключові слова: тактичні моделі гри, формування основних технік, гандбол, змішаний метод.

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EFFECT OF INTENSIVE PHYSICAL LOADS ON PLASMA TESTOSTERONE AND CORTISOL CONCENTRATION IN ELITE ATHLETES

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Abstract

The study purpose was to investigate changes in the content of testosterone and cortisol in the blood of qualified athletes after testing them to determine their maximal oxygen consumption (VO_{2max}).

Materials and methods. Thirty-seven international level athletes: 15 biathletes, 12 rowers, 6 boxers, 4 modern pentathletes participated in this study. The test to evaluate VO_{2max} used exercise of increasing intensity on a rowing ergometer for rowers and on a treadmill for biathletes, boxers, modern pentathletes. Total testosterone and cortisol concentrations were determined in blood serum by an immunoenzyme analyzer before and after the test for determination of VO_{2max} .

Results. The concentration of total testosterone has been found to decrease significantly on average by 24.4% and the concentration of cortisol has increased by 34% due to physical activity. The highest level of maximum oxygen consumption was found in athletes with high levels of basal testosterone and cortisol in the blood. There is a high correlation between the basal content of total testosterone and the maximum consumption of oxygen in athletes ($r = 0.58$).

Conclusions. The high content of basal testosterone and cortisol is an important factor for the athlete's special working efficiency: higher level of basal cortisol has been accompanied by smaller increases in cortisol per load and high basal level of testosterone makes it possible to keep its concentration sufficient. The concentration of total testosterone and cortisol can be used as a marker of the effect of a training load.

Keywords: testosterone, cortisol, athletes.

Introduction

The endocrine system plays an essential role in the maintenance of the normal functioning of organisms' various systems, as well as in the reconstruction of metabolism during the development of urgent and long-term adaptation of the organism to physical loads and in recovery processes after stress, etc. (Hammami et al., 2017; Strahorn et al., 2017). During physical loads, the functions of many endocrine glands, especially those which participate in the formation of organisms' general adaptation to stress factors are changed. The magnitude and direction of these changes depend on their participation in providing metabolic processes during training, as well as on the intensity, duration of physical loads, and body training. The content of hormones in blood plasma depends on muscle fibers, the amount included in

the work, the volume of performed muscle work, physical training direction, level of physical preparation, duration of rest intervals between workouts, etc. (Viru A. & Viru M., 2004; Hansen et al., 2001; Popovic et al., 2019).

The most attention is paid to hormones testosterone and cortisol. In practice, they are used primarily as markers of fatigue (Gaviglio, 2018). Also, the possibility of using basal concentrations of hormones and their changes under conditions of physical loads as markers of overtraining syndrome is investigated (Cadegiani & Kater, 2019). However, accurate data on the expression of changes in these indicators are absent, which creates difficulties in its interpretation for control and correction of training and competition loads, as well as the process of recovery in the athletes' bodies.

According to the results of modern scientific data, cortisol level is increased in response to intensive physical loading (Jacks et al., 2002; Vingren et al., 2016; Suay et al., 1999). As for the contents of the testosterone in conditions of physical loading: 30-minute exercises on endurance increase

its content in blood serum, as well as intensive exercises, but without an increase in cortisol concentration. The peak of testosterone content connected with physical exercises should be considered an adaptive phenomenon, but the data about their short-term and long-term effect is not enough (Sgrò et al., 2014).

Our preliminary research shows that physical exercise is accompanied by the levels of testosterone and cortisol (Maydanyuk & Vdovenko, 2021). The expression of their changes depends on the orientation of loading, functional state of health, and individual organism characteristics of athletes.

The contents of cortisol and testosterone are used as an indicator of success in competitions: the larger it is during competitions, the higher the performance of the athlete is. Research with the participation of representatives of different sports showed that the winners of the competition had higher concentrations of cortisol (Lautenbach & Lobinger, 2018; Papacosta et al., 2016; Vingren et al., 2016) and testosterone (Suay et al., 1999; Crewther et al., 2016). With a higher basal level of cortisol athletes need less stimulation to reach peak levels, which may be one of the forms of athletes' adaptation to repeated physical loads (Popovic et al., 2019). Thus, in the last work of Muscella and co-authors (Muscella et al., 2021), a reliable correlation of cortisol and testosterone concentrations in plasma with the level of functional preparation of judges is established, namely, with maximal oxygen consumption ($\text{VO}_{2\text{max}}$, $\text{ml}\cdot\text{min}^{-1}\cdot\text{kg}^{-1}$).

The correlation between testosterone and cortisol levels is rather diverse and contradictory (Kraemer & Ratamess, 2005; Cadegiani & Kater, 2018). Some scientists interpret them as an indicator of physiological stress during training or an index of anabolism (Andrzejewski et al., 2021), others as a predictor of competition results (Gaviglio, 2018).

Thus, it is extremely interesting and promising to study changes in the testosterone and cortisol concentrations under conditions of different physical loads, as this will allow for the future assessment, control, and regulation of the training process in time.

The purpose of our work was to study changes in the content of the testosterone and cortisol in the blood of qualified athletes after the performance of the test for the determination of the $\text{VO}_{2\text{max}}$.

Materials and methods

Study participants

Thirty-seven international level athletes: 15 biathletes, 12 rowers, 6 boxers, 4 modern pentathletes (age 27.0 ± 0.7 years old, height 182.0 ± 1.8 cm, body mass 75.2 ± 1.9 kg, and body fat percentage $9.8 \pm 0.5\%$) participated in this study.

Laboratory research

Total testosterone and cortisol concentrations were determined in blood serum by immunoenzyme analyzer ChemWell (awareness Technology, USA) using test systems AccuBind ELISA (Monobind Inc., USA). The concentration of lactate was measured enzymatically on variophotometer Diaglobal (Diaglobal GmbH, Germany) with the use of LAC142 standard reagent sets (Diaglobal GmbH, Germany).

Study organization

The research design included three steps (Figure 1).

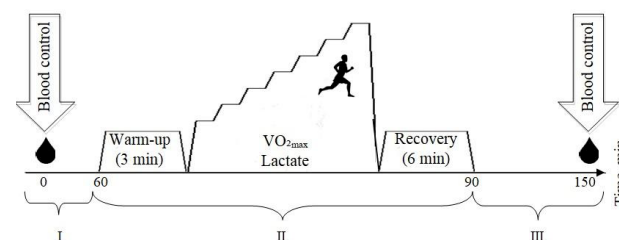


Fig. 1. Experimental design

The first step (I) involved the taking of blood samples for evaluation of the initial concentration of total testosterone and cortisol concentrations. The first blood draws before the physical load was carried out at 7 a.m. on an empty stomach. The second step (II) included the load test to evaluate the maximal oxygen consumption ($\text{VO}_{2\text{max}}$, $\text{ml}\cdot\text{min}^{-1}\cdot\text{kg}^{-1}$) and blood lactate concentration (Lactate, $\text{mmol}\cdot\text{l}^{-1}$). The third step (III) involved the taking of blood samples for evaluation of total testosterone and cortisol concentration after test load. The second blood draw was taken one hour after the test load.

All participants did not take any food 2 hours before and during the study.

Load testing

Test to evaluate the $\text{VO}_{2\text{max}}$ used exercise of increasing intensity on the rowing ergometer Concept II (USA) for rowers and on the LE 500 treadmill (Vyair Medical GmbH, Germany) for biathletes, boxers, modern pentathletes. The load test lasted until the athletes reached the $\text{VO}_{2\text{max}}$. The sign of reaching $\text{VO}_{2\text{max}}$ was the lack of increase in oxygen consumption with increasing power or its fluctuations within $100 \text{ ml}\cdot\text{min}^{-1}$. Respiratory system parameters were recorded using an Oxycon mobile gas analyzer (CareFusion, USA; Jaeger, Germany). Calibration of the test system was carried out following the recommendations of the producer. Before performing the test load, a 6-minute warming up was performed, and after the test was completed, the rate of recovery processes was assessed for three minutes. The degree of the initial exercise load on the Concept rowing ergometer was $1.5 \text{ W}\cdot\text{kg}^{-1}$ body mass, at each subsequent stage the load increased by 30 W; the initial load on the running ergometer was 2.0 W per kg body mass (running speed – $10 \text{ km}\cdot\text{h}^{-1}$). The duration of each step of the test load was two minutes (testing on a treadmill) or three minutes (testing on a rowing ergometer).

Blood draws for evaluation of the maximum concentration of lactate were performed immediately (within 1 to 7 seconds) after the test load. Samples of capillary blood were taken from the lateral surface top phalange of the ring finger.

Ethics

The research was conducted following the basic bioethical norms of the Helsinki Declaration of the World Medical Association on Ethical Principles of Scientific and Medical Research, as amended (2000, as amended in 2008), the Universal Declaration on Bioethics and Human Rights (1997),

and the Council of Europe Convention on Human Rights and Biomedicine (1997). Each study participant provided written informed consent to participate in the study.

Statistical analysis

All statistical analyses were performed using “STATISTICA 12” with a significance level set at 0.05 unless stated to the contrary. One-way ANOVA, cluster analysis (k-means), correlation analysis (Spearman correlation) were used to assess cortisol and testosterone levels change during CPET. The Duncan method (post hoc analysis) was used for differences estimation between groups. The correspondence of the sample to the normal distribution was checked for asymmetries and excesses, which indicated the proximity of the distribution to the normal curve.

Results

The main anthropometric characteristics (height, weight, percentage of body fat) and results of the athletes' tests are presented in Table 1.

It was found that the concentration of basal testosterone in the athletes' blood serum was within the reference values for men (Maydanyuk, & Vdovenko, 2021). The main attention in this study is devoted to studying the influence of test loading on the levels of total testosterone and cortisol in blood plasma. Total testosterone levels decreased on average by 24.4% after the physical loading (Table 2).

It is necessary to note sufficient variation of total testosterone concentration in an hour after loading compared with the values registered in rest. For example, the decrease in the total testosterone content was registered in 73% of cases (27 athletes): including a slight rise (5-20%) in 24% (9 athletes), significant increase (more than 50%) – 30% of cases (11 athletes) and 19% (7 athletes) cases of total testosterone concentration decreased by 20-50%.

In response to the impact of the load, cortisol level in blood plasma an average significant increase of 34% was detected ($p = 0.025$). The testosterone/cortisol (T/C) ratio per hour after loading was reduced by an average of 36% ($p = 0.00012$). For example, the average T/C ratio values were $6.1 \pm 0.61\%$ (4.9-7.4%) before the load and $3.8 \pm 0.47\%$ (2.9-4.8%) after it. It is necessary to note the correlation between the content of basal testosterone and VO_{2max} ($r = 0.58$,

Table 1. Anthropometric characteristics and results of athletes' tests ($n = 37$)

Indicator	M ± m	CI 95%*
Age, years	27.0 ± 0.7	25.5 – 28.6
Height, sm	182.0 ± 1.8	178.3 – 185.6
Weight, kg	75.2 ± 1.9	71.3 – 79.1
Body fat, %	9.8 ± 0.5	8.9 – 10.8
Power, W·kg ⁻¹	5.3 ± 0.2	4.9 – 5.6
Maximal oxygen consumption, ml·min ⁻¹ ·kg ⁻¹	59.2 ± 1.3	56.5 – 61.83
Lactate, mmol·l ⁻¹	11.0 ± 0.5	9.9 – 12.0

CI 95% – confidence interval.

Table 2. Total testosterone and cortisol levels in athletes' blood before and after the test load ($n = 37$)

Indicator	M ± m (CI 95%)		P
	Before load	After load	
Total testosterone, nmol·l ⁻¹	25.4 ± 1.94 (21.5 – 29.3)	17.23 ± 1.3 (14.6 – 19.9)	0.00001
Cortisol, nmol·l ⁻¹	487.4 ± 42.3 (401.6 – 573.2)	578.1 ± 44.3 (488.1 – 668.2)	0.025
Testosterone/ cortisol ratio, %	6.1 ± 0.6 (4.9 – 7.4)	3.8 ± 0.5 (2.9 – 4.8)	0.00012

CI 95% – confidence interval.

$p = 0.0001$), which is coordinated with the data Muscella and co-authors (2021). At the same time, there is no reliable correlation between the basal level of cortisol and the VO_{2max} . A reliable correlation between concentrations of total testosterone and cortisol after loading ($r = -0.47$, $p = 0.028$) is also established. The results of the study show the importance of metabolism activation, including anabolic processes, to achieve high performance.

Thus, physical loads are accompanied by changes in levels of testosterone and cortisol. The expression and direction of changes in these hormones depend on the condition and individual athletes' characteristics. For more detailed analysis, we used clustering and conditionally divided the group

Table 3. Content of total testosterone, cortisol and the maximum oxygen consumption in athletes of different clusters (M ± m)

Indicator		Cluster A (n = 13)	Cluster B (n = 13)	Cluster C (n = 11)
Testosterone, nmol·l ⁻¹	1	32.0 ± 2.7	18.9 ± 1.1*	10.7 ± 1.5*, **
	2	17.1 ± 2.1	16.9 ± 1.6	10.8 ± 1.9*, **
Cortisol, nmol·l ⁻¹	1	790.2 ± 34.0	334.3 ± 20.9*	251.3 ± 35.1*
	2	755.0 ± 63.7	462.1 ± 72.3*	428.0 ± 72.5*
Testosterone/cortisol ratio, %	1	4.1 ± 0.4	6.0 ± 0.6*	4.6 ± 0.8*
	2	2.6 ± 0.4	4.8 ± 0.8*	2.9 ± 0.8*
Maximal oxygen consumption, ml·min ⁻¹ ·kg ⁻¹		62.0 ± 1.9	59.8 ± 1.6	52.2 ± 2.4*, **

Note: clustering is based on basal testosterone and cortisol contents. 1 – basal level, 2 – one hour after the test load, * – differences with cluster 1 are statistically significant ($p \leq 0.05$), ** – differences with cluster 2 are statistically significant ($p \leq 0.05$).

Table 4. Total testosterone and cortisol concentrations and VO_{2max} in athletes of different clusters ($M \pm m$)

Indicator		Cluster I (n = 11)	Cluster II (n = 14)	Cluster III (n = 11)
Testosterone, $nmol \cdot l^{-1}$	1	32.2 ± 2.8	27.8 ± 1.5	$13.4 \pm 1.0^{*,**}$
	2	21.4 ± 2.5	15.8 ± 1.0	12.0 ± 1.3
Cortisol, $nmol \cdot l^{-1}$	1	509.4 ± 81.8	$605.0 \pm 70.9^*$	$345.5 \pm 50.4^{*,**}$
	2	587.0 ± 76.9	$616.6 \pm 68.1^*$	$530.6 \pm 86.2^{**}$
Testosterone/cortisol ratio, %	1	6.5 ± 1.3	5.7 ± 1.0	$4.5 \pm 0.4^{*,**}$
	2	3.7 ± 1.4	3.2 ± 0.5	3.1 ± 0.5
Maximal oxygen consumption, $ml \cdot min^{-1} \cdot kg^{-1}$		66.3 ± 1.6	62.6 ± 1.2	$55.1 \pm 1.5^{*,**}$

Note: clustering is based on total testosterone before and after test load. 1 – basal level, 2 – one hour after the test load, * – differences with cluster 1 are statistically significant ($p \leq 0.05$). ** – differences with cluster 2 are statistically significant ($p \leq 0.05$).

into three clusters: clusters “A” and “B” included 13 people, and cluster “C” – 11 people. Clustering is based on basal testosterone and cortisol contents with the prior normalization of data (Table 3).

Cluster “A” is characterized by high cortisol ($790.2 \pm 34.0 \text{ nmol} \cdot l^{-1}$) and total testosterone levels ($32.0 \pm 2.7 \text{ nmol} \cdot l^{-1}$) in rest. After the test load, total testosterone content is significantly reduced on average by 47% and cortisol does not change ($755.0 \pm 63.7 \text{ nmol} \cdot l^{-1}$). For cluster “B”, there are slight fluctuations in total testosterone concentration (within 10%) and average growth of 38% in cortisol content in response to test load. Cluster “C” is characterized by the lowest total testosterone level, which does not change after the test is performed and significant growth of cortisol content after the test load – on average by 72%. Three clusters are likely to differ in values in basal total testosterone concentrations. Cortisol concentrations both before and after one hour of loading are quite different from the rest only in cluster “A”, differences between clusters “B” and “C” are not statistically significant.

It is necessary to note statistical differences in athletes’ VO_{2max} in cluster “C” with the other two clusters. For example, the average VO_{2max} values in cluster “A” and “B” were $62.0 \pm 1.9 \text{ ml} \cdot min^{-1} \cdot kg^{-1}$, and $59.8 \pm 1.6 \text{ ml} \cdot min^{-1} \cdot kg^{-1}$, and in cluster “C” were $52.2 \pm 2.4 \text{ ml} \cdot min^{-1} \cdot kg^{-1}$.

We also did not find the differences in T/C ratio between clusters and no statistically significant correlation between T/C ratio on the one hand and testosterone and cortisol levels on the other. Thus, T/C ratio does not correlate separately with testosterone or cortisol, at the same time the basal concentration of cortisol correlates (negative correlation) with the basal content of testosterone.

Due to the significant correlation between total testosterone concentration and VO_{2max} ($r = 0.58$, $p = 0.0001$), we also analyzed by cluster method the values of total testosterone before and after loading. Three clusters were allocated according to the results: I – 11 athletes (total testosterone level 33.2 ± 2.8 and $21.4 \pm 2.5 \text{ nmol} \cdot l^{-1}$ (before and after loading)), to II – 14 athletes (27.8 ± 1.5 and $15.8 \pm 1.0 \text{ nmol} \cdot l^{-1}$), to III – 12 athletes (13.4 ± 1.0 and $12.0 \pm 1.3 \text{ nmol} \cdot l^{-1}$) (Table 4). It was found that the highest values of VO_{2max} were demonstrated by athletes with high or above-average basal total testosterone content, as well as the highest values of T/C ratio.

In our research statistically significant the higher cortisol level (basal and after test loading) in athletes I and II clusters

relative to III was found. The greatest increase in cortisol content in response to the impact of test loading is observed in athletes in the III cluster: cortisol content increased by an average of 58%, at the same time by 26% and 15% in clusters I and II, respectively.

The best results of the test were demonstrated by athletes of I and II clusters (the highest total testosterone level before and after test load and basal cortisol content): the average values of VO_{2max} were 66.3 ± 1.6 and $62.6 \pm 1.2 \text{ ml} \cdot min^{-1} \cdot kg^{-1}$, respectively. The lowest value of VO_{2max} is in the III cluster – 55.0 ± 1.5 (the lowest testosterone and basal cortisol values).

Discussion

The results of this study showed a significant ($p = 0.00001$) decrease (by an average of 36%) in total testosterone content and a significant ($p = 0.025$) increase (by an average of 34.2%) in cortisol level in an hour after intensive load with the achievement of VO_{2max} . This fact shows the considerable influence of intensive physical loads on steroid hormones. It is necessary to note variations of changes in total testosterone concentration under physical loading influence: its content was reduced in the majority of cases one hour after test load, at the same time in 27% of cases total testosterone was either unchanged or increased. The results obtained in this study coincide with Popovic et al. (2019) on changes in cortisol and testosterone levels in the near recovery period after test load. At the same time, the results of research by Sgrò et al. (2014) demonstrate an increase in total testosterone content after a test loading. Therefore, changes in testosterone levels in response to the impact of load are not unambiguous. The direction and expression of changes in testosterone and cortisol concentrations will depend on intensity, duration of loading and basal levels of hormones.

Jacks and co-authors (2002) were shown that cortisol content increased only due the intensity is 76% VO_{2max} and the duration of the load is not less than an hour and remains unchanged after load is 45% to 62% VO_{2max} . Also, the authors note that at 40-minute loads the level of cortisol is not changed. In turn, Toro-Román et al. (2021) indicates that after an incremental test in qualified cyclists the removal of cortisol with an urina is reduced. This can confirm the conclusion that acute fatigue or overstress are associated with

a significant blood cortisol concentration decrease during physical loading (Viru, 2004). Popovic et al. (2019) note the positive effect on athletes' performance of the increasing basal cortisol levels. Authors explain this as an advantage of the intensive muscle activity energy supply, resulting from long-term adaptation to physical loads.

In the works of Papacosta et al. (2016) and Vingren et al. (2016) with co-authors, cortisol level is considered as one of the important factors influencing the competition's success and athletes' performance. The authors note that the highest cortisol content is typical for the most successful athletes. In our study, we found significantly the highest cortisol concentration (basal and after test loading) in athletes I and II clusters relative to III (depending on the content of the testosterone before and after loading test). The greatest cortisol level increase in response to the impact of test load is observed among III cluster representatives – on average by 58%, and by 26% and 15% respectively in clusters I and II. Thus the cortisol concentration growth under influence of loading is larger in case of its lower basal content.

The research data demonstrated different variants of steroid hormones changes due test loading. In 13 out of 37 athletes with high basal testosterone and cortisol levels (cluster "A") a significantly reduced testosterone content and a non-significant decrease in cortisol concentration. Testosterone concentration practically did not change in athletes with average levels of basal testosterone and cortisol (cluster "B"), at the same time cortisol content on average increased by 37.7%. The testosterone levels did not change and significantly increased cortisol concentration (on average by 72.3%) in 11 athletes (cluster "C") with extremely low basal testosterone levels. According to European Academy of Andrology (EAA) recommendations is defined as the lowest total testosterone serum concentration in men within 8-12 nmol·l⁻¹. It should be noted that athletes with high and average basal testosterone values demonstrated the highest results of VO₂max. This fact and significant correlation between basal testosterone and VO₂max ($r = 0.58$) allow approving the importance of anabolic processes for achieving high VO₂max, which is coordinated with Muscella and co-authors (2021). At the same time, there is correlation between basal cortisol level and VO₂max.

Many research works are indicated to information value T/C ratio for estimation of anabolic-catabolic processes and also for the forecast of athletes' special performance (Gaviglio, 2018; Kraemer & Ratamess, 2005; Andrzejewski et al., 2021). In this study, the T/C ratio in an hour after loading has been significantly reduced by an average of 36%. We have not found any correlation between T/C ratio and total testosterone and cortisol contents. Thus, T/C ratio does not correlate separately with testosterone or cortisol concentrations. Similarly, there is no significant correlation between T/C ratio and VO₂max in this study.

Conclusion

1. A significant decrease in total testosterone content by an average of 24.4% and an increased plasma cortisol concentration by 34% in response to the impact of VO₂max test has been established.

2. It has been found that total testosterone and cortisol contents can be used as a marker for the training load effect.

The relationship between testosterone concentrations and VO₂max was established 0.58 ($p = 0.0001$). The highest level of VO₂max was achieved by athletes with high basal testosterone and cortisol contents in the blood.

3. The higher basal cortisol content is accompanied by its less growth due test loading. High basal level of testosterone allows it to keep sufficient content during physical loading. This is an important factor in the athlete's special performance.

Conflict of interest

The authors state no conflict of interest.

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ВПЛИВ ІНТЕНСИВНИХ ФІЗИЧНИХ НАВАНТАЖЕНЬ НА КОНЦЕНТРАЦІЮ ТЕСТОСТЕРОНУ ТА КОРТИЗОЛУ В КРОВІ ЕЛІТНИХ СПОРТСМЕНІВ

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Мета дослідження – дослідити зміни вмісту тестостерону та кортизолу в крові кваліфікованих спортсменів після виконання тесту на визначення максимального споживання кисню (МСК).

Матеріали і методи. Дослідження проводили за участю 37 кваліфікованих спортсменів (чоловіки), що мали досвід виступів на Олімпійських іграх або інших міжнародних змаганнях. Серед них 15 спортсменів, які спеціалізуються в біатлоні, 12 – у веслуванні академічному, 6 – боксі, 4 – сучасному п'ятиборстві. Тест на визначення МСК передбачав виконання навантаження зростаючої потужності на веслувальному ергометрі (веслування академічне) або на біговій доріжці (біатлон, бокс, сучасне п'ятиборство). Вміст тестостерону, кортизолу визначали у сироватці крові спортсменів на імуноферментному аналізаторі до та після виконання тесту на визначення МСК.

Результати. Концентрація загального тестостерону значно знизилася в середньому на 24,4%, а концентрація кортизолу зросла на 34% через фізичну активність. Найвищий рівень максимального споживання кисню виявлено у спортсменів з високим рівнем базального тестостерону і кортизолу в крові. Існує висока кореляція між базальним вмістом загального тестостерону та максимальним споживанням кисню у спортсменів ($r = 0,58$).

Висновки. Високий вміст базального тестостерону і кортизолу є важливим фактором для особливої працездатності спортсмена: вищий рівень базального кортизолу супроводжується меншим збільшенням кортизолу на навантаження, а високий базальний рівень тестостерону дозволяє підтримувати його концентрацію достатньою. Концентрацію загального тестостерону і кортизолу можна використовувати як маркер ефекту тренувального навантаження.

Ключові слова: тестостерон, кортизол, спортсмени.

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ORIGINAL SCIENTIFIC ARTICLE

ASSESSMENT OF THE QUALITY OF ACTIVE FAMILY LEISURE

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Abstract

Study purpose. The study was aimed at assessing the quality of active family leisure and identifying motivations for and interests in health-enhancing and recreational physical activity of parents and children.

Materials and methods. The study involved 106 families. A set of generally accepted research methods was used including theoretical analysis and generalization of scientific and methodological literature as well as domestic and international practical experience related to family leisure; sociological methods (questionnaire surveys), and mathematical statistics methods.

Results. The questionnaire survey provided an opportunity to identify priority areas of joint physical activity of children and parents and to assess the quality of family well-being and active family leisure. The attitude of parents to winter types of recreation in the organization of active leisure was identified. According to the survey data, 9.4% of the families had a high level, 59.4% had an average level, 30.3% had a satisfactory level, and 0.9% had an unsatisfactory level of family well-being. The vast majority of respondents (45.2%) believed that their family members had a satisfactory level of physical activity, 40.6% of families reported they had an average level, only 10.4% indicated they had a high level, and 3.8% said they had an unsatisfactory level. Among the surveyed families, 63.2% indicated an average level of satisfaction with family leisure, 29.2% rated their leisure as satisfactory, and the remaining 3.8% indicated an excellent or unsatisfactory level.

Conclusions. The focus was on identifying prevailing motivations, which contribute to the optimization of the family leisure process and the degree of activity when using recreational technologies. The obtained results indicate a significant potential for expanding physical activity of families with children, including through the use of winter recreation.

Keywords: health-enhancing physical activity, family well-being, active leisure, parents, children.

Introduction

Leisure is one of the spheres of life where the objectives of preserving the health of the population can be addressed most fruitfully (Krutsevich et al., 2021; Williamson et al., 2019). In this context, the most important tasks are to strengthen physical health, promote a healthy lifestyle, and improve the quality of active recreation (Andrieieva, 2014;

Drozdovska et al., 2020; Galan et al., 2019). Health-enhancing and recreational technologies occupy a special place in the system of development of a healthy lifestyle that allows to use them as a means of development of a healthy family leisure. The expansion of recreational activities is both the cause and the consequence of significant changes in the life of modern society, which are associated with improving the quality of life and standard of living, increasing cultural and educational level, and increasing the amount of leisure time. The scale of recreation as an area of human activity can be demonstrated by the published data, which show that 20% (i.e. one fifth of the world's population) annually are involved

in recreational activities, 40–55% of the population of major cities around the globe are involved in recreational active leisure on weekends; household consumption expenditures on recreation services in economically developed countries are 2.3 times higher than the spendings on clothing and footwear and 18% higher than the spendings on food (Pomaza-Ponomarenko, 2020). Recreation changed from privilege in the past to the most important sector of consumer demand in the modern world and became a characteristic element of a lifestyle (Zabriskie et al., 2018).

Currently in Ukraine, more and more attention is paid to ensuring the quality of recreational products, the perception of which is largely subjective and depends on the individual characteristics of a vacationer (Velichko, 2013). In the field of physical recreation, a large number of studies has been conducted on the engagement of different groups of the population in active recreation using various means of physical activity (Andrieieva et al., 2019). Its theoretical and methodological foundations have been identified in the works of leading scientists including Krutsevich et al. (2021), Kashuba et al. (2021), Andrieieva (2014), and others. Innovative health-enhancing and recreational technologies that take into account personal characteristics and motivation of an individual are effectively introduced into practice (Andreeva et al., 2019). Issues of scientific substantiation of the use of various means of physical activity and assessment of their recreational potential are examined in the studies of Imas et al. (2018), Orikhovskaya et al. (2020), Hakman et al. (2020), and others.

Rational organization of family leisure has been the subject of studies both in Ukraine and abroad (Andrieieva et al., 2019; Kashuba et al., 2021; Townsend et al., 2017). The importance of organization of active family leisure was emphasized by the modern culturologist Petrova (2011) who summarized the practical experience of family leisure centers in foreign countries and analysed wide range of their offers and services. The influence of family and household traditions on the peculiarities of active leisure was examined by Bocheliuk (2006). At the same time, long-term underestimation of the importance of comprehensive and systematic studies of the organization of active family leisure has led to the accumulation of unresolved issues and aggravation of family health situation along with the lack of a holistic view of the causes and consequences of the negative and crisis phenomena. The studies on the organizational and methodological support of health-enhancing and recreational activities of various groups in entertainment and leisure complexes are clearly lacking and they are mainly focused on improving the activities of organizers of active leisure (animators) (Pasichniak, 2016), various outdoor activities (Velichko, 2013), and socio-cultural conditions for the organization of family leisure by means of health-enhancing and recreational technologies (Hodge, 2015). Assessing the level of satisfaction and quality of family leisure will contribute to increasing the recreational effects of leisure, including optimization of physical, mental, and social status of a person.

Material & methods

Study participants

In total, 106 families living in large cities with a population of over 500,000 participated in the survey. The study was conducted in accordance with the ethical principles of

the World Medical Association Declaration of Helsinki. The study was conducted at the National University of Ukraine on Physical Education and Sport (Kyiv, Ukraine). Ethical approval of research protocol was obtained from the Ethics Commission of the NUUPES.

Study organization

The Family Leisure questionnaire was created to establish the prevailing motives and interests in the health-enhancing and recreational physical activity of age diverse groups of population. This instrument was validated through a pilot test with the focus group of 7 people, created from educational staff of the Departments of Fitness and Recreation, and Innovation and Information Technologies in Physical Culture and Sport of the National University of Ukraine on Physical Education and Sport, who have children and, therefore, are potential respondents representing the general population, which was studied further. Furthermore, the questionnaire did not include dichotomous ('Yes' or 'No') items, so all the items provided relevant information about the condition of the families with children and contributed to the study of their well-being through the prism of their leisure activities. The sampling method was a simple random sample. Each participant was interviewed only once. Taking into account the social homogeneity of the sampled population, the sample was representative.

Statistical analysis

To assess the reliability of the Family Leisure questionnaire, we used Cronbach's Coefficient Alpha, which is calculated based on the ratio of the variance associated with each item to the variance associated with the total scale. If not the actual value is measured, but only the random error in the answers to the questions, then the variance of the total will be the same as the sum of the variances of individual items, and the value of the coefficient will approach zero. In our study, the alpha was 0.92, and the standardized Cronbach's alpha was 0.898, i.e. the coefficient approached 1 that indicated the high reliability of the questionnaire. Questions, which generated qualitative (textual) data, were treated separately. To assess the representativeness of the sample, the whole set of answers was randomly divided into equal parts, after which the Kendall tau coefficient was calculated. It should be mentioned that this correlation coefficient was calculated for the items that produced unambiguous answers. Calculations showed that for all the items the coefficient was close to one ($\tau > 0.64$) and was statistically significant ($p < 0.05$). Therefore, these data indicate that the developed Family Leisure questionnaire had high validity and reliability, and the sample of respondents was representative.

Since a normality test of the raw data using the Shapiro-Wilk test showed that they did not comply with the normal distribution; therefore, the median (Me) and 25 and 75 percentiles were used to represent the data, and Spearman's rank correlation coefficient was used for correlation analysis.

Pearson's χ^2 test was used for comparing categorical variables. Fisher's F-test was used to compare continuous variables. The significance level was set to $\alpha = 0.05$. The exact p-values are given in the test, and when the p-value was less than 0.0001, it was indicated that $p < 0.01$. Mathematical and statistical processing of the raw data was performed using the computer program Statistica 10.0 and Statistica Data Miner module.

Results

Analysis of the survey data showed that the majority of respondents (46.2%) were families, which were married more than 12 years ago. Another 21.7% of respondents were young families with up to 7 years of family life. The remaining 32.1% were families married 7 to 12 years ago. The smallest share of the families (22.6%) were families with preschool-age children. Furthermore, 45.3% of respondents had primary school-age children and 32.1% had middle school-age children. More than half of the families involved in the study (50.9%) had one child, 44.4% were families with two children, and only 4.7% of respondents were families with three or more children. The survey sample was dominated by parents who did not have chronic diseases, overweight, and bad habits. The highest percentage of respondents at health risk (19.8%) were parents who had bad habits like smoking. The vast majority of respondents were families who generally cared about their health and were not at health risk.

The analysis of the survey results showed that the sample included a large proportion of families in which both parents had previous exercise experience and a significant proportion of families which had previous experience with physical activity.

We found that the vast majority of families (83.0%) were maintaining an active lifestyle, 14.2% of families were living a passive lifestyle, and 2.8% of parents admitted that they led a lifestyle that is not conducive to health. There was no significant difference between the percentage of parents who regularly engaged in health-enhancing and recreational physical activity (HRPA) with children and those who participate in winter recreation ($p > 0.05$). It was found that the majority of respondents (83.0%) were the families, in which parents cared about the health of its relatives. Furthermore, the vast proportion of families (63.2%) understood how active family recreation affects the well-being of the family. Nevertheless, less than half of the respondents indicated that they have sufficient knowledge on the organization of active family recreation through the use of health-enhancing and recreational technologies.

Among various types of physical activity, families with children typically used walks in the park, as was indicated by 90.3% of respondents. In addition, a significant percentage

of families (69.4%) preferred to ride bicycles or scooters with children or to play active games (46.8%).

Analysis of responses to the questionnaire revealed a seasonal decrease in health-enhancing physical activity, which is significantly different from the uniform distribution ($\chi^2 = 66.60$; $df = 3$; $p < 0.05$). Furthermore, the number of families who indicated a decrease in health-enhancing physical activity in winter and autumn is statistically significantly higher than that of families who reported a decrease in spring and summer ($\chi^2 = 57.40$; $df = 1$; $p < 0.05$).

The study ranked the most attractive types of active leisure and the reasons that prevent families with children from participating in them. According to this ranking, the respondents prefer outdoor walking, regular health-enhancing physical activity and active games. The use of these types of leisure was hindered mainly due to lack of time, as well as low quality of services provided by entertainment centers (Table 1).

We also determined the rankings of motives for participating in winter recreational activities as well as of reasons preventing families with children from participating in these activities. It was found that lack of time and lack of financial resources are the main reasons that prevent families from participation in winter recreation (Table 2).

Statistical processing of the obtained data showed that the distribution of the number of days, during which parents were engaged in active recreation or walking with children, did not comply with the normal distribution: in the first case the Shapiro-Wilk test W statistic was 0.93 at $p > 0.05$, and in the second one it was 0.89 at $p > 0.05$. It was found that during the last week, the respondents were engaged in active recreation together with children, including active games, physical exercises, cycling, dancing (2; 1; 3) days, and outdoor walking with children (2; 1; 4) days. Comparative analysis showed that parents spent significantly more time in walking than in active entertainment ($U = 33$; $z = -2.59$; $p = 0.0097$).

The study showed that families spent more than 1 hour on passive leisure such as watching TV, playing computer games or communicating online, etc. both on weekdays and weekends, and on weekends the share of families who indicated this increased by 16.0% (49.1% and 65.1%, respectively). Analysis of indicators of the families' condition in the current period indicated that the raw data showed a significant departure of from normality (Shapiro-Wilk W statistic

Table 1. Ranking of the most attractive forms of active leisure and the reasons that prevent families with children from participating in them ($n = 106$)

Types of active leisure	Ranks		Reasons for limiting activities	Ranks	
	$\bar{r}$	Rank		$\bar{r}$	Rank
Systematic physical activity	3.24	2	Lack of time	2.84	1
Visiting resorts / sanatoriums	3.84	4	Lack of interesting offers	4.45	6
Outdoor walking	3.06	1	Low quality of services provided by entertainment centers	4.15	3
Body hardening	4.55	6	Lack of finances	4.24	4
Visiting entertainment centers	5.30	7	Low level of knowledge and skills of organizing active leisure	4.59	5
Active games	3.67	3	Lack of motivation to systematically engage in health-enhancing physical activity	4.48	7
Practicing physical exercise with family members	4.33	5	None, we are engaged in active leisure	3.25	2

Table 2. Ranking of motives for participating in winter recreational activities as well as of reasons preventing families with children from participating in these activities (n=106)

Motives for participating in winter recreational activities	Ranks		Reasons for limiting participation in winter recreational activities	Ranks	
	$\bar{r}$	Rank		$\bar{r}$	Rank
Improvement of physical health of family members	3.39	1	Lack of time	3.24	1
Body hardening	4.19	4	Lack of interesting offers	4.29	5
Improvement of family wellbeing	4.25	6	Low quality of services provided by entertainment centers	4.44	7
Meaningful and emotionally rich leisure	3.60	2	Lack of finances	3.76	2
Common hobbies and interests	4.05	3	Low level of knowledge and skills of organizing this type of active leisure	4.02	4
Improvement of endurance and physical working capacity of family members	4.27	7	Lack of desire to engage in winter recreational activities	4.38	6
Increasing mental working capacity	4.24	5	None, we participate in winter recreational activities	3.86	3

ranged from 0.835 to 0.902 at $p > 0.05$), so the median, and 25 and 75 percentiles were used to describe sample averages, and nonparametric criteria and Spearman's rank correlation coefficient were used for further analysis. Despite the fact that the median scores for all parameters equaled 8 points, thus indicating a high score given by the respondents to the family condition in the current period, and that we used the same scoring range for every parameter (0 to 10 points), we can see that, in contrast to other parameters, respondents rated slightly lower such indicators as typical emotional background, the degree of support between family members, and social activity of the family: the 25th percentile for these indicators was 5 points, while the 25th percentile for other indicators equaled 6 points (Fig. 1).

Figure 1. Median scores for the studied parameters according to families' self-assessment (n = 106), where 1 – quality of family life; 2 – health condition of family members; 3 – psychological climate in family; 4 – level of social well-being of the family; 5 – degree of satisfaction with everyday family life; 6 – typical emotional background; 7 – degree of support between family members; 8 – social activity of the family

The correlation matrix generated for all the parameters of current family condition showed that they all have significant positive correlations with each other (Table 3).

In the analysis, we only considered parameters for which strong or very strong correlation was observed. A very strong positive correlation was found between psychological climate in the family and typical emotional background ($\rho = 0.936$), which in turn was strongly correlated with social activity of the family ($\rho = 0.738$) and very strongly correlated with the level of social well-being of the family ($\rho = 0.909$) and the degree of satisfaction with everyday family life ($\rho = 0.944$). The very strong correlations found in this study indicate the dependence of the degree of satisfaction with everyday family life on the level of social well-being of the family.

Discussion

Contemporary research shows concern about the low level of engagement in physical activity of the populations of many countries around the world that has led to increased

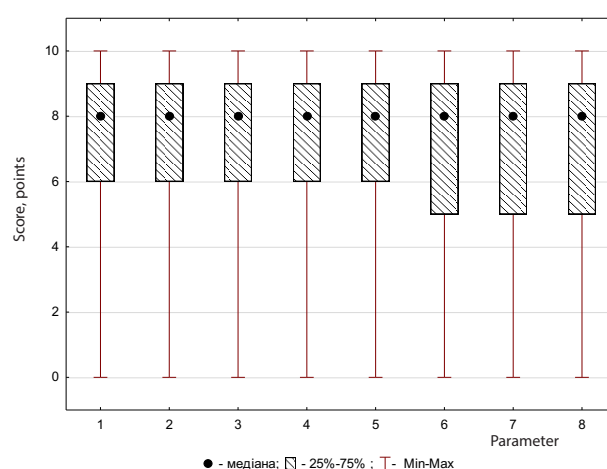


Fig. 1. Median scores for the studied parameters according to families' self-assessment (n = 106), where 1 – quality of family life; 2 – health condition of family members; 3 – psychological climate in family; 4 – level of social well-being of the family; 5 – degree of satisfaction with everyday family life; 6 – typical emotional background; 7 – degree of support between family members; 8 – social activity of the family

prevalence of non-communicable diseases and reduced life expectancy (Imas et al., 2018). Researchers emphasize that a significant change in the situation is possible by encouraging regular physical exercise in leisure time or in specially allotted time (Andrieieva et al., 2019). We expected that determining the prevailing motivations and interests in health-enhancing recreational physical activity of parents and children will improve the quality of active family leisure. In addition, assessing the level of satisfaction with recreational consumers services will contribute to increasing the involvement of various population groups in regular physical activity, rational organization of leisure activities, and increasing their motivation to organize active family leisure.

One of the most important issues of the modern family is the organization of its leisure time, which includes active family leisure. Organization of family leisure was studied by (Hodge et al., 2018; Zabriskie et al., 2019). It was confirmed

Table 3. Spearman correlation matrix of parameters characterizing family's condition in the current period (n = 106)

Parameters of family's condition in the current period	Parameters of family's condition in the current period							
	1	2	3	4	5	6	7	8
1	1.000	0.777*	0.827*	0.786*	0.811*	0.816*	0.780*	0.620*
2	0.777*	1.000	0.819*	0.773*	0.735*	0.748*	0.758*	0.676*
3	0.827*	0.819*	1.000	0.868*	0.899*	0.936*	0.889*	0.741*
4	0.786*	0.773*	0.868*	1.000	0.900*	0.909*	0.825*	0.802*
5	0.811*	0.735*	0.899*	0.900*	1.000	0.944*	0.836*	0.688*
6	0.816*	0.748*	0.936*	0.909*	0.944*	1.000	0.892*	0.738*
7	0.780*	0.758*	0.889*	0.825*	0.836*	0.892*	1.000	0.760*
8	0.620*	0.676*	0.741*	0.802*	0.688*	0.738*	0.760*	1.000

Note: 1 – quality of family life; 2 – health condition of family members; 3 – psychological climate in family; 4 – level of social well-being of the family; 5 – degree of satisfaction with everyday family life; 6 – typical emotional background; 7 – degree of support between family members; 8 – social activity of the family; * – Spearman correlation (ρ) is significant at the level of $\alpha = 0.05$

that the family is a privileged area for the construction of the children's leisure (Valdemoros et al., 2014) and that family-shared leisure provides benefits for family functioning (Agate et al., 2009; Sanz et al., 2018).

Active family leisure was found to significantly affect the psychological climate, as well as emotional background and social activity of the family (Andrieieva et al., 2019; Burns et al., 2022).

Leading motives that impel different populations to take part in active leisure are: getting pleasure and positive emotions from physical activity; desire to escape from everyday problems of domestic and professional activities; emotional relaxation; enjoying nature; and improving well-being. The most attractive forms of active leisure and the reasons that prevent families with children from participating in them were identified. The obtained results confirmed the conclusions of previous studies on the choice of priority types of physical activity in the organization of joint family leisure (Shannon et al., 2017; Camarillo et al., 2020). Information on the factors limiting the participation of families with children in health-enhancing and recreational physical activity (Pasichnyak, 2016; Galan et al., 2021) was extended. The reasons we have identified are more specific and individual that is probably due to the clear specification of questions in the questionnaire aimed at clarifying the personal characteristics of respondents.

Our study confirmed the published data on the popularity of recreation in the organization of family leisure (Kashuba et al., 2021; Krutsevich et al., 2019; Stodolska et al., 2020). Nevertheless, there is a clear lack of research aimed at assessing the quality of active family leisure, especially of winter recreation. When comparing the identified motives for the participation in winter recreation programs with those reported in the professional literature, minor differences were found, which consist in the prevalence of such motives as common hobbies and meaningful and emotionally rich leisure.

The percentage of the families with high and moderate levels of family well-being was significantly higher than the percentage of the families with satisfactory and unsatisfactory levels. The same applies to the families with high and moderate levels of satisfaction with family leisure: their percentage was significantly higher compared to the fami-

lies with satisfactory and unsatisfactory levels of satisfaction. However, the percentage of respondents who rated the physical activity of family members as high and moderate does not differ significantly from the percentage of the families with satisfactory and unsatisfactory levels of physical activity.

The obtained results indicate a significant potential for expanding physical activity of families with children, including through the use of winter recreation. The results of the survey allowed us to identify the prevailing motives and interests of the families to health-enhancing and recreational physical activity. Based on the answers to the questionnaire, the most attractive forms of active family leisure were ranked, and the reasons that prevent the families from participating in them were identified.

Conclusions

The focus was on the identifying prevailing motivations, which contribute to the optimization of the family leisure process and the degree of activity when using recreational technologies. More than half of the respondents rated their satisfaction with family leisure as high or moderate. By constructing a correlation matrix, we established significant correlations between the indicators of the current family condition. A strong positive correlation ($\rho > 0.9$) was observed between the psychological climate in the family and the typical emotional background. The typical emotional background had strong positive correlations with the social activity of the family ($\rho = 0.619$), the level of social well-being of the family ($\rho = 0.909$) and the degree of satisfaction with everyday family life ($\rho = 0.944$).

Conflicts of interest

The authors declare that they have no competing interests.

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ОЦІНКА ЯКОСТІ АКТИВНОГО СІМЕЙНОГО ВІДПОЧИНКУ

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Авторський вклад: А – дизайн дослідження; В – збір даних; С – статаналіз; D – підготовка рукопису; Е – збір коштів

Реферат. Стаття: 7 с., 3 табл., 1 рис., 27 джерел.

Мета дослідження. Метою цього дослідження була оцінка якості активного сімейного відпочинку та визначення факторів мотивації батьків і дітей до фізичної активності, що сприяє покращенню здоров'я, і рекреаційної фізичної активності та їхньої зацікавленості в таких формах активності.

Матеріали та методи. У дослідженні брали участь 106 сімей. У дослідженні використовували набір загальноприйнятих методів дослідження, зокрема теоретичний аналіз та узагальнення науково-методологічної літератури, а також вітчизняного та міжнародного практичного досвіду стосовно сімейного відпочинку; соціологічні методи (анкетні опитування) і методи математичної статистики.

Результати. Анкетне опитування дало можливість визначити пріоритетні напрямки спільної фізичної активності дітей і батьків та оцінити якість сімейного добробуту й активного сімейного відпочинку. Було визначено ставлення батьків до зимових видів відпочинку під час організації активного відпочинку. Згідно з даними опитування, 9,4% сімей мали високий рівень сімейного добробуту, 59,4% – середній, 30,3% – задовільний і 0,9% – незадовільний. Переважна більшість респондентів (45,2%) уважали, що члени їхніх сімей мають задовільний рівень фізичної активності, 40,6% сімей повідомили, що в них середній рівень, лише 10,4% вказали, що в них високий рівень, а 3,8% – незадовільний. Серед сімей, які пройшли опитування, 63,2% вказали середній рівень задоволення сімейним відпочинком, 29,2% оцінили їхній відпочинок як задовільний, а інші 3,8% вказали відмінний або незадовільний рівень.

Висновки. Основну увагу було зосереджено на визначенні переважних факторів мотивації, які сприяють оптимізації процесу сімейного відпочинку та ступеня активності під час використання рекреаційних технологій. Одержані результати вказують на значний потенціал для розширення фізичної активності сімей із дітьми, у тому числі шляхом використання зимового відпочинку.

Ключові слова: оздоровчо-рекреаційна рухова активність, що сприяє покращенню здоров'я; сімейний добробут, активний відпочинок, батьки, діти.

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ORIGINAL SCIENTIFIC ARTICLE

THE EFFECT OF LIMB MUSCLE EXPLOSIVE POWER, FLEXIBILITY, AND ACHIEVEMENT MOTIVATION ON SICKLE KICK PERFORMANCE IN PENCAK SILAT LEARNING

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

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Abstract

Study Purpose. This study background is that the performance of the sickle kick in Pencak Silat learning is very important to improve the athlete's performance during the match, both when attacking and defending. The objective is to analyze the performance of the Pencak Silat sickle kick in terms of the quality of physical conditions (such as leg muscle explosive power and flexibility), and psychological elements (such as achievement motivation).

Materials and methods. This study involved Pencak Silat athletes of Tangan Mas College, Padang, Indonesia. The participants who became the study sample were 30 male athletes aged 14–17 (athletes in the adolescent category). The sample selection was based on the sample criteria providing that participants had participated in regional level competitions and had attended training for at least 2 years. Data were obtained from several tests and measurements: leg muscle explosive power was measured using the Vertical Jump Test and then processed by the Lewis formula (nomogram). Flexibility was measured using the Side Split Test, achievement motivation was assessed using a questionnaire validated by experts, and a sickle kick performance was tested. The data obtained were analyzed using simple regression analysis and multiple regression analysis, followed by path analysis to calculate the coefficient value of each variable.

Results. The data obtained were analyzed using structural model path analysis. Results: (1) there is an effect of leg muscle explosive power on the sickle kick performance by 21.59%; (2) there is an effect of flexibility on the sickle kick performance by 6.94%; (3) there is an effect of achievement motivation on the sickle kick performance by 9.74%; (4) there is an effect of leg muscle explosive power through achievement motivation on the sickle kick performance by 38.14%; (5) there is an effect of flexibility through achievement motivation on the sickle kick performance by 13.51%; and (6) there is a simultaneous effect of these variables by 51.41%.

Conclusions. Based on the analysis of the three factors above, it was concluded that leg muscle explosive power is the dominant factor and needs to be taught and trained seriously. However, the other factors are no less important. Future studies are urgently needed to include other variables that affect the results of this study, as well as a wider number of samples to validate the results of this study.

Keywords: Pencak Silat learning, limb muscle explosive power, flexibility, achievement motivation, sickle kick.

Introduction

Martial arts around the world are stepping phase rapid development, such as, MMA, Wing Chun, Karate, Judo Kungfu, Tai Chi, Shorinji Kempo, Jiu Jitsu, Taekwondo,

Muay Thai and Pencak Silat. This martial art has the characteristics of different moves/techniques in its implementation (Tack, 2013). Martial arts are characterized by high intensity requiring complex skills, emphasizing exercises that harmonize body, soul, and mind (Reishehrei et al., 2014), are also useful as self-defense. The others study said that exercise can form a positive character in humans.

Pencak Silat is one of the fastest-growing martial arts in Indonesia (Kartomi, 2011). It is proven by Pencak Silat being used as one of the lessons in the Physical Education

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curriculum (from Elementary School, Junior High School, Senior High School, to Higher Education). Physical condition is one of the components that must get serious attention for teachers/trainers in the preparation of training/teaching programs (Ihsan et al., 2020). Exercise is a structured and planned learning activity, the initial portion of exercise (learning) is more emphasized on physical conditions (Saputra & Ihsan, 2020). The others study suggested that the physical and physiological state of athletes are supporting factors to determine the quality of athlete performance in a sport (Bridge et al., 2014).

One of the important elements that must be taught and trained in Pencak Silat is kicking, because it can affect a fighter's performance, both when attacking and defending (van der Kruk et al., 2016). Kick technique in martial arts is a complex series, consisting of a series of elements to produce an integrated movement (Quinzi et al., 2016). The common kicking technique in martial arts is the "circle" type (Estevan et al., 2015). This complex kick is also the type of kick that is most often used in competition (Zago et al., 2015).

Power is a physical component to overcome the burden at high contraction speed in the fastest time possible. The basis of explosive power is strength and speed, such as jumping, hitting, running at high speed (Sampaio et al., 2014), throwing, and kicking (Ozbar, 2015). Lower leg muscle function is related to kicking ability. Asymmetry between the legs is associated with decreased kicking ability and a higher risk of injury (Eagle et al., 2019; Ryu & Lee, 2021). Flexibility is defined as the ability of joints to perform movements over a wide range (Pinto-Escalona et al., 2021). This is because flexibility is the main source of controlling the power of a punch or kick, then strength is the main driver in producing a fast and strong attack rate to penetrate the opponent's defense (Lipowski et al., 2019).

In addition to the explosive power of leg muscles and flexibility in the ability to kick the sickle, motivation is a psychological element that needs to be a "question" in learning Pencak Silat. The main psychological characteristic associated with study and exercise habits among children and adolescents is achievement motivation (Shekhar & Devi, 2012). Achievement motivation is a theoretical model that is intended to explain how the motives for achieving goals and motives for avoiding failure. Achievement motivation consists of two components: (1) Motivation to pursue goals that enhance one's performance or knowledge with reference to past levels, regardless of the values of others and society (attainment of self-fulfillment), and (2) Motivation aimed at seek social prestige by beating or achieving better results than others (competitive achievement motivation) (Horino & Mori, 1991).

Basically, Pencak Silat requires quality physical and psychological conditions. To display the quality of the physical and psychological condition of an athlete, interaction between coaches and athletes is needed, as well as adequate infrastructure. Interaction between individuals is one of the important factors in establishing reciprocal relationships between individuals and groups. Seeing this problem, especially in Pencak Silat learning which requires quality physical and psychological conditions, then a person or group requires reciprocal interaction during the learning/training process so that athletes can improve their performance to the maximum during matches. Based on this phenomenon,

we studied scientific data to analyze Pencak Silat's sickle kick ability in terms of: the quality of physical condition (eg, leg muscle explosive power, flexibility) and psychological (eg, achievement motivation).

Materials and Methods

Participant

This study involved Pencak Silat athletes at the Tangan Mas College, Padang, Indonesia. The participants who became the research sample were 30 athletes with an age range of 14-17 (athletes in the adolescent category) and male. Sample selection based on sample criteria had participated in regional level competitions and had attended training for at least 2 years.

Procedure

This research is an associative quantitative with path analysis model. This study will examine and evaluate the effect of leg muscle explosive power (X_1), flexibility (X_2) and achievement motivation (X_3) on sickle kick ability (Y). The following is a chart and procedure for this research (Fig. 1).

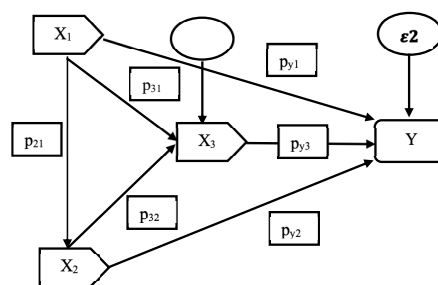


Fig. 1. Research Path Diagram

Based on Picture 1, the procedure in this study through 2 stages of testing the structural model. The first model (structural 1) is leg muscle explosive power (X_1), flexibility (X_2) and achievement motivation (X_3). While the second model (structural 2) is leg muscle explosive power (X_1), flexibility (X_2), achievement motivation (X_3) and sickle kick ability (Y) (Fig. 2, 3).

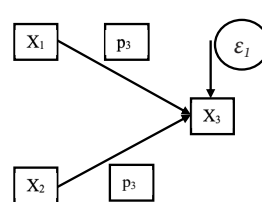


Fig. 2. Path Diagram of Structural Model One

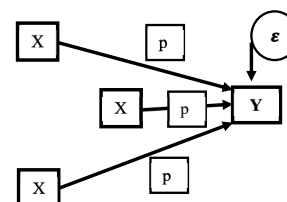


Fig. 3. Path Diagram of Structural Model Two

Instrument

Data in this research were obtained from several tests and measurements: (a) the explosive power of the leg muscles was obtained through the Vertical Jump Test where the data will be the difference between achievement score and

range score. Then, weight measurement was also carried out and then the data was processed using the Lewis nomogram with the formula:

$$P = \sqrt{4.9 \cdot \text{Weight} \cdot \sqrt{D}},$$

Remark: P = Power (kg.m/s), Weight = Sampel Weight (kg), D = Score Vertical Jump (m).

(b) Flexibility is obtained through the Side Split Test. Athletes who were sampled did a side split test by opening their feet as wide as possible to form the lowest possible position. The data in this study were the distance between the floor and the groins; (c) achievement motivation is obtained through questionnaires validated by experts; and (d) Pencak Silat sickle kick ability test. The sample performs a kick towards the target as quickly as possible with the left and right foot for 10 seconds.

Data Analysis

Data were analyzed using simple regression analysis and multiple regression analysis, then continued with path analysis to calculate the coefficient value of each variable.

Result

The objective of descriptive analysis in the research data is to describe the discrimination of differences in the explosive power of leg muscles, flexibility, achievement motivation, and sickle kicks of Pencak Silat athletes, from the average value, standard deviation, minimum value, maximum value, and total amount based on the test results and measurement. The recap of descriptive analysis of data from each variable is shown in the following table.

Table 1. Descriptive Analysis

Remark	Limb Muscle Explosive Power (P)	Flexibility	Achievement Motivation	Sickle Kick
Amount	3320.63	438.70	2264.78	754.00
Average	110.69	14.62	75.49	25.13
SD	10.83	4.94	2.02	1.92
Maximum	132.36	25.60	79.57	30.00
Minimum	96.23	8.00	71.74	22.00

According to Table 1, descriptive analysis stated that there are differences in each variable. This is evidenced by the average value of each (110.69 kg.m/s, 14.62 cm, 75.49, and 25.13).

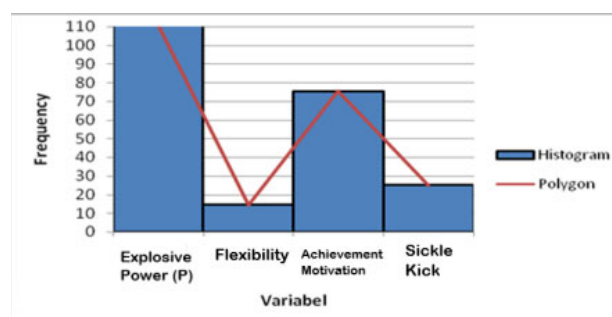


Fig. 4. Histogram of Mean Values for Limb Muscle Explosive Power, Flexibility, Achievement Motivation, and Sickle Kick

The detail information, the description of the data on the variables can be seen in the table below.

Table 2. Sickle Kick Performance

No	Interval Class	Frequency		Remark
		Absolute	Relative	
1	≥ 28	4	13.33	Very Good
2	27-26	8	26.67	Good
3	25-24	11	36.67	Satisfied
4	23-22	7	23.33	Poor
5	≤ 21	0	0.00	Very Poor
TOTAL		30	100.00	

Based on the table above, it can be seen that most athletes have the ability to kick the sickle in the moderate category. For more details can be seen in the diagram below:

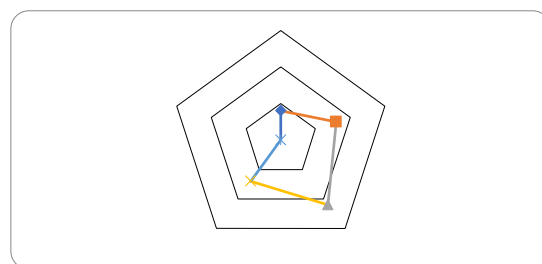


Fig. 5. Sickle kick ability data diagram

Table 3. Limb Muscle Explosive Power

No	Interval Class	Frequency		Remark
		Absolute	Relative	
1	≥ 127.05	3	10.00	Very Good
2	126.94-116.21	7	23.33	Good
3	116.1-105.27	7	23.33	Satisfied
4	105.16-94.44	13	43.33	Poor
5	≤ 94.33	0	0.00	Very Poor
TOTAL		30	100	

Based on the table above, it can be seen that most athletes have leg muscle explosive power in the less category. For more details can be seen in the diagram below:

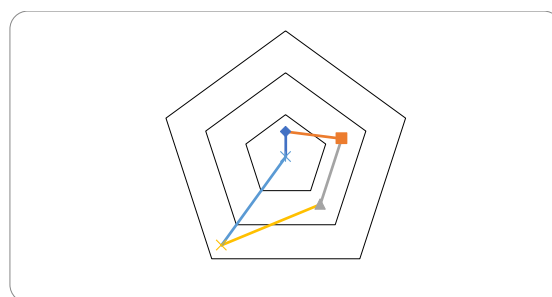
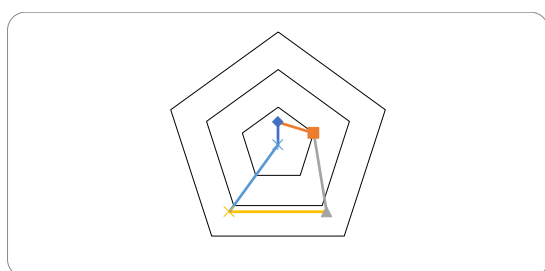


Fig. 6. Data diagram of leg muscle explosive power

Table 4. Flexibility

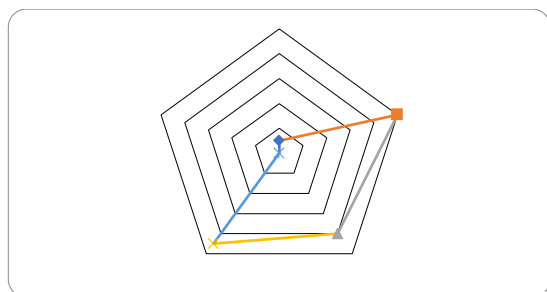
No	Interval Class	Frequency		Remark
		Absolute	Relative	
1	≥ 22.09	3	10	Very Good
2	22.04-17.14	5	16.67	Good
3	17.09-12.15	11	36.67	Satisfied
4	12.10-7.21	11	36.67	Poor
5	≤ 7.16	0	0.00	Very Poor
TOTAL		30	100	

Based on the table above, it can be seen that most athletes have flexibility in the moderate and less categories. For more details can be seen in the diagram below:

**Fig. 7.** Flexibility Data Diagram**Table 5.** Achievement Motivation

No	Interval Class	Frequency		Remark
		Absolute	Relative	
1	≥ 78.54	1	3.33	Very Good
2	78.52-76.52	10	33.33	Good
3	76.49-74.49	8	26.67	Satisfied
4	74.47-72.47	9	30.00	Poor
5	≤ 7.16	0	0.00	Very Poor
TOTAL		30	100	

Based on the table above, it can be seen that most athletes have achievement motivation abilities in the good category. For more details can be seen in the diagram below:

**Fig. 8.** Diagram of achievement motivation data

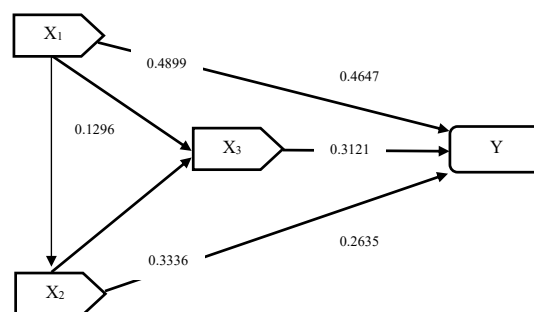
Structural Model

The hypothesis testing result were obtained through two stages of model testing (structural one and structural two). The summary of testing this structural model can be seen in Table 6.

Table 6. Summary of Structural Models One and Two

Structural	Variable	Path Coefficient	t-count	t-table	Remark
One	$X_1 \cdot X_3 (p_{31})$	0.4899	4.5864		Significant
	$X_2 \cdot X_3 (p_{32})$	0.3336	2.2196		
Two	$X_1 Y (p_{y1})$	0.4647	3.6171	1.69	Significant
	$X_2 Y (p_{y2})$	0.2635	2.2263		
	$X_3 Y (p_{y3})$	0.3121	2.2397		

Based on Table 2, the path coefficient of leg muscle explosive power with achievement motivation (p_{31}) is 0.4899, flexibility with achievement motivation (p_{32}) is 0.3336, leg muscle explosive power with sickle kick ability (p_{y1}) is 0.4647, flexibility with sickle kick ability (p_{y2}) obtained 0.2635, and achievement motivation with sickle kick ability (p_{y3}) was obtained 0.3121. In the other words, these two structural models are significant ($t_{count} > t_{table}$).

**Fig. 9.** Combined Results of Structural Model Path Coefficient

Hypothesis Testing

The Influence of leg muscle explosive power on sickle kick ability

Based on the results of testing the structural model two, the path coefficient of the explosive power of the leg muscles on the sickle kick ability (p_{y1}) is 0.4647 and the value of $t_{count} < t_{table}$ (significant path coefficient), with an effect of 21.59%.

The Influence of flexibility on sickle kick ability

Based on the results of testing the structural model two, the path coefficient of flexibility on the sickle kick ability (p_{y2}) is 0.2635 and the value of $t_{count} < t_{table}$ (significant path coefficient), with an effect of 6.94%.

The Influence of achievement motivation on sickle kick ability

Based on the results of testing the two structural models, the path coefficient value of achievement motivation on sickle kick ability (p_{y3}) is 0.3121 and the value of $t_{count} < t_{table}$ (significant path coefficient), with an effect of 9.74%.

Table 7. Summary of Research Result

Path Coefficient	Direct Influence			Indirect Influence			
	Coefficient	([^] 2)	(%)	Intervention	Coefficient	([^] 2)	(%)
X _{1Y} (p _{y1})	0.4647	0.2159	21.59	X1→X3→Y	0.6176	0.3814	38.14
X _{2Y} (p _{y2})	0.2635	0.0694	6.94	X2→X3→Y	0.3676	0.1351	13.51
X _{3Y} (p _{y3})	0.3121	0.0974	9.74				
X ₁ ,X ₂ ,X ₃ →Y		$\rho_{y1}+(\rho_{21}\cdot\rho_{y2})+(\rho_{31})\cdot(\rho_{y3})+(\rho_{21})+(\rho_{32})\cdot(\rho_{y3})$			0.717	0.5141	51.41

The Influence of leg muscle explosive power through achievement motivation on sickle kick ability

Based on the test results of structural models one and two (X₁→X₃→Y), $p_{31}\cdot p_{y3} = 0.6176 > p_{y1} = 0.4647$. That is, indirectly there is a mediating effect given by the achievement motivation variable on the sickle kick ability of 38.14%.

The Influence of flexibility through achievement motivation on sickle kick ability

Based on the results of testing structural models one and two (X₂→X₃→Y), $p_{32}\cdot p_{y3} = 0.3676 > p_{y2} = 0.2635$ is obtained. That is, indirectly there is a mediating effect given by the achievement motivation variable on the sickle kick ability of 13.51%.

The Influence of leg muscle explosive power, flexibility, and achievement motivation on sickle kick ability

Based on the overall test results, leg muscle explosive power, flexibility, and achievement motivation on the sickle kick ability obtained an effect of 51.41%.

Discussion

Based on these findings, it is necessary to study further why the results of the analysis are accepted as correct and why the explosive power of leg muscles, flexibility, and achievement motivation have a significant effect on the ability of the sickle kick in Pencak Silat learning.

The results of this study indicate that the quality of physical condition (explosive power of leg muscles and flexibility), as well as achievement motivation are the main determinants of the ability to kick the sickle, especially at the Hand College of the City of Padang, Indonesia. This is supported by the results of our descriptive analysis and inferential analysis. If athletes have a good quality of physical condition (explosive leg muscles, flexibility) and achievement motivation, then they can win every match. Likewise, if an athlete does not have the quality of physical condition and achievement motivation, then they will not win every match. The results of this study are supported by the statement, that the physical and technical components play an important role in determining the outcome of the match (Corrêa et al., 2016). Suggested that an athlete has a good quality of physical condition, then they can perform better (Shin et al., 2016). The quality of the physical condition is the dominant basic factor in determining the maximum physical condition so that athletes can gain achievement, and are not easy to experience fatigue when receiving the next training load. Another study states that the stability and technical performance of athletes is determined by the physical ability of the athlete himself (Lipowski et al., 2019).

Pencak Silat is categorized as a sport with complex movements, performed with high speed and good stamina. This intense martial art requires the support of physical abilities (such as strength, stamina, speed, and muscle endurance) that are involved during the training process and matches (Lenetsky & Harris, 2012). Successful sports performance at the elite level of competition is often highly dependent on the explosive power of the athlete's leg muscles (James et al., 2016). Trainers need to develop training techniques designed to improve and measure the explosive power of the athlete's leg muscles (Haff & Stone, 2015; Muceli et al., 2010). Vertical jump has been widely used by professional sports as a direct assessment method to measure limb muscle explosive power (Haff & Stone, 2015), and to determine the effectiveness of training programs (Hara et al., 2006; Peráček et al., 2018). Another study stated that the better the level of flexibility of the body in the hips, the easier it will be to control the speed and power generated. In the literature, sequential actions have been analyzed only for the one-footed technique (Estevan et al., 2015; Jemili et al., 2017; Zago et al., 2015), with the exception of Hoblin (Höbling et al., 2017), and the case study by Alsamad for multiple kicks. The functional phase is defined solely for the action of the kicking leg (Quinzi et al., 2016). Errors in assessment/measurement may occur, therefore the use of technology is very important in measuring sports (Saputra & Ihsan, 2020).

Achievement motivation is a determining factor for athletes to excel, and factors that influence the athlete's appearance during matches. Therefore, the athlete's achievement motivation is one of the psychological indicators to support the athlete's success. Findings from other sports, suggest that several motivational constructs (eg, achievement motivation, achievement goal orientation, self-determination) are relevant for talent development and later success (Forsman et al., 2016; Gillet et al., 2009; MacNamara et al., 2010; Ihsan et al., 2021). Athlete motivation is well researched in the field of sports psychology, with many books and articles written on this issue (Hagger & Chatzisarantis, 2008; Zuber et al., 2015)). Previous research has focused on theories such as: goal attainment orientation (Biddle et al., 2003) and self-determination theory both of which have been helpful in framing and guiding current understanding of athlete motivation for achievement.

Conclusion

Based on these findings, it conclude that the ability to kick the sickle in Pencak Silat learning has a relationship with leg muscle explosive power, flexibility, and achievement motivation. Of these three factors, the explosive power of the

leg muscles is the dominant factor that affects the results of the sickle kick ability. However, other variables are no less important in influencing it, moreover the ability to kick the sickle is a basic technique needed in Pencak Silat, and its implementation requires several components (physical and psychological) that holistically produce maximum kicking abilities. We emphasize the importance of further research to expand what we did in this study, including expanding the sample size, other influencing variables, and the role of teachers/trainers in Pencak Silat learning. This needs to be done to analyze in depth to validate the results of this study.

Conflict of Interest

The authors declare no potential conflicts of interest with respect to the research, authorship, and publication of this article.

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ВПЛИВ ВИБУХОВОЇ СИЛИ М'ЯЗІВ КІНЦІВОК, ГНУЧКОСТІ ТА МОТИВАЦІЇ ДОСЯГНЕННЯ НА ВИКОНАННЯ СЕРПОПОДІБНОГО УДАРУ НОГОЮ ПІД ЧАС НАВЧАННЯ ПЕНЧАК-СИЛАТУ

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Авторський вклад: А – дизайн дослідження; В – збір даних; С – статаналіз; D – підготовка рукопису; Е – збір коштів

Реферат. Стаття: 8 с., 7 табл., 9 рис., 35 джерел.

Мета дослідження. Передумовою цього дослідження є те, що виконання серпоподібного удару ногою під час навчання пенчак-силату є дуже важливим для покращення показників спортсмена під час матчу, як у процесі нападу, так і в процесі захисту. Метою дослідження є аналіз виконання серпоподібного удару ногою в пенчак-силаті з огляду на такі аспекти, як якість фізичного стану (наприклад, вибухова сила м'язів ніг і гнучкість) і психологічні елементи (наприклад, мотивація досягнення).

Матеріали та методи. У цьому дослідженні брали участь спортсмени, які займаються пенчак-силатом, із коледжу Танган Мас, Паданг, Індонезія. Учасниками, які стали досліджуваною вибіркою, були 30 спортсменів чоловічої статі віком 14–17 років (спортсмени юнацької категорії). Вибірку здійснювали за критеріями вибірки, які передбачали, що учасники брали участь у змаганнях на регіональному рівні та відвідували тренування принаймні протягом 2 років. Дані отримували з кількох тестів і вимірювань: вибухову силу м'язів ніг оцінювали за допомогою тесту на стрибок у висоту з наступною

обробкою результатів за формулою (номограмою) Льюїса. Гнучкість вимірювали за допомогою тесту на повздовжній шпигат, мотивацію досягнення оцінювали за допомогою анкети, затверджені експертами, а виконання серпоподібного удару ногою оцінювали шляхом тестування. Аналіз даних здійснювали з використанням простого регресійного аналізу та множинного регресійного аналізу з наступним пат-аналізом для обчислення значення коефіцієнта для кожної змінної.

Результати. Аналіз одержаних даних проводили з використанням пат-аналізу структурної моделі. Результати: (1) встановлено вплив вибухової сили м'язів ніг на виконання серпоподібного удару ногою на 21,59%; (2) встановлено вплив гнучкості на виконання серпоподібного удару ногою на 6,94%; (3) встановлено вплив мотивації досягнення на виконання серпоподібного удару ногою на 9,74%; (4) встановлено вплив вибухової сили м'язів ніг спільно з мотивацією досягнення на виконання серпоподібного удару ногою на 38,14%; (5) встановлено вплив гнучкості спільно з мотивацією досягнення на виконання серпоподібного удару ногою на 13,51%; та (6) встановлено одночасний вплив цих змінних на 51,41%.

Висновки. На підставі аналізу трьох факторів, згаданих вище, зроблено висновок про те, що вибухова сила м'язів ніг є основним фактором і потребує серйозного навчання та тренування. Проте інші фактори є не менш важливими. Терміново потрібні подальші дослідження, що включатимуть інші змінні, які впливають на результати цього дослідження, а також більшу кількість вибірок для підтвердження правильності результатів цього дослідження.

Ключові слова: навчання пенчак-силату, вибухова сила м'язів ніг, гнучкість, мотивація досягнення, серпоподібний удар ногою.

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SIMULATION OF COMPETITIVE ACTIVITIES OF SKATERS IN SHORT-TRACK

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Abstract

Modeling of competitive activity forms the basis for the rationalization and improvement of those means and methods that are used in sports training of athletes. In this regard, a hypothesis was put forward that predictive skating models will ensure the achievement of a certain level of sports results in short-track speed skating.

Study purpose. The aim of the study was to develop a prognostic model of the competitive activity of elite athletes at a distance of 500 m in short-track on the basis of regression analysis with a focus on achieving specified results.

Materials and methods. The study used an analysis of official competition protocols, modeling method, statistical analysis. The behavior of changes in the speed of skating at a distance of 500 m in 173 elite athletes was analyzed. The main components of competitive activity in short-track were revealed.

Results. The results obtained have theoretical significance which lies in the scientific substantiation of the need to improve competitive activity on the basis of its studying and the building of skating models. Their practical significance consists in the development and use of models of competitive activity of elite athletes at a distance of 500 m in short-track, taking into account the construction of a skating option. The presented data are an action plan that allows you to purposefully manage the training process and improve the training of athletes in short-track speed skating at a distance of 500 m in an annual cycle. When processing the results of the study, the level of statistical significance was taken as $p \leq 0.05$.

Conclusions. The informative characteristics of competitive activity that affect the result at a distance of 500 m include acceleration speed and running speed on the first, second, third and fourth laps of the distance, multiple correlation coefficient $r = 0.985$ ($p < 0.01$). These are objective criteria which are a system-forming factor that determines the structure and content of the training process of elite athletes, and allow monitoring the level of special readiness, as well as predicting the ways of further improvement and making timely corrections in the training process.

Keywords: regression analysis, predictive models, short-track, modeling, competitive activity, informative characteristics of competitive activity.

Introduction

At present, the intensity of competitive struggle in the sports arena is associated with a high density of results. This increases the requirements for the quality of training athletes, stimulates the search for new ways and methodological solutions to build the training process (Platonov, 2013, 2017).

There is a rich arsenal of mathematical methods and modeling tools that can be usefully used in study, training and competitive activities (Witte et al., 2010).

Modeling forms the basis for the rationalization and improvement of those means and methods that are used in sports training (Plotnikov, 2007; Platonov, 2015).

One of the directions of modeling in sports is the development of models of competitive activity. They are based on quantitative and qualitative characteristics that ensure the achievement of the desired results in the chosen sport. Modeling the competitive activity of highly qualified athletes

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predetermines the content of the training process in the system of sports training (Tompson, 2013).

This is confirmed by the data of leading experts in the field of sports training, who note the importance of studying and developing model characteristics of the competitive activity of the best athletes in the world at the present stage (Plotnikov, 2007; Tompson, 2013; Platonov, 2017; Fitton & Symons, 2018).

The methodology for modeling competitive activity has been widely developed in cyclic sports: in athletics (Dobryn'skaya & Kozlova, 2013; Morais et al., 2014; Lundstrom et al., 2017; Yang et al., 2020); in swimming (Barbosa et al., 2010; Platonov, 2011; Skirenko, 2009).

An analysis of the available data showed that, despite a fairly high level of scientific developments in this area, unfortunately, in the short track, modeling issues have not been sufficiently studied. In particular, models of running technique in a straight line and a turn have been developed (Litvinenko, 2008), anthropometric model characteristics of athletes (Kugaevsky & Kotlyar, 2005; Kugaevsky, 2011) and models of muscle strength of the lower extremities (Wang, 2011). Also, much attention was paid to considering the tactics of passing distances (Koning, 2011; Konings et al., 2014; Haug et al., 2015) and the use of modern equipment that allows you to register various biomechanical characteristics of competitive activity in real time (Wang, 2012).

At the same time, there is practically no information related to the modeling of competitive activity in short track speed skating at various distances. Insufficient data on the components affecting the effectiveness of the competitive activity of qualified athletes in short track speed skating.

In this regard, the study of the competitive activity of highly qualified athletes, taking into account the specifics of this sport, the definition of characteristics that affect the sports result, and on this basis, the development of models of the competitive activity of athletes at a distance of 500 m is an urgent scientific direction.

This is due to the fact that in short track speed skating, a lot depends on the tactical actions of the opponents in the race (Noorbergen et al., 2016) and the athlete needs to model the upcoming competitive struggle, taking into account specific opponents and the conditions of the upcoming competition (Song, 2014). Therefore, modeling the upcoming competitive wrestling acquires a special meaning in this sport.

Hypothesis. It is assumed that the models of competitive activity of athletes specializing in short track speed skating at a distance of 500 m, developed on the basis of the analysis of the dynamics of the running speed of highly qualified athletes, will improve the efficiency of the training process and improve sports results in this sport.

Purpose of study – on the basis of regression analysis, a prognostic model of the competitive activity of highly qualified athletes at a distance of 500 m in short track was developed, focused on achieving the specified results.

Materials and methods

Participants

The study involved 173 athletes. The protocols of the competitions of the World and European Championships, the stages of the World Cup at a distance of 500 m were

analyzed. The results were taken from the protocols with an accuracy of 0.01 s. The speed was calculated with an accuracy of $0.01 \text{ m} \cdot \text{s}^{-1}$.

In the course of the research, the following methods were used: analysis of official competition protocols, modeling method, statistical analysis.

Data analysis

Regression analysis was used to model the relationship between the time shown at a distance and the components of the competitive activity of athletes in a high-qualification short track. The method of mathematical modeling made it possible to develop equations of linear multiple regression and to obtain a mathematical analysis of the structure of competitive activity at distances of 500 m of highly qualified athletes in short track. On their basis, prognostic models of competitive activity were developed, focused on achieving a given result.

Statistical analysis

Pearson's simple correlations were used to determine the relationship between the studied characteristics of competitive activity and sports results (time to cover the distance).

For each of the dependent variables, a straight step linear regression model was created using significant correlation data. Statistical analysis was performed using Statistica (v. 6.0; StatSoft, Tulsa, OK, USA), statistical significance was set at $p < 0.05$, and some results were obtained at higher significance levels $p = 0.01$ and $p = 0.001$.

Results

The analysis of punctures of the largest international competitions made it possible to trace the dynamics of the running speed of the strongest athletes in the world and reveal some patterns. It should be noted that at the largest international competitions such an indicator as the time to overcome various parts of the distance is recorded in the short track and processed using modern equipment and computer technologies. They allow you to receive information in real time, create data banks and subject the data to mathematical processing.

Analysis of scientific and methodological literature (Litvinenko, 2008; Kholodova, 2013; Haug et al., 2015; Kholodova, 2015) and the experience of advanced sports practice made it possible to identify the main components of competitive activity in short track (Wang, 2011; Konings et al., 2014):

- the speed of passing those segments of the distance that characterize the start, distance and finish speed;
- time of passing the distance laps;
- the difference in speed in the first and second half of the distance, excluding the first lap;
- time to overcome the fastest and slowest laps;
- the difference between the time to overcome the slowest and fastest laps without taking into account the first lap;
- the number of laps in the qualifying position;
- the number of laps in the leading position;
- the position of the athlete in the group on the first part of the distance;

- the position of the athlete for the circle to the finish.

Thus, for the analysis of the running speed at a distance of 500 m, the following segments were identified: starting, which characterizes the starting speed (55.52 m), the first, second and third laps, which characterize the distance speed; fourth lap - finishing speed. As a result, four main tactical options were identified, which were used in all qualifying circles of the competition.

Most often, the strongest athletes used the option in which the athletes ran at the minimum distance speed on the first lap of the distance. Gradually increasing the speed to the maximum already on the second lap (in 42.4-57.1% of cases, depending on the qualifying circle of the competition).

The obtained characteristics of competitive activity made it possible to determine informative indicators and carry out multiple regression analysis between sports results at distances of 500 m.

The equation of multiple step-by-step regression, which characterizes the peculiarities of the dependence of the sports result on the speed at acceleration and on four laps of a distance of 500 m for the most used running variant, is as follows:

$$t = 83.26 - 0.77 \times X_1 - 0.94 \times X_2 - 0.60 \times X_3 - 0.69 \times X_4 - 0.56 \times X_5,$$

where t is a sports result, s;

X_1 – acceleration speed, $m \cdot s^{-1}$;

X_2 – average running speed on the first lap, $m \cdot s^{-1}$;

X_3 – average running speed on the second lap, $m \cdot s^{-1}$;

X_4 – average running speed on the third lap, $m \cdot s^{-1}$;

X_5 – average running speed on the fourth lap, $m \cdot s^{-1}$;

the standard error of the model estimate is .088 s;

multiple correlation coefficient $r = 0.985$;

determination coefficient $r^2 = 0.97$;

model is statistically significant at $p < 0.001$.

The carried out regression analysis of the relationship between sports result and speed during acceleration and four laps of a distance of 500 m made it possible to calculate the quantitative characteristics of predictive running models that ensure the achievement of prizes at the national championships.

Table 1 shows fragments of such a model at a distance of 500 m with the option of running with maximum speed on the second lap of the distance, minimum – on the first.

According to the data obtained, the most optimal in terms of reliability at a distance of 500 m is a model where the factors of influence were the speed on the first, second, third and fourth laps. Thus, having the results character-

izing the components of the competitive activity of highly qualified short trackers, it is possible to predict the time at a certain distance.

Discussion

According to leading experts in the theory and practice of sports, current level of its development makes it necessary to look for new ways to improve training efficiency of highly qualified athletes. This is due to the fact that many components of the training process have reached their limit (Plotnikov, 2007; Tompson, 2013; Platonov, 2015). Thus, the coaches are faced with the need to choose such training means and methods that will bring sports training to real modes of competitive activity as close as possible.

In this regard, in order to confirm the main hypothesis, during the study, we have studied the structure of competitive activity performed by highly qualified athletes specialized in short track at a 500 m distance. This has allowed us to develop predictive models focused on a given result. They are based on informative characteristics that affect the achievement of high sports results at a given distance.

The data obtained in the course of the study are in good agreement with the conclusions of well-known experts, which are as follows: the most important direction in optimizing the training process of highly qualified athletes is the management of competitive activity components, the study of competitive structure is relevant and timely today, and the methodology for training athletes must fully comply with the requirements of competitive activity (Drjukov, 2000; Dick, 2007; Kostiukevych, 2012).

Despite the fact that in cyclic sports, including short track, the composition of competitive activity is determined in advance, the athlete needs to model the upcoming competitive struggle, taking into account specific opponents and the conditions of upcoming competitions (Plotnikov, 2007). In short track skating, a lot depends on the tactical actions of the opponents in the race. Therefore, modeling of the upcoming competitive event acquires a special sense in this sport (Litvinenko, 2008).

The study of special literature and generalization of best practice experience have shown that the construction of competitive activity models of qualified athletes specialized in short track, despite the high degree of this problem relevance, has not found its proper place and comprehensive exposure in scientific literature.

Table 1. Fragments of the predictive model of competitive activity at a distance of 500 m. Focused on achieving the desired results

Result, s	Distance segment									
	first		Second		Third		Fourth		fifth	
	t, s	v, m·s ⁻¹	t, s	v, m·s ⁻¹	t, s	v, m·s ⁻¹	t, s	v, m·s ⁻¹	t, s	v, m·s ⁻¹
41.5	6.8	8.2	9.0	12.4	8.4	13.2	8.6	13.0	8.8	12.6
42.5	7.0	7.9	9.2	12.1	8.6	12.9	8.7	12.7	9.0	12.4
43.0	7.2	7.7	9.2	12.1	8.7	12.8	8.8	12.6	9.1	12.2

Notes: t cr – time to overcome the circle; – average running speed on the segment; presents a range of indicators aimed at achieving results from 41.1 to 43.5 at intervals of 0.1 s

At the same time, our research complements the data of special literature that in cyclic sports it is necessary to know the dynamics of the athlete's movement speed along the distance, both developed by them individually and in comparison with the main competitors. To do this, it is needed to record time at a distance so many times that can allow to cover the most characteristic areas that require from the athlete usage of entire arsenal of tactical and technical techniques. The general patterns of competitive activity in cyclic sports include the ability to evaluate the effectiveness of passing a distance directly during competitions using indicators that underlie the construction of model characteristics, namely, the time to overcome individual segments of the distance (Skirenia, 2009; Kiriiienko & Shpak, 2009; Robertson, 2009).

In accordance with the obtained regression equations, regularities for the influence of informative characteristics of competitive activity on sports results are established. Multiple regression analysis has shown that the result of high-class athletes specialized in short track depends on the efficiency of the start, the speed of the starting acceleration, the level of distance speed, and the ability to maintain high speed at the finish line. These data are consistent with those available in the specialized literature and supplement them.

The special scientific and methodological literature on various sports quite fully provides information on the structure of competitive activity, and also offers its statistical model characteristics (Robertson, 2009; Morton, 2009; Samuylenko, 2013). However, in studies on short track, this information has been almost absent until now. In this regard, our analysis of the running speed dynamics by highly qualified short trackers at various distances, followed by the development of competitive activity models, can be attributed to absolutely new data.

It should be noted that for the first time at a distance of 500 m in the short track, four main running options have been identified, which have been used in all rounds of competitions by highly qualified athletes. The first option: the maximum speed – on the second lap, the minimum – on the first one. The second option: the maximum speed – on the second lap, the minimum – on the last one. The third option: the maximum speed – on the third circle, the minimum – on the first one. The fourth option: maximum speed – on the third lap, minimum – on the fourth one.

The data obtained by us in the course of the study are in good agreement with the data of scientific and methodological literature (Platonov, 2011) that the models of competitive activity, the achievement of which is associated with the athlete's personal achievement at the level of a given sports result, are a factor that determines the structure and content of the preparation process for this stage of sports improvement. The developed models will allow revealing the reserves for achieving the planned indicators of competitive activity, determining the main directions for improving fitness, establishing optimal levels of its various aspects development among short trackers, as well as the correlation and relations between them (Kugaevskii, 2011; Kholodova, 2013; Dobrynskaia & Kozlova, 2013).

The obtained results have both theoretical and practical significance. The theoretical significance lies in scientific substantiation of the need to improve competitive activity on the basis of its study and the construction of running models. Practical one consists of the development and use of

competitive activity models of highly qualified short trackers at a 500 m distance, taking into account the construction of a running mode variant; in the development and application of preparing recommendations for building up a training process within the annual cycle aimed at preparing for covering various distances. The presented data is an action plan that allows athletes to guide, improve and control the preparation for individual distances of short trackers in the annual cycle.

Thus, in the preparation of highly qualified athletes, first of all, it is necessary to take into account the characteristic features of competitive activity and build up a training process based on knowledge about it. In this regard, it is advisable to carry out further research in the direction of introducing automated systems for recording and processing the main indicators of competitive activity during competitions and training process, as well as in the direction of substantiating new means and methods of training short trackers of various qualifications.

Conclusion

The informative characteristics of competitive activity that affect the result at a distance of 500 m include: acceleration speed and running speed on the first, second, third and fourth laps of the distance, multiple correlation coefficient $r = .985$ ($p < .01$). They are objective criteria and backbone factors that determine the structure and content of the training process of qualified athletes, and also allow monitoring the level of special readiness, predicting ways of further improvement and making timely corrections in the training process.

Conflicts of interest

The authors declare that they have no competing interests.

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МОДЕЛЮВАННЯ ЗМАГАЛЬНОЇ ДІЯЛЬНОСТІ КОВЗАНЯРІВ У ШОРТ-ТРЕКУ

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Авторський вклад: А – дизайн дослідження; В – збір даних; С – статаналіз; D – підготовка рукопису; Е – збір коштів

Реферат. Стаття: 6 с., 1 табл., 33 джерела.

Моделювання змагальної діяльності становить основу раціоналізації і вдосконалення тих засобів і методів, які використовуються в спортивній підготовці спортсменів. У зв'язку з цим була висунута гіпотеза про те, що прогностичні моделі бігу забезпечать досягнення певного рівня спортивного результату в шорт-треку.

Мета дослідження. На основі регресійного аналізу розробити прогностичну модель змагальної діяльності спортсменів високої кваліфікації на дистанції 500 м в шорт-треку, орієнтовану на досягнення заданих результатів.

Матеріали та методи. Аналіз офіційних протоколів змагань, метод моделювання, статистичний аналіз. Проаналізовано динаміку зміни швидкості бігу на дистанції 500 м в 173 спортсменів високої кваліфікації

Результати. Виявлено основні компоненти змагальної діяльності в шорт-треку. Отримані результати мають теоретичну значущість, яка полягає в науковому обґрунтуванні необхідності вдосконалення змагальної діяльності на основі її вивчення і побудови моделей бігу. Практична – полягає в розробці та використанні моделей змагальної діяльності спортсменів високої кваліфікації на дистанції 500 м в шорт-треку з урахуванням побудови варіанти бігу. Представлені дані є планом дій, які дозволяють цілеспрямовано керувати тренувальним процесом і вдосконалювати підготовку спортсменів в шорт-треку на дистанції 500 м в річному циклі. При обробці результатів дослідження брали рівень статистичної значущості $p \leq 0,05$.

Висновки. До інформативним характеристикам змагальної діяльності, що впливає на результат на дистанції 500 м, відносяться: швидкість розгону і швидкість бігу на першому, другому, третьому і четвертому колах дистанції, коефіцієнт множинної кореляції $r = 0,985$ ($p < 0,01$). Це об'єктивні критерії, які є системоутворюючим фактором, що визначає структуру і зміст тренувального процесу кваліфікованих спортсменів, і дозволяють здійснювати контроль за рівнем спеціальної підготовленості, а також прогнозувати шляхи подальшого вдосконалення і вносити своєчасні корекції в процес підготовки.

Ключові слова: регресійний аналіз, прогностні моделі, шорт-трек, моделювання, змагальна діяльність, інформативні характеристики змагальної діяльності.

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EFFECT OF PHYSICAL ACTIVITIES TRAINING AND MESSAGES ON THE PHYSICAL FITNESS OF ELDERLY PEOPLE

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Abstract

Study purpose. The study aimed to investigate the effect of physical activities and massages on the physical fitness of elderly people.

Materials and methods. The participants were 32 females aged 62-75 who were willing to participate in the study. They were selected through a systematic random sampling. The participants were divided into two groups: the experimental and control groups. The experimental group performed physical activities such as Qi Gong and Ruesi Dadton (RSD), and received a massage for 90 minutes a day, 3 days a week, for a period of 8 weeks. The control group did not perform the physical activities in question. Quantitative data were gathered by measuring the elderly people's body potential such as balance, strength of the leg and arm muscles, flexibility, flexibility of the shoulders, cardiovascular and respiratory endurance before and after training in the fourth and eighth weeks. Qualitative data were collected by means of a semi-structured interview.

Results. The study found that following the training in the fourth and eighth weeks, the experimental group had a better mean of body balance, muscular strength in arms and legs, flexibility in shoulders, cardiovascular and respiratory endurance than before training and the control group at a statistical significance ($p < 0.05$).

Conclusions. As regards the benefits to the physical fitness, it was found that the subjects had a better body balance, strength and endurance, better mental health, and more socialization.

Keywords: physical activities, massage, physical fitness, elderly people.

Introduction

Aging is associated with a significant decline in the musculoskeletal system, which affects an individual's capacity to perform daily activities (Frontera, 2017; Minjoon et al., 2021). Both physical and mental health, finally contributing to a decrease in quality of life in the elderly (Murman, 2015; Shen et al., 2021). The elderly often suffers declining physical abilities such as reduced bodily strength, weakened bones or brittle bones (Mubashir et al., 2013). Which may affect daily functioning. To treat and manage this condition, Therefore

physical activity is necessary for the health and physical fitness of the elderly.

Encouraging older adults to exercise regularly is important and beneficial to physical fitness, including respiratory and circulatory tolerance, muscle strength, muscle weakness, and proper body proportions or balance (Hoeger & Hoeger, 2006). The physical activities consume more energy than usual and a key component of maintaining health, is becoming alternative in reducing medical expenses for the old people (Suksom, 2018; Sang-Wan & Ji-Youn, 2020). Body balance helps in the development of proper body posture control (Vikas et al., 2022). It also strengthens the body and also helps to improve mental, social and intellectual health (Bushman, 2011; Rungney, 2016; Supaporn, 2018).

Massage can bring about a body balance. If muscles are excessively used or if there is imbalance in muscles, massage

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can increase the performance of muscles and keep muscles balanced (Silalertdetkun, 2005). The massage is a touch to feel comfortable and relax (Phungphai, 2007). Moreover massage control pain and it is treatment for prevention and recovery of muscle fatigue (Oh et al., 2003; Jun-Ho et al., 2014).

Physical activities and exercise in various forms suitable and useful to health and mind of the elderly. The activities in question were Qi Gong, Tai chi and Yoga (Pimboon, 2019). Qi Gong is a slow movement of body parts in conformity with one's breathing (Supaporn, 2003). Ruesi dadton (RSD) is a physical movement in varying positions. It requires one's muscular flexibility in line with a breathing exercise (Peepathum, 2004). Ruesi dadton (RSD) is a traditional Thai exercise that involves slow movement with breathing. RSD is also a type of mind-body exercise, just like yoga and Thi chi (Noradechannunt et al., 2017; Canli & Ozyurda, 2020; Phaksachphon et al., 2021). However, studies in Southeast Asia are lacking in data related to exercise training combined with massage. This information can be used as an alternative activity of the elderly. Therefore, the current knowledge on this topic must be summarized as a guideline. It focuses on the physical fitness of older adults and identifies possible approaches for future research.

Materials and methods

Study participants

The volunteers were females aged 62-75 years, selected by means of a systematic random sampling. The participant were divided into two groups. The experimental group did the physical activities by practicing Qi Gong and Ruesi Dadton (RSD) for a period of eight weeks. It was done three days of 90 minutes per week. The other group was the control one. Quantitative data were collected based on the elderly's physical fitness, that is, balance, strength of leg and hand muscles, flexibility, flexibility of the shoulders, cardiovascular and respiratory endurance. Qualitative data were derived by means of a semi-structured interview and a participatory observation. The criteria used to select the participants in the research. 1) Females aged 62-75 years, who could participate in the research throughout the data collecting period. 2) Had no diseases or chronic illness which could be impediment to physical activities. Criteria to exclude the participants from the research 1) The subjects got injured or sick, making them unable to participate in the physical activities or absent from the activities for more than three times. 2) The participant withdrew themselves or they did not want to participate in the activities in the specified time.

Human research ethics

The research had been approved by the committee for the research ethics of Buriram Rajabhat University. The certificate issued was BRU: -rdi006-006/2564.

Study organization

In the present research, data were collected by having the subjects do the physical activities, that is, Qi Gong, Ruesi Dadton (RSD) and body massage for 90 minutes a day, 3 days a week for the period of 8 weeks. Quantitative data were collected by verifying the physical fitness of the elderly, includ-

ing body balance, strength of leg and hand muscles, flexibility, flexibility of the shoulders, cardiovascular and respiratory endurance. The semi-structured interview and participatory observation were used to collect the qualitative data.

Statistical analysis

Quantitative data were analyzed by testing the difference of the average of the body balance, limb muscular strength, flexibility, flexibility of the shoulder and cardiovascular and respiratory endurance. Derived data were analyzed by testing the difference before and after the training, after the fourth and eighth weeks. Qualitative data were collected by means of a semi-structured interview.

Results

The research found that following the training in the fourth and eighth weeks, it was found that the experimental group had a better mean of body balance, muscular strength in arms and legs, flexibility in shoulders, cardiovascular and respiratory endurance than before training and the control group at a statistical significance $p < 0.05$. As regards the benefits to the physical fitness, it was found that the subjects had a better body balance, strength and endurance, better mental health, and more socialization.

Table 1. Characteristics of the samples

Given name	Age	Weight	Height	BMI	Health Problems
s.y.1	75	58	160	33.20	leg pain
s.y.2	70	40	150	17.77	backache
s.y.3	69	47	145	22.38	shoulder pain
s.y.4	66	46	149	20.72	leg pain
s.y.5	72	63	150	28.00	knee ache
s.y.6	69	56	155	23.33	shoulder pain
s.y.7	68	52	150	23.11	leg pain
s.y.8	69	50	150	22.22	back ache
s.y.9	64	66	150	29.33	waist pain
s.y.10	65	62	150	27.55	shoulder dislocation
s.y.11	74	57	156	23.45	knee pain
s.y.12	62	69	150	30.66	back ache
s.y.13	62	64	165	23.52	knee pain
s.y.14	75	45	145	21.42	shoulder pain
s.y.15	67	52	152	22.51	hip pain
s.y.16	66	54	150	24.00	shoulder dislocation
X	68.3	55.0	151.6	24.57	

Table 1, the participant with the given name s.y. were aged 62-75 years. Their average age was 68.3, their average weight was 55.0 kg, average height was 151.6 cm, and BMI was 24.47. They have got similar problems, that is, physical joint pains.

Table 2. Research results

Benefits of the physical activities and massages for the elderly
1. Good balance and good flexibility
2. Cardiovascular and respiratory endurance
3. Better mental health
4. Increased socialization

Table 2, the research results can be detailed as follows.

1. Good balance and flexibility: physical activities and massages are bodily movements of the main muscle parts. These took time to be effective and the body balance was important. As s.y.3 said: "Before training, I have no strength in my muscles. I can barely walk and balance myself. After I regularly do the physical activities, I can move comfortably, able to raise my hands and legs easily and walk with good balance."

2. More strength and better endurance: physical activities and massages kept the elderly physically stronger and better able to endure. As s.y.4 put it: "Before doing activities, I cannot walk for longer minutes, I always have bodily pains."

I have got tired even though I have a short walk. Now, I become stronger and I do not easily get tired." s.y.6 added. "Before doing the activities, I get exhausted if I have worked longer. As for now, I feel my muscles grow stronger, not feeling tired easily as before."

3. Improved mental health: the physical activities and massages improved the elderly's mental health. As s.y.10 said: "Before I do the activities, I am habitually sensitive and worried with many things. After doing the activities, I feel energetic, I rarely get worried."

4. Increased socialization and more friends: the elderly who took part in the physical activities got more opportunity to come to know more people. AS s.y.4 put it: "Mostly we meet one another on the important religious or cultural events. By doing more activities and massages, we have more often met more people. That is good as I do not feel lonely." s.y.11 commented: "I come for the activities and massages. I am happy to have met more friends and relatives." s.y.19 added: "The activities make me active and happy. We have been pleased to have participated in these."

Quantitative data were analyzed by testing the difference of the average of the body balance, limb muscular strength, flexibility, flexibility of the shoulder and cardiovascular and respiratory endurance. Derived data were analyzed by testing the difference before and after the training, after the fourth and eighth weeks. It was analyzed by one-way repeated measures ANOVA, comparison of differences in pairs of the mean of each repeated measures.

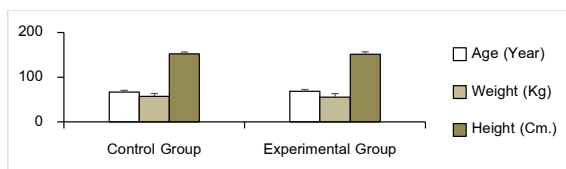


Figure 1 shows a comparison of the mean in age, weight and height of the control group and the experimental group. It was found that the mean and standard deviation between the groups were different with a statistical significance of $p < 0.05^*$.

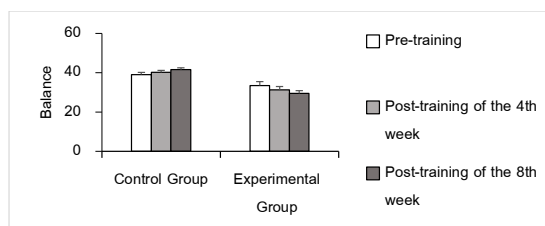


Figure 2 shows a comparison of the mean of the balance before and after training, in the fourth week and eighth

weeks of the control group and the experimental group. The mean between the groups was different with a statistical significance of $p < 0.05^*$. The mean was different within the group with a statistical significance of $p < 0.05$.

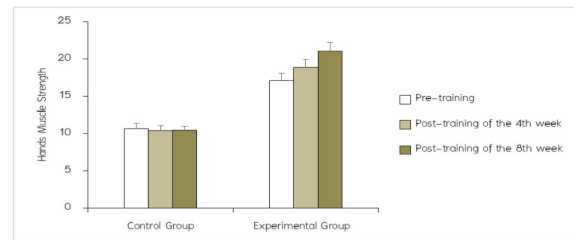


Figure 3 shows a comparison of the mean in the arms' muscular strength before and after training in the fourth and eighth weeks of the control group and the experimental group. The mean of the difference between the groups was statistically different with a significance of $p < 0.05^*$.

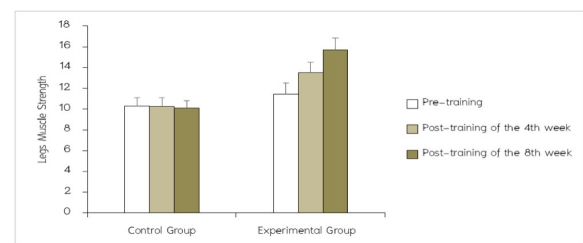


Figure 4 shows a result of the mean of the legs' muscular strength before and after training, in the fourth and eighth weeks of the control group and the experimental group. The mean between the groups was statistically different with a significance of $p < 0.05^*$.

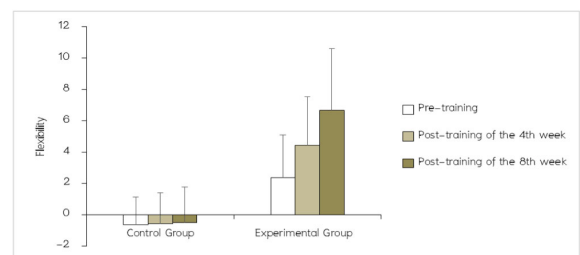


Figure 5 shows the result of the mean of flexibility before and after training, in the fourth and eighth weeks of the control group and the experimental group. The mean between the groups was different with a statistical difference with significance of $p < 0.05^*$. The mean within the group was different with significance of $p < 0.05$.

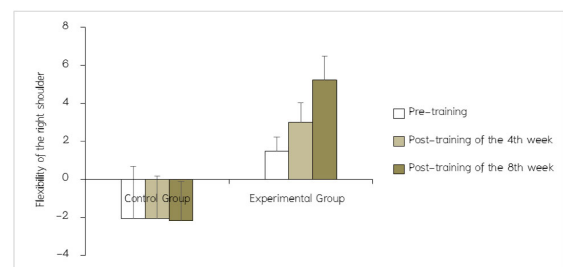


Figure 6 shows a result of the mean of the flexibility of the right shoulder before and after training, in the fourth

and eighth weeks of the control group and the experimental group. The mean is statistically different with significance of $p < 0.05^*$. And the mean within a group was different with a significance of $p < 0.05$.

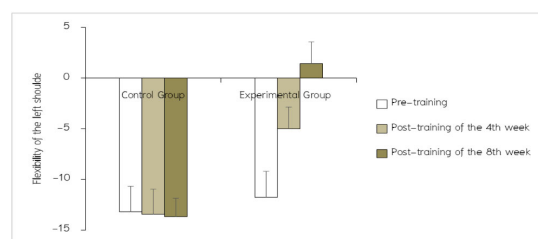


Figure 7 shows a result of the mean of the flexibility of the left shoulder before and after training, in the fourth and eighth weeks of the control group and the experimental group. The mean between the groups was statistically different with significance of $p < 0.05^*$. The mean within the group was statistically different with significance of $p < 0.05$.

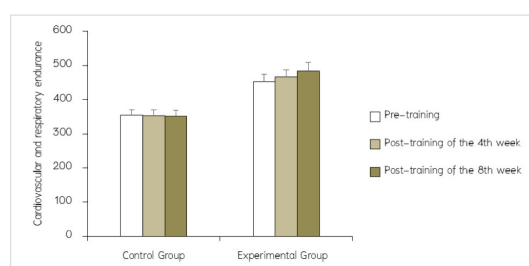


Figure 8 shows the result of the mean of cardiovascular and respiratory endurance before and after the training, in the fourth and eighth weeks of the two groups. It was found that the mean between the two groups was statistically different with significance of $p < 0.05^*$, and the mean in the group was statistically different with significance of $p < 0.05$.

Discussion

Based on the present research, it was found that after doing the physical activities and massages in the fourth and eighth weeks of training, the experimental group had a better average body balance, strength in the leg muscles, flexibility, flexibility of the shoulder, cardiovascular and respiratory endurance than before and they could perform better than the control group at a statistical significance of 0.05. In addition, the subjects had the following: improved balance and flexibility, heart and respiratory endurance and strength, better mental health, more socialization. The findings were consistent with the study by Nontakhod et al. (2021) who found that the physical activities such as Qi Gong, Yoga and stretching could have a positive impact on health. That is the person would have 1) good health including good balance, flexibility, improved breath, reduced arches; 2) good health; 3) more socialization and 4) better concentration. Likewise, Pimboon (2019) said that training oneself in Qi Gong, Tai Chi and Yoga proves beneficial to health of the old people. People who did the activities in question gained the following: proper physical balance, body strength, flexibility, better breathing, reduced pains, more mindfulness, calmness and

reduced stress. This find was in line with the study by Nontakhod et al., (2020). Studied the effects of doing Tai Chi and rubber stretching on the body balance and strength of the elderly, and found that the subjects had better body balance, better flexibility, more relaxation and better mental conditions, more socialization and friends. The findings were in accordance with the work by Saetae et al., (2018) that found that Qi Gong and Yoga could have a positive impact on health, making the person physically and mentally healthy. Consistent with the study balance and resistance training could reduce risk factor of fall by improving balance and lower limb strength among old adults with T2DM and balance impairment including effectiveness of band exercise in improving muscle strength (Kraiwong et al., 2021; Minjoon et al., 2021). The finding was also supported by the research of Thaiprasert et al. (2019) which found that yoga practice made the elderly healthier physically, mentally and socially. Past research has shown that Tha Chi, Qi Gong, and Applied Ruesi Dadton (RSD) can improve helpers with balance, strength, flexibility and health (Ching et al., 2013; Kim et al., 2014; Zou et al., 2017). Consistent with the study Qigong exercise improve the physical fitness of elderly females, and Pilates exercises aid in disease prevention and rehabilitation and the development of balance in the elderly (Ladawan et al., 2022; Samuel et al., 2021). In addition, Tai Chi and Qi Gong Training found that the elderly had better social interactions and had better mental health (Chan et al., 2017). The favorable of Qigong training on strengths are consistent with previous studies demonstrating significant improvements of knee extension strength after Tai Chi training in elderly subjects (Song et al., 2014; Klarod et al., 2020). Therefore that the elderly should be able to have the activities of their own choice, and they should not be too heavy or arduous, and they should be easy for them to practice (Khoo et al., 2014; Krabuanrat & Supaporn, 2014; Supaporn, 2018).

Conclusions

Physical activity involves using and combining different forms of activity, including Ruesi Dadton Qigong (RSD) and massage to improve body balance. Arm and leg muscle strength, flexibility, shoulder flexibility Cardiovascular system and respiratory system. The aim is to make the elderly have good physical fitness. Physical activity in this study the elderly should be careful to move appropriately and this is an alternative activity for the elderly.

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Conflict of interest

The author declares that there is no conflict of interest.

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ВПЛИВ ЗАНЯТЬ ФІЗИЧНИМИ ВПРАВАМИ ТА СЕАНСІВ МАСАЖУ НА ФІЗИЧНУ ФОРМУ ОСІБ ПОХИЛОГО ВІКУ

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Авторський вклад: А – дизайн дослідження; В – збір даних; С – статаналіз; D – підготовка рукопису; Е – збір коштів

Реферат. Стаття: 6 с., 2 табл., 8 рис., 40 джерел.

Мета дослідження. Метою дослідження було вивчення впливу фізичних вправ і сеансів масажу на фізичну форму осіб похилого віку.

Матеріали та методи. Учасницями цього дослідження були 32 жінки віком 62–75 років, які висловили бажання взяти участь у дослідженні. Вони були відібрані методом систематичного випадкового вибору. Їх розділили на дві групи: експериментальну та контрольну. Експериментальна група виконувала такі фізичні вправи, як китайська гімнастика цигун і тайська йога, та отримувала сеанси масажу тривалістю 90 хвилин на день, 3 дні на тиждень, протягом 8 тижнів. Контрольна група не виконувала зазначених фізичних вправ. Збір кількісних даних здійснювали шляхом виконання вимірювань таких показників потенціалу організму в осіб похилого віку, як рівновага тіла, сила м'язів ніг і рук, гнучкість, гнучкість плечей, серцево-судинна та дихальна витривалість, до та після занять на четвертий і восьмий тиждень. Збір якісних даних здійснювали шляхом проведення напівструктурованих інтерв'ю.

Результати. На підставі результатів аналізу даних було встановлено, що за підсумками занять на четвертий і восьмий тиждень експериментальна група мала кращий середній показник рівноваги тіла, сили м'язів рук і ніг, гнучкості плечей, серцево-судинної та дихальної витривалості, ніж до початку занять і порівняно з контрольною групою, на статистично значущому рівні ($p < 0,05$).

Висновки. Стосовно позитивного впливу на фізичну форму, було встановлено, що учасники дослідження в експериментальній групі мали кращі показники рівноваги тіла, сили та витривалості, кращі показники психічного здоров'я, а також вищий рівень соціалізації.

Ключові слова: фізичні вправи, масаж, фізична форма, особи похилого віку.

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ORIGINAL SCIENTIFIC ARTICLE

ASSOCIATION BETWEEN CLUB SPORTS PARTICIPATION AND PHYSICAL FITNESS OF 6–10-YEAR-OLD MACEDONIAN CHILDREN

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Abstract

Background. Physical inactivity is associated with poor physical fitness and weight gain. Organized sports activities can be a significant component in providing adequate fitness which, on its part, is an important aspect of general health and well-being. The purpose of the study was to establish the relationship between participation in organized sports activity and obesity as well as physical fitness of 6–10-year-old children from the region of the city of Skopje in the Republic of North Macedonia.

Materials and methods. The height, weight, body mass composition, and various components of physical fitness were measured in 940 children (aged 8.98 ± 3.39). The sports participation and confounding variables, such as parents' education and body weight as well as parents' sports activities, were estimated through a questionnaire completed by parents. In order to achieve the study purpose, the study used the multinomial logistic regression analysis and the multivariate analysis of covariance (MANCOVA).

Results. Less-than-once-a-week sports participation was established in 41.1% of the children, once or twice a week – in 48.4%, and more often – in 10.5%. Obesity was established in 38.1% of the children. Children that had organized sports activity 1–2 times a week or more often showed a higher physical fitness level.

Conclusions. Even though causality cannot be established, facilitation of organized sports activities may be a crucial aspect in public health efforts addressing the growing problems associated with overweight and obesity.

Keywords: cardiorespiratory endurance, strength, power, agility, body weight, children, adolescents, physical activity.

Introduction

Not engaging in physical activity (PA) is one of the main causes affecting public health, due to its negative impact on physical and mental health (Trost et al., 2014; Pedersen & Saltin, 2015). Young people to have good health, should participate in physical activities at least 60 minutes during the day (WHO, 2016), the largest possible participation in physical activities during the early childhood can become a habit during adult age (Malina, 1996). Many children and adolescents are at risk for cardiovascular disease through inactivity (Thomas & Williams, 2008), although the clinical symptoms of cardiovascular disease may not become apparent before adulthood (Berenson, et al., 2005). Bad hab-

its such as sitting, watching TV, playing computer games are what children and adolescents during in their free time (Kaiser-Jovy et al., 2017; Biddle et al., 2009). Low stage of physical activities in childhood and adolescence also have their share in the physical fitness decrease (Tomkinson & Olds, 2007; Fraser et al., 2019; Runhaar et al., 2010), which, on its part, have negative implications with various health destructions and affects the cognitive development and academic performances (Ortega et al., 2008; Mintjens et al., 2018; Marques et al., 2018). Physical fitness is defined as a person's ability to carry out daily activities without undue fatigue (Malina & Katzmarzyk, 2006). Children and adolescents have adopted the habit of spending most of their time in sedentary activities, which results in having less activity of physical recreation. So, children's participation in sports activities, such as sports clubs, influences the growth of PA in youth (Wickel & Eisenmann, 2007; Malina, 2009;

Marques et al., 2016). In addition, organized physical activity promotes health promotion in children and adolescents (Tremblay et al., 2016). Recent studies have shown that 40–59% of European children participate in various sports clubs (Tremblay et al., 2016). Therefore, participation in organized physical activities increases the physical activity of children by fulfilling the recommendations of participation in physical activities (Hebert et al., 2015; Marques et al., 2016; Kokko et al., 2018; Lee et al., 2018). Particularly, recommendations for vigorous PA have been more definitively achieved in club sports participants (Kokko et al., 2018; Riso et al., 2019), and it is assumed that there is a positive connection of the organized physical activity in childhood and adolescence with the level of physical activity in adulthood (Tammelin et al., 2003; Hallal et al., 2006; Azevedo et al., 2007). It has also been established that there is a stronger relation of the organized sports activity with the physical fitness compared to the unorganized leisure-time physical activity (Tammelin et al., 2003). The high level of physical abilities stimulates the willingness of children to participate in physical activities. So, physical fitness is an important factor in the health and well-being of children (Lang et al., 2019). The present research was organized in order to provide better understanding of the relation between the organized sports activity participation and physical fitness, which could make serious input into developing the strategy and intervention in promoting physical activity. The purpose of the study, therefore, was to examine the association between participation in organized sports and physical fitness as well as overweight in 6–10 year-old children while considering various environmental constraints.

Materials and methods

Study participants

Baseline data from 940 (49.6% male, 50.4% female) first-grade children (8.98 ± 3.39 years) were of random selection from several primary schools in the region of Skopje in the Republic of Macedonia. The sample covers all participants whose parents agreed for their children to take part in the project, and who were mentally and physically healthy and regularly attended the classes of Physical Health and Education. Along with that, the final analysis data collection did not include some of the participants who had not undergone all of the measurements and tests or of some other reasons dropped from the project. The respondents were treated in accordance with the Helsinki Declaration (revision of Edinburgh, 2013). Protocols were approved by the Ethics Committee at the Ss. Cyril and Methodius University of Skopje. The measurements were realized in March, April and May 2019.

Anthropometric measures

The anthropometric measurements were taken according to the standard methodology of the International Biological Program (IBP) and recommendations the World Health Organization (WHO) and Weiner and Lourie (1981). Weight was measured in underwear and without shoes with a medical decimal weight scales, to the nearest 0.1 kg, and height was measured barefoot in the Frankfurt horizontal plane with a telescopic height measuring instrument (Martin's anthropometry) to the nearest 0.1 cm. Body mass index

(BMI kg/m^2) was calculated as weight in kilograms divided by the square of height in meters. Components of the body composition were determined by the method of bioelectrical impedance (measuring of the electric conductivity – Bioelectrical Impedance Analysis – BIA). The measuring was completed by a Body Composition Monitor, model “OMRON – BF511”, by means of which we have measured the body weight, fat tissue percent and muscular mass percent. Prior to commencing the measurement, we had entered the parameters of gender, years and body height of the respondent in the Body Composition Monitor. In order to provide better precision of the results obtained from the estimation of the body composition, prior to each measuring, we ensured that the preconditions recommended by ACSM (2005) and Heyward (2006) had been fulfilled.

Evaluation of Physical Fitness

Prior to starting the study, the researchers involved in the project undertook training sessions in order to guarantee the standardization, validation, and reliability of the measurements. Seven tests, forming part of the EUROFIT battery, validated and standardized by the European Council, were applied in the following order:

- Sit and Reach Test.
- Hand Grip Test.
- Standing Broad Jump Test.
- Sit-ups 30 sec.
- Shuttle Run: 4×10 meters.
- CRF was measured using the 20-m shuttle-run test.

Sports Participation

To determine participation in organized sports outside the school setting was used a parental questionnaire. Children's sports participation was classified as less than once a week, once or twice a week, and more than twice a week.

Confounding Variables

In addition, the questionnaire assessed confounding variables such as parental education, parental overweight and parental participation in organized sports. Confounding variables were dichotomized. Level of parents' education was differentiated by 12 years of schooling of either father or mother. A BMI cutpoint of 25 was used to determine between overweight and nonoverweight, and parental sports participation was separated by participation in organized sports or visiting a fitness centre more than one hour per week.

Statistical Analysis

Descriptive statistics for the three sports participation groups were calculated and checked for normal distribution. The relationship between overweight and obesity, sports participation in children and predictor variables (parental education, maternal education, paternal overweight, maternal overweight and paternal organized sport) were determined by multinomial logistic regression analysis. Differences in individual fitness parameters by sports participation were calculated via multivariate analysis of covariance (MANCOVA), again adjusting for the previously mentioned confounding

variables. Bonferroni adjustment was used for post hoc analyses in case of significant group differences. Missing values were excluded per case, and level of significance was defined as $p < 0.05$. All statistics were calculated in SPSS (24.0.0).

Results

Table 1 represents the age, anthropometric measures and measures of assessing body composition regarding the whole

sample and each group in particular that is formed in accordance with its sports participation. The inspection of Table 1 shows that the body height of those children who had done an organized sports activity for more than two times a week is statistically significantly greater and they have a greater muscle mass percentage in comparison with the children who had done organized sports activity 1-2 times a week or less than once a week. Also, the children who had done organized sports activity more than twice a week are statisti-

Table 1. Subjects characteristics of the total sample (all) stratified by participation in organized sports per week. Values are mean and SD

Variables	Children's participation in organized sports per week							
	All		Less than once		1-2 times		More often	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Age (years)	8.98	3.39	8.92	4.73	8.82	1.44	9.31	1.40
Weight (kg)	34.67	10.55	33.60	10.42	34.73	9.99	36.71	11.14
Height (cm)	134.84	10.41	133.02	10.29	135.20	9.78	137.98	10.65
BMI (kg/m ²)	18.73	3.59	18.64	3.61	18.71	3.42	18.96	3.77
Body fat percentage	23.35	8.09	23.43	8.37	23.42	7.87	23.11	7.84
Muscle mass percentage	30.46	3.03	29.86	3.02	30.66	2.80	31.39	3.06

Table 2. Distribution of the occurrence of confounding variables of the total sample (all) stratified by participation in organized sports per week. Indicated are N and %.

Variables	Children's participation in organized sports per week							
	All		Less than once		1-2 times		More often	
Overweight	357	38.1%	168	37.8%	106	38.0%	83	39.0%
Parental education ≤ 12 y	544	59.5%	295	67.5%	134	49.8%	115	55.3%
Maternal education ≤ 12 y	385	42.1%	230	53.0%	77	28.2%	78	37.5%
Paternal overweight	622	73.8%	289	71.7%	191	76.1%	142	75.1%
Maternal overweight	579	66.9%	264	64.2%	180	69.0%	135	69.6%
Paternal organized sport	335	35.6%	106	23.8%	129	46.1%	100	46.7%

Table 3. Prevalence of overweight and obesity by multiple logistic regression analysis

Explanatory variables	Unstandardized coefficient (B)	Wald statistics	p	OR (95% CI)
Children sports participation				
Less than once	-0.02	0.01	0.92	0.98 (0.66-1.45)
1-2 times	-0.03	0.03	0.87	0.97 (0.64-1.46)
More often (Ref)				
Sports participation parents				
Nonparticipation	-0.05	0.09	0.77	0.95 (0.69-1.31)
Participation (Ref)				
Weight status father				
Normal weight	0.65	12.96	0.00	1.92 (1.35-2.73)
Overweight (Ref)				
Weight status mother				
Normal weight	0.36	5.24	0.02	1.44 (1.05-1.97)
Overweight (Ref)				
Education father				
Education ≤ 12 y	-0.03	0.02	0.88	0.97 (0.70-1.35)
Education > 12 y (Ref)				
Education mother				
Education ≤ 12 y	-0.12	0.45	0.50	0.89 (0.64-1.25)
Education > 12 y (Ref)				

*Dependent variable: overweight and obesity-BMI (Cole et al., 2000, 2007)

Table 4. Odds ratio (OR) for overweight by participation in organized

Explanatory variables	Unstandardized coefficient (B)	Wald statistics	p	OR (95% CI)
Weight status				
Normal weight	0.07	0.21	0.65	1.08 (0.79-1.47)
Overweight				
Sports participation parents				
Nonparticipation	0.89	28.96	0.00	2.43 (1.76-3.35)
Participation (Ref)				
Weight status father				
Normal weight	0.05	0.07	0.79	1.05 (0.74-1.48)
Overweight (Ref)				
Weight status mother				
Normal weight	0.01	0.00	0.98	1.01 (0.73-1.39)
Overweight (Ref)				
Education father				
Education ≤ 12 y	0.41	5.76	0.02	1.51 (1.08-2.11)
Education > 12 y (Ref)				
Education mother				
Education ≤ 12 y	0.66	14.83	0.00	1.93 (1.38-2.70)
Education > 12 y(Ref)				

Table 5. Mean values and SD for individual fitness tests by participation in organized sports. F and p-values are from MANCOVA

Dependent Variable	Children's participation in organized sports per week						MANCOVA		
	Less than once		1-2 times		More often		F	p	eta
	Mean	SD	Mean	SD	Mean	SD			
Sit and reach test (cm)	15.44	6.68	15.84	15.98	16.61	6.66	1.78	0.170	0.01
Handgrip strength (kg)	12.76	3.70	13.70	13.68	14.20	5.21	10.08	0.000	0.03
Standing longjump (cm)	106.67	21.91	112.36	112.44	115.76	25.49	11.74	0.000	0.03
30 sec sit ups (n)	11.69	5.10	13.22	13.17	14.51	5.00	21.18	0.000	0.05
4×10m shuttle run test (sec)	15.36	2.02	15.00	14.97	14.53	2.05	11.37	0.000	0.03
CRF (VO _{2max})	47.57	3.29	48.03	47.99	49.60	3.81	28.63	0.000	0.07

*Difference between less than once a week and weekly sports participation.

cally significantly heavier than those having sports activity less than once a week. The children with 1-2 times-a-week organized sports activity are higher and possess a greater percentage of muscle mass than those having less than once a week an organized sports activity. Within the rest of the variables (age, BMI, body fat percentage), statistically significant differences between the groups are not established.

Table 2 displays the prevalence of potential confounding variables on child's sports participation. The relation between overweight and fatness that are classified due to BMI in children and the predictor variables (sports participation, parental education, maternal education, paternal overweight, maternal overweight and paternal organized sport) are determined through the multinomial logistic regression analysis, and the obtained results are presented in Table 3. The inspection of Table 3 shows that those of the children whose parents' body weight is normal (OR: 1.92, CI: 0.69-1.31, $p \leq 0.00$; OR: 1.44; CI: 1.05-1.97, $p \leq 0.05$), run less possibility of being classified as OV/OB than the children whose parents' body weight is excessive. It is not established to be present a statistically significant relation between the criterion and the rest of the predictor variables.

The relation between the sports participation and predictor variables (weight status, parental education, maternal education, paternal overweight, maternal overweight and paternal organized sport) is established through the multinomial logistic regressive analysis, whereas the obtained results are presented in Table 4. The inspection of Table 4 shows that there is less possibility to undertake organized sports 1-2 or more often per week for those children whose fathers are not doing sports (OR: 2.43, CI: 1.76-3.35, $p \leq 0.00$), mothers' education is less than ≤ 12 y (OR: 1.51, CI: 1.08-2.11, $p \leq 0.05$) and fathers' education is less than ≤ 12 y (OR: 1.93, CI: 1.38-2.70, $p \leq 0.00$).

Using MANCOVA, controlling for age, sex, BMI, parental education, maternal education, paternal overweight, maternal overweight and paternal organized sport, a significant main effect of participation in organized sports on most physical fitness parameters was shown (Table 5). Post hoc analysis using Bonferroni adjustment shows that the children who had done organized sports more than twice per week demonstrate statistically significantly better results in the fitness tests 30 sec sit ups, 4×10 m shuttle run test and CRF (VO_{2max}) as compared to the children who had done or-

ganized sports 1-2 or less times per week. The children with organized sports activity for more than twice a week show statistically significantly better results in the fitness tests of handgrip strength and standing long jump than those who had done organized sports less than once a week. Those of the children who had organized sports activity 1-2 times per week show statistically significantly better results in the fitness tests of handgrip strength, standing long jump and 30 sec sit ups than the children who participated less than once a week in organized sports. Statistical differences between the groups are not found in sit and reach test.

Discussion

Participation in organized sports activity for less than once a week was marked in 41,1% of the children; for once or twice a week – in 48,4%; and more often – in 10,5%. The prevalence and obesity in the present research is 38,1% for the whole sample of respondents. Although the sample does not represent the entire population of the country, the prevalence of overweight and obesity is similar to values established in other studies conducted on samples of Macedonian children and adolescents (Gontarev & Ruzdija, 2014; Gontarev & Ruzdija, 2015; Gontarev et al., 2018). Yet, the present study provides an additional indication that the mentioned relation further persists even after the control of different confusing variables related to the family was performed. The results suggest that participation in sports activities is important when considering overweight and physical fitness, even when it comes to young ages. The present study does not establish a correlation between the overweight/obesity, estimated through BMI, and sports participation of the children. Similar results have been obtained in some other studies conducted on samples of similar age (Graf et al., 2004; Zahner et al., 2009; Vella et al. 2018), but several of these studies - conducted on adolescents (Ara et al., 2004; QUINTO Romani et al., 2011), children aged 10 to 11 (Saar & Jürimäe, 2007) and children of preschool age (Nagel et al., 2009) – a correlation between regular sports activity participation and overweight/obesity is established. Some explanation for these results can be found in the assumption that BMI does not necessarily make difference between body fats and the fat-free component, but in this research the fatty/adipose tissue percentage was measured, too, which confirms previous results. The lower amount of body fat in children with greater participation in sport can be disguised by higher percentage of the fat-free component, which would result in statistically insignificant differences of BMI. In a certain way, this is confirmed in the present study, namely the children having 1-2 times organized sports activity weekly possess a greater percentage of muscle mass than the children who do sports activity less than once a week.

Zahner et al. (2009), however, relied on skinfold measurements rather than BMI but could not show any connection between BMI and participation in physical sports activities. This gives us limited information about the effect of different sports on body composition. Along with this, participation in sports is only a component of young children's physical activity, so through free games they increase participation in physical activities. Thus, long-term participation in physical activities is related to engaging in organized sports activities (Kjønniksen, Anderssen & Wold,

2009). This study shows that parents's body weight as well as their education should be taken into account when examining the correlation between organized sports engagement and children's body weight. The results show that parents' overweight correlates with the overweight/obesity of their children (Treuth et al., 2003; Keane et al., 2012), and parents' education and sports engagement correlate with the organized sports activities of their children. In addition, Van der Horst et al. (2007) The support of children by parents, by sending children to training and sports competitions, is an important factor that affects the participation of children in sports activities. Furthermore, the research results suggest about the correlation between sports participation and various components of physical fitness, regardless the age, sex, BMI, paternal education, maternal education, paternal overweight, maternal overweight and paternal organized sport. Particular importance should be given to regular physical activity, because it affects the improvement of aerobic skills, because the association between aerobic fitness and the risk of cardiovascular disease has been reported in children (Andersen et al., 2006). Drenowatz et al. (2019) established better performances with the 6-minute test in children aged 6-14 years who were engaged in organized sports activity. Carlisle et al. (2019) established that those children who participated in organized sports activity had better results in the 12-minute Cooper's test of running/walking than those who did not participate in organized sports activity. The regular doing of sports also improves: strength, explosive power, repetitive power, coordination, agility, speed (Graf et al., 2004; Zahner et al., 2009). To be active in participating in various sports activities, motor skills have an important role, thus, having better motor skills and performance of students is better and increases their motivation to participate in sports activities.

Interestingly, Saar and Jürimäe (2007) they show that there is a connection between participating in sports and fitness activities only in adolescents, but not in young children. According to (Zahner et al., 2009) young children are not very active in organized sports, so their interest is more to do exercises through unorganized sports (Salmon et al., 2006). Bürgi et al. (2011) claim that it is the participation in energetic activity in particular boosts the physical fitness, and that kind of activities can appear in non-structured playing as well as in general physical activity. It should also be considered that the directionality of the relationship between regular sports participation and physical fitness cannot be determined via a cross-sectional study. It is possible for children of higher level of physical fitness to have more frequent participation in organized sports activities due to their better abilities. It should also be established if the greater weight/obesity is a result of insufficient sports participation or it is the bias and partiality selection that is the reason for a smaller number of children with overweight/obesity to participate in organized sports activity. The present research has not confirmed this thesis, namely it has not established differences in the weight/obesity between the children doing organized sports activity more or less. It is very likely for the correlation between the sports participation and physical fitness as well as the body composition to be twofold, which will make it harder to establish the cause-and-effect relation even in longitudinal research works. Nevertheless, the participation in sports is one of the ways to increase the physical fitness and

decrease the body fats (Michaud et al., 1999; Van Mechelen et al., 2000), although it should be taken into consideration the role of the biological and genetic factors.

In addition to the cross-sectional design other limitations of the present study should be addressed. Collecting data on children's participation in sports activities through questionnaires that are answered by parents may have had some unobjective partiality, particularly as parents were informed about the intention of the study due to the following intervention. In addition, there is no information about the intensity of the training as well as its duration. In general, however, training in organized sports at this age lasts between 60 and 90 minutes per day. Also, it was taken into account only the participation in sports activities and not the whole physical activity, which can occur as a shortage, especially when young children are into consideration. Ebenegger et al. (2012), shows the correlation between participation in sports activities and daily physical activities of preschool children from 1st grade to 5th grade. The large sample size, on the other hand, is a strength of the present study, and an analysis of missing value did not show any systematic bias. In addition, the anthropometric measures and measures of physical fitness were conducted by trained professionals and the standard procedures were followed, which increases the research credibility.

Conclusions

In spite the fact that the direction of the mentioned correlation can not be determined, the study results emphasize the necessity of early foundation of active lifestyle, including an organized sports activity, in order to provide development of different components related to the physical fitness, since it can give impetus to long-term engaging in sports and physical activity. Considering the low levels of physical education at school, and the running risk of further decrease, the promotion and facilitation of engagement in organized sports would be an important aspect concerning public health. What is more, participation in organized sports is positively related to the development of psycho-social components such as better self-confidence, stress tolerance, and lower stage of social isolation (Coatsworth & Conroy, 2007). Therefore, the facilitation of access to various sports that allow children with different abilities to engage in a variety of activities is a crucial aspect in today's efforts concerning public health.

Conflict of interest

The authors declares that there is no conflict of interest.

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ЗВ'ЯЗОК МІЖ УЧАСТЮ В ЗАНЯТТЯХ У СПОРТИВНИХ СЕКЦІЯХ І ФІЗИЧНОЮ ПІДГОТОВЛЕНІСТЮ 6–10-РІЧНИХ ДІТЕЙ У ПІВНІЧНІЙ МАКЕДОНІЇ

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Авторський вклад: А – дизайн дослідження; В – збір даних; С – статаналіз; D – підготовка рукопису; Е – збір коштів

Реферат. Стаття: 9 с., 5 табл., 54 джерела.

Передумови. Брак фізичної активності асоціюється зі слабкою фізичною підготовкою та збільшенням ваги. Організовані заняття спортом можуть бути вагомим складовою забезпечення належної фізичної підготовленості, яка, зі свого боку, є важливим аспектом загального стану здоров'я та гарного самопочуття. Метою цього дослідження було

встановлення зв'язку між участю в організованих заняттях спортом та ожирінням, а також фізичною підготовкою дітей віком від 6 до 10 років із регіону міста Скоп'є в Республіці Північна Македонія.

Матеріали та методи. У 940 дітей (віком $8,98 \pm 3,39$ року) вимірювали зріст, вагу, склад маси тіла та різні компоненти фізичної підготовки. Участь у заняттях спортом і фактори, які здатні спотворювати результати дослідження, наприклад, освіта та маса тіла батьків, а також заняття батьків спортом, оцінювали за допомогою анкети, яку заповнювали батьки. Для досягнення мети дослідження в дослідженні застосовували поліноміальний логістичний регресійний аналіз і багатоваріантний коваріаційний аналіз (MANCOVA).

Результати. Було встановлено, що 41,1% дітей брали участь у заняттях спортом рідше одного разу на тиждень, 48,4% – раз або двічі на тиждень, а 10,5% – частіше. У 38,1% дітей було встановлено наявність ожиріння. Діти, які брали участь в організованих заняттях спортом 1-2 рази на тиждень або частіше, показували вищий рівень фізичної підготовленості.

Висновки. Навіть якщо встановити причинний зв'язок неможливо, сприяння організованим заняттям спортом може бути ключовим аспектом заходів органів охорони здоров'я, спрямованих на вирішення зростаючих проблем, пов'язаних із надлишковою масою тіла та ожирінням.

Ключові слова: кардіореспіраторна витривалість, міць, сила, спритність, маса тіла, діти, підлітки, фізична активність.

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ORIGINAL SCIENTIFIC ARTICLE

CHILDREN'S ATTITUDES TOWARDS INCLUSION OF VISUALLY IMPAIRED STUDENTS IN PHYSICAL EDUCATION CLASSES: GENDER DIFFERENCES

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Abstract

Study purpose. The study purpose was to investigate gender differences in children's attitudes toward the inclusion of a student with visual impairment in physical education classes.

Materials and methods. The study sample comprised 419 able-bodied primary school students in 6th to 9th grade (boys, $n = 204$, mean age 13.23 ± 1.17 years; girls, $n = 215$, mean age 13.08 ± 1.19 years). A modified version of the standardized attitudinal questionnaire CAIPE-R for the inclusion of visually impaired (VI) students was used as a research method. The internal reliability of CAIPE-R was measured using Cronbach's α . The Shapiro-Wilk test was used to assess the normality of sample distribution. The non-parametric Mann-Whitney U-test was used to assess differences between boys and girls, and the Wilcoxon Signed-Rank test assessed differences between general and sport-specific attitudes.

Results. Boys presented rather neutral or indifferent (mean scores 3.19, 3.44 points) attitudes, and girls had slightly positive (mean scores 3.59, 3.74 points) attitudes toward inclusive physical education (PE). Girls, compared to boys, expressed more positive general ($U=16786$, $p=0.000$) as well as sport-specific ($U=16586$, $p=0.003$) attitudes towards the inclusion of the VI student in PE classes. Both groups of children declared more positive general attitudes than sport-specific attitudes towards the inclusion of VI students (boys, $Z=-4.230$, $p=0.000$; girls, $Z=-3.015$, $p=0.003$).

Conclusions. Girls expressed more positive general and sport-specific attitudes towards the inclusion of VI students in PE classes than boys. Boys' attitudes were only neutral or indifferent, and girls' attitudes were only moderately positive. Both genders declared more positive general attitudes towards the inclusion of VI students in PE classes compared to sport-specific attitudes. Taking into consideration the above, to find the most appropriate solutions as regards the inclusion of students with different kinds of disabilities in PE classes, it is necessary to learn more about the attitudes towards inclusion from students, teachers, and school management.

Keywords: girls, boys, inclusive physical education, visual impairment, general attitudes, sport-specific attitudes.

Introduction

Strategy 2020 in the European Union establishes that fighting against social exclusion is the main objective (European Commission, 2010), seeking to develop innovative programs designed to face discrimination toward people with disabilities, although substantial improvements are still needed toward the inclusion of students with disabilities into physical education (PE) classes (Klavina & Kudláček, 2011). More and more PE teachers face the reality of teaching these pupils in inclusive physical education (IPE) together with stu-

dents without disabilities (Wang, 2019; Li, Haegele, McKay, & Wang, 2021). IPE includes pupils with disabilities in regular PE classes (Cosier, Causton-Theoharis, & Theoharis, 2013; Theoharis & Causton, 2014; Rogers & Johnson, 2018). IPE supports pupils with disabilities who want to participate in other physical activities before, during, and after school and encourages them to have the same roles and experiences as their peers who do not have a disability (CDC, 2020).

The perspective of individuals with visual impairments (VI), and particularly children with VI, has so far received much less attention than the viewpoints of professionals, and just a few studies focusing specifically on subjective constructions of PE by children with VI (Alves, Haegele, & Duarte, 2018; Haegele & Buckley, 2019). Even though

many pupils with VI had positive experiences in inclusive education, one-third felt lonely or isolated and dissatisfied with their social relationships (Jessup, Bundy, Hancock, & Broom, 2018). Unfortunately, some students were teased or bullied because of their disabilities (Chang, & Schaller, 2002; Brydges, & Mkandawire, 2017). Challenges exist both socially and academically. PE is one of the academic subjects where pupils and students with VI experience isolation and exclusion (Haegele, & Porretta, 2015; Haegele, & Zhu, 2017). These negative experiences appear to be informed by instances of being bullied or ostracized by peers (Haegele, Hodge, Zhu, Holland, & Wilson, 2020), as well as being removed or isolated from activities by physical educators or paraeducators because of perceptions of inability (Alves, Haegele, & Duarte, 2018). Importantly, pupils with VI have reported that physical educators may unknowingly influence social dynamics by communicating ideals of inability while belittling or discriminating against pupils with VI in front of peers without VI (Yessick, & Haegele, 2019; Ruin, Giese, & Haegele, 2021).

One of the variables that significantly influence attitudes towards IPE is a gender. Findings of the Slininger, Sherrill, and Jankowski (2000) study showed that attitudes towards inclusion in PE classes is more positive for females than for males. Authors Loovis and Loovis (1997) utilized a One-Group Pretest-Posttest Design and the Children's Attitude Toward Handicapped Scale (Rapier, Adelson, Carey, & Croke, 1972) to measure attitudes of 430 elementary school pupils. The disability awareness program, among other, consisted of disability simulations such as orientation and mobility when blindfolded. Females in the study showed statistically significant, positive attitude improvement after the training, while the males showed moderate but not statistically significant attitude improvement.

The objective of the study was to investigate the gender differences in the children's attitudes towards the inclusion of a pupil with visual impairment in physical education classes.

Materials and Methods

Study participants

The research sample comprised a total of 419 able-bodied primary school pupils of the 6th to 9th-grade level (6th grade – $n = 69$; 7th grade – $n = 120$; 8th grade – $n = 109$; 9th grade – $n = 94$), representing two schools in the Slovak cities Bratislava and Púchov. 204 boys (mean age 13.23 ± 1.17 years), and 215 girls (mean age 13.08 ± 1.19 years) participated in the questionnaire survey. Able-bodied primary school pupils were informed of the purpose of the research and the procedure for filling out the questionnaire. The questionnaire was completed in the presence of their headteacher and the researchers. In this study, informed consent was obtained from the pupils' legal representatives, i.e., the parents. The research was approved by the Ethics Committee of the Faculty of Physical Education and Sports, Comenius University in Bratislava, Slovakia (No. 10/2019).

Instrument and organisation

A modified version of a standardized diagnostic tool an attitudinal questionnaire entitled CAIPE-R (Children's At-

titude toward Inclusive Physical Education-Revised) (Block, 1995) was used as a primary research method. The CAIPE-R is generalizable to more than one disability label and appears to be a valid and reliable instrument for measuring the attitudes of children without disabilities towards including children with disabilities in PE. Czech version (CAIPE-CZ) of the questionnaire (Kudláček, Ješina, & Wittmannová, 2011) was translated into the Slovak language (Nemček & Bumbera, 2021) and modified for the inclusion of visually impaired pupils (Olekšák, Nemček, & Ruman, 2022). The questionnaire consists of basic questions, where we were informed about each student (gender, age, class, and place of residence). Then a description of a child with VI called Richard was used for the present study. However, we decided not to use a vignette, following a similar format as Kudláček, Ješina, and Wittmannová (2011). The last part of the questionnaire consisted of 12 following statements regarding the inclusion of Richard in PE classes which are shown in Table 1. Six statements were aimed at the inclusion of VI pupils in the PE classroom (general attitude towards IPE; Table 2), and six statements regarding possible adaptations in team sports (soccer) that would promote the inclusion of pupils with VI (sport-specific attitude towards IPE; Table 3). Between two parts of statements, we ask able-bodied pupils the question "Which rules in soccer, where you play with a ball that makes a sound, do you think we could change if someone like Richard played with us?". Each statement was accompanied by a 5-point scale from point 1 (strongly disagree) to point 5 (strongly agree). Overall children's attitudes (general and sport-specific) were calculated by summarizing scores of all 6 statements (total score). A higher mean point score meant a more positive attitude and a lower point score more negative attitude towards the inclusion of pupils with visual impairment in PE classes.

Statistical analysis

The program IBM SPSS Statistics version 23.0 was used for data processing. The data were described using absolute and relative frequencies, including the mean (M) and standard deviation ($\pm SD$). The internal reliability of the modified CAIPE-R was measured using Cronbach's α . A Shapiro-Wilk test was used to assess the normality sample distribution. Shapiro-Wilk showed a significant departure from normality [$W(419) = 0.984, p = 0.000$], therefore the Non-parametric Mann-Whitney U-test (two independent samples) was used to assess differences in children's attitudes between boys versus girls, and the Non-parametric Wilcoxon Signed Rank test (two related samples) was used to assess differences between general and sport-specific attitudes in boys' and girls' groups. The significance level was set at $\alpha \leq 0.05$ (*) and $\alpha \leq 0.01$ (**).

Results

The internal consistency (Cronbach's α) of the modified attitudinal questionnaire CAIPE-R for the inclusion of pupils with VI in PE classes was 0.789 (Table 1). The item-total correlation > 0.7 indicated acceptable correlation (George & Mallery, 2003).

In both groups of able-bodied children, we revealed the most positive attitudes towards the inclusion of a VI pupil

Table 1. Internal consistency of the modified CAIPE-R

Statements	Internal consistency (n=419)		
	Mean score $\pm$ SD	Item-total correlation	Cronbach's α if the item is deleted
1. It would be OK having Richard come to my P.E. class.	3.71 $\pm$ 1.18	0.488	0.769
2. Even Richard cannot play sports very well; he would not slow down the game for everyone.	3.07 $\pm$ 1.21	0.287	0.788
3. If we were playing a team sport such as soccer, it would be OK to have Richard on my team.	2.97 $\pm$ 1.30	0.437	0.774
4. P.E. would be fun if Richard was in my P. E. class.	3.74 $\pm$ 1.12	0.349	0.782
5. If Richard were in my P.E. class, I would talk to him and be his friend.	4.09 $\pm$ 1.01	0.504	0.769
6. If Richard were in my P.E. class, I would like to help him practice and play the games.	3.99 $\pm$ 1.11	0.602	0.759
7. When practicing soccer skills, I cover my eyes with a shade to put myself in Richard's position.	2.88 $\pm$ 1.45	0.421	0.777
8. In soccer, passes that are directed at Richard must not be blocked.	3.13 $\pm$ 1.36	0.396	0.779
9. In soccer I would allow Richard to shoot into an empty goal.	3.36 $\pm$ 1.41	0.402	0.778
10. Richard could stay in the area in front of the goal longer than the rules allow.	3.59 $\pm$ 1.25	0.482	0.769
11. In soccer it would be good if nobody could steal the ball from Richard while passing.	3.03 $\pm$ 1.30	0.456	0.772
12. If Richard got the ball during the game, I would help him with verbal instructions to score a goal, since he is a player of my team.	4.39 $\pm$ 0.99	0.403	0.778
Total score	3.50 $\pm$ 0.68		0.789

Table 2. Gender differences in general attitudes towards IPE

No	Statement	Boys (n = 204)	Girls (n = 215)	Mann-Whitney U-test	
		Mean score $\pm$ SD		U	p
1.	It would be OK having Richard come to my P.E. class.	3.58 $\pm$ 1.22	3.84 $\pm$ 1.14	19182*	0.021
2.	Even Richard cannot play sports very well, he would not slow down the game for everyone.	2.90 $\pm$ 1.31	3.23 $\pm$ 1.08	18464**	0.004
3.	If we were playing a team sport such as soccer, it would be OK having Richard on my team.	2.88 $\pm$ 1.30	3.05 $\pm$ 1.31	20447	0.221
4.	P.E. would be fun if Richard was in my P. E. class.	3.66 $\pm$ 1.16	3.82 $\pm$ 1.07	20277	0.165
5.	If Richard were in my P.E. class, I would talk to him and be his friend.	3.89 $\pm$ 1.06	4.29 $\pm$ 0.91	16957**	0.000
6.	If Richard were in my P.E. class, I would like to help him practice and play the games.	3.74 $\pm$ 1.19	4.22 $\pm$ 0.97	16829*	0.000
The general attitude towards I.P.E.		3.44 $\pm$ 0.74	3.74 $\pm$ 0.73	16786**	0.000

by stating that if he were in their PE class, they would talk to him and be his friends. On the other hand, the least positive attitude was prevalent in both groups in the third statement whereby they declared that they would not want a VI pupil in their team very much. The overall general attitude towards IPE was significantly more positive in girls compared to boys which were supported by four of the six statements (statement no. 1, 2, 5, 6) falling under general attitudes towards IPE (Table 2).

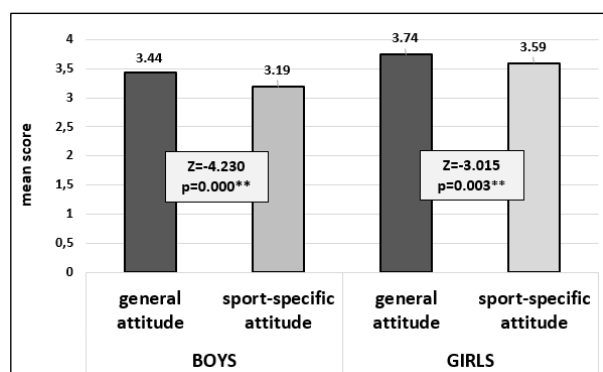
Analysis of the sport-specific attitudes of the children revealed lower rates of positive attitudes towards the inclusion of pupils with VI in PE class in the boys' group compared to the girls' group, across all statements (Table 3). Both

groups of able-bodied children were least likely to agree that when they practice soccer skills, they cover their eyes with a shade to put themselves in the position of a VI pupil. On the other hand, both groups of children according to gender declare the most positive attitude in the twelfth statement, where they agree to the highest extent that if a VI pupil got the ball during the game, they would help him with verbal instructions to score a goal since he is a player of their team. The overall sport-specific attitude towards IPE was significantly more positive in girls compared to boys which were supported by five of the six statements (statement no. 7, 8, 9, 11, 12) falling under sport-specific attitudes towards IPE (Table 3).

Table 3. Gender differences in sport-specific attitudes towards IPE

No	Statement	Boys (n=204)	Girls (n=215)	Mann-Whitney U-test	
		Mean score $\pm$ SD		U	p
7.	When practicing soccer skills, I cover my eyes with a shade to put myself in Richard's position.	2.67 $\pm$ 1.47	3.09 $\pm$ 1.40	18201**	0.002
8.	In soccer, passes that are directed at Richard must not be blocked.	2.84 $\pm$ 1.46	3.40 $\pm$ 1.19	16982**	0.000
9.	In soccer, I would allow Richard to shoot into an empty goal.	3.15 $\pm$ 1.51	3.56 $\pm$ 1.27	18701**	0.008
10.	Richard could stay in the area in front of the goal longer than the rules allow.	3.48 $\pm$ 1.35	3.69 $\pm$ 1.13	20568	0.254
11.	In soccer, it would be good if nobody could steal the ball from Richard while passing.	2.81 $\pm$ 1.36	3.24 $\pm$ 1.21	17991**	0.001
12.	If Richard got the ball during the game, I would help him with verbal instructions to score a goal, since he is a player of my team.	4.21 $\pm$ 1.14	4.56 $\pm$ 0.81	18388**	0.001
Sport-specific attitude towards I.P.E.		3.19 $\pm$ 0.90	3.59 $\pm$ 0.67	16586**	0.000

Summarising the data, boys presented a rather neutral or indifferent general (mean scores 3.44 ± 0.74 points) and sport-specific (mean scores 3.19 ± 0.90 points) attitudes towards IPE. Girls showed slightly positive general (mean scores 3.74 ± 0.73 points) and sport-specific (mean scores 3.59 ± 0.67 points) attitudes towards IPE.

**Fig. 1.** Differences between general and sport-specific attitudes towards IPE

A comparison of general and sport-specific attitudes towards the inclusion of VI pupils in PE revealed significantly more positive general attitudes compared to sport-specific attitudes in both the boys' and girls' groups (Figure 1).

Discussion

The objective of the present study was to investigate the gender differences in the children's attitudes towards the inclusion of a pupil with visual impairment in physical education classes. In general attitudes towards the inclusion of VI in PE class, we found significantly more positive attitudes for girls compared to boys by saying that it would be OK to have a VI pupil in PE class, he would not slow down everyone's play, they would have fun with him and be his friend and help him practice and play games. Several research studies have found significantly more positive attitudes towards the inclusion of pupils with disabilities in groups of girls

compared to boys (Slininger, Sherrill, & Jankowski, 2000; Bossaert, Colpin, Pijl, & Petry, 2011; Hutzler, 2012), and this has been also confirmed by the present research. Girls have more favourable attitudes as well as are more responsible than boys toward peers with disabilities (Tripp, French & Sherrill, 1995; Kalyvas, Koutsouki, & Skordilis, 2011). On the other hand, the results of some studies show the same baseline attitude level towards IPE between both genders (Panagiotou, Evaggelinou, Doukeridou, Mouratidou & Koidou, 2008).

In the present study also in sport-specific attitudes towards the inclusion of VI in PE class, was revealed significantly more positive attitudes for girls compared to boys. Girls were significantly more likely to cover their eyes while learning motor skills, they were more likely to agree that passes to a VI pupil should not be blocked, that he could shoot into an empty net, and that no one could steal the ball while passing, and they would help him to score with verbal instructions. For boys, the adapted games as a part of IPE are not very challenging because these are too easy, not competitive, and different from that they used to play at general PE classes (Kalyvas & Reid, 2003). Different results were revealed in the research, which found that boys expressed higher mean scores in sport-specific attitudes towards IPE compared to girls, by integrating VI pupils (Cordente-Mesas, González-Vílora, Block, & Contreras-Jordán, 2016). Even though children with VI enjoy sports and physical activity as much as able-bodied children (Pashkevich & Kriventsova, 2017; Fyodorov, Erlikh, Khafizova, & Bendíková, 2019; Foley, Santarossa, Tindall, & Lieberman, 2020), boys of the present study express rather neutral or indifferent attitudes towards the inclusion of VI pupils in PE classes. Kurková and Nemček (2016, 2018) and other authors found, that pupils with VI have a higher percentage of positive attitudes than students who are deaf or hard of hearing in indicators: popularity, importance, students' efforts, and their feelings towards PE classes (Změlíková & Kurková, 2021).

The results of the present study further revealed significantly more positive general attitudes towards IPE compared to sport-specific attitudes. Researchers Mesas, Vílora, and Jordán (2017) have sought to improve the attitudes of able-bodied pupils towards people with VI through a formative

PE program. They conducted an experiment where able-bodied pupils (n=910) simulated VI during eight lessons of PE in the context of play and sports. The results of their study indicated a significant improvement in children's attitudes toward persons with VI. The authors of the research recommend the application of a formative PE program in schools to promote better attitudes towards the inclusion of students and pupils with VI (Mesas, Villora, & Jordán, 2017).

This study has potential limitation. The research would have a significant scientific interest if it were supplemented with the results of children's reactions to the direct inclusion of visually impaired pupils in the process of physical education, not only considering their possible reactions.

Conclusions

The present study's results confirmed that able-bodied girls expressed more positive general attitudes and sport-specific attitudes towards the inclusion of VI pupils in PE than able-bodied boys. Boys' attitudes towards inclusion were only neutral or indifferent and girls' attitudes were only moderately positive. Both girls and boys declared more positive general attitudes towards the inclusion of VI pupils in PE classes compared to sport-specific attitudes. Taking into consideration, the most appropriate solutions to include pupils with different kinds of disabilities in the PE classes, it is necessary to learn more about the attitudes towards inclusion from pupils, teachers, and school management.

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Conflict of interest

The author declares that there is no conflict of interest.

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СТАВЛЕННЯ ДІТЕЙ ДО ІНКЛЮЗІЇ УЧНІВ ІЗ ПОРУШЕННЯМИ ЗОРУ ДО ЗАНЯТЬ ІЗ ФІЗИЧНОГО ВИХОВАННЯ: ГЕНДЕРНІ ВІДМІННОСТІ

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Авторський вклад: А – дизайн дослідження; В – збір даних; С – статаналіз; D – підготовка рукопису; E – збір коштів

Реферат. Стаття: 9 с., 3 табл., 1 рис., 40 джерел.

Мета дослідження. Метою цього дослідження було вивчення гендерних відмінностей у ставленнях дітей до інклюзії учня з порушенням зору до занять із фізичного виховання.

Матеріали та методи. Досліджувана вибірка включала 419 фізично здорових учнів 6–9 класів загальної початкової школи (хлопчики, $n = 204$, середній вік $13,23 \pm 1,17$ року; дівчинки, $n = 215$, середній вік $13,08 \pm 1,19$ року). Як метод дослідження використовували модифікований варіант стандартизованої ставленнєвої анкети «Ставлення дітей до інклюзивного фізичного виховання» (нова редакція) щодо інклюзії учнів із порушеннями зору. Внутрішню надійність анкети «Ставлення дітей до інклюзивного фізичного виховання» (нова редакція) вимірювали з використанням коефіцієнта альфи Кронбаха. Для оцінки нормальності розподілу вибірки використовували критерій Шапіро-Вілка. Для оцінки відмінностей між хлопчиками та дівчинками використовували непараметричний U-критерій Манна-Вітні, а відмінності між загальними та зумовленими спортивною специфікою ставленнями оцінювали з використанням критерію знакових рангів Вілкоксона.

Результати. Хлопчики показали досить нейтральні або байдужі (середні оцінки 3,19; 3,44 очка) ставлення, а дівчинки мали дещо позитивні (середні оцінки 3,59; 3,74 очка) ставлення до інклюзивного фізичного виховання. Дівчинки, порівняно з хлопчиками, виявили позитивніші загальні ($U = 16786$, $p = 0,000$), а також зумовлені спортивною специфікою ($U = 16586$, $p = 0,003$) ставлення до інклюзії учня з порушенням зору до занять із фізичного виховання. Обидві групи дітей висловили позитивніші загальні ставлення, ніж зумовлені спортивною специфікою ставлення до інклюзії учнів із порушеннями зору (хлопчики, $Z = -4,230$, $p = 0,000$; дівчинки, $Z = -3,015$, $p = 0,003$).

Висновки. Дівчинки виявляли позитивніші загальні та зумовлені спортивною специфікою ставлення до інклюзії учнів із порушеннями зору до занять із фізичного виховання, ніж хлопчики. Ставлення хлопчиків були лише нейтральними або байдужими, а ставлення дівчинок були лише помірно позитивними. Обидва гендери висловлювали позитивніші загальні ставлення до інклюзії учнів із порушеннями зору до занять із фізичного виховання, порівняно із зумовленими спортивною специфікою ставленнями. Беручи до уваги вищевикладене, для знаходження найдоцільніших рішень щодо інклюзії учнів із різного роду інвалідністю до занять із фізичного виховання необхідно більше дізнатися про ставлення до інклюзії з боку учнів, учителів і шкільної адміністрації.

Ключові слова: дівчинки, хлопчики, інклюзивне фізичне виховання, порушення зору, загальні ставлення, зумовлені спортивною специфікою ставлення.

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ORIGINAL SCIENTIFIC ARTICLE

PATTERN RECOGNITION: AGE-SPECIFIC FEATURES OF FUNDAMENTAL MOVEMENT SKILLS FORMATION IN ELEMENTARY SCHOOL STUDENTS

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Abstract

The purpose of the study was to determine the age-specific features of fundamental movement skills formation in elementary school students.

Materials and methods. The study participants were boys aged 7 to 10 (24 boys aged 7; 28 boys aged 8; 35 boys aged 9; 36 boys aged 10). The children and their parents or legal guardians were fully informed about all the special aspects of the study and all the parents or legal guardians gave their consent thereto. The study protocol was approved by the Ethics Committee of the University.

The features of teaching 7–10-year-old boys to throw a ball at a vertical target were investigated. The proficiency level in throwing exercises in class was assessed using an alternative method ("performed", "failed"), the probability of the exercise performance was calculated ($p = n/m$, where n is the number of successful attempts, m is the total number of attempts). A method of algorithmic instructions was used in teaching boys aged 7 to 10. The study materials were processed by IBM SPSS 20 statistical analysis software. A discriminant analysis was conducted.

Results. It was established that the first canonical function explains 64.5% of the variation in results, while the second one does 34.4%, which indicates their high informativity ($r_1 = 0.762$; $r_2 = 0.652$). The materials of the canonical function analysis show the statistical significance of the first and second canonical functions ($\lambda_1 = 0.236$; $p_1 = 0.001$; $\lambda_2 = 0.5633$; $p_2 = 0.001$). The first and second functions have a high discriminative ability and value in interpretation with respect to the general population.

Conclusions. The discriminant analysis made it possible to determine the age-specific features of throwing skills formation in boys aged 7 to 10; answer the questions to which extent the differences in the effectiveness of skills formation in boys aged 7 to 10 are significant; which motor tasks are the most specific to boys aged 7, 8, 9, 10; which class an object belongs to based on the values of discriminant variables.

It was established that the level of proficiency in exercise 4 "Throwing a ball forward-upward standing with the left side to the throwing direction" has the greatest effect on the process of throwing movement skills formation in boys aged 7 to 10. For boys aged 8 to 10, such an exercise is "Throwing a ball forward-upward standing feet apart", and for boys aged 9 to 10, such an exercise is "Throwing a ball at a target 3 m away".

Keywords: fundamental movement skills, boys, discriminant analysis.

Introduction

The problem of studying the patterns and regularities of the formation of motor skills in schoolchildren is of relevance in view of the need to optimize their motor activity and improve their health (Barnett et al., 2013; Chan et al., 2016; Lubans et al., 2010).

A number of studies are devoted to the development of the definition of "Fundamental Movement Skills" and its introduction into the practice of physical education (Barnett et al., 2009, 2016; Cools et al., 2011). Barnett et al. (2016) defined the concept of FMS, discussed the context of what skills can be considered fundamental, how the development of these skills is related to the context of health development and pedagogical approaches in teaching FMS. According to the authors, FMS are defined as basic learned movement patterns that are artificially created and are the basis for more

complex physical and sports exercises. They can be divided into three individual categories: locomotion (moving the body, such as running), object control (manipulative skills, such as catching a ball), and stability skills, such as balancing. Motor coordination is a major component of FMS.

The studies by Mathisen (2016), Nurulfa et al. (2021), Fernández-Valero et al. (2021) show the importance of developing manual dexterity, body balance and ball exercise performance skills in children. The importance of FMS formation in children and adolescents is supported by the findings of the studies by Akbar et al. (2021), Basman (2019), Iermakov et al. (2021).

The features of manipulative skills formation in children and adolescents were studied by Sulistiyono et al. (2021), Samsudin et al. (2021), Dudley et al. (2011). Gaming activities were established to have a positive effect on the effectiveness of manipulative skills formation (Marchenko & Handymov, 2021; Marchenko & Satdyiev, 2021). Throwing a small ball at a vertical target was considered as one of the elements of fundamental movement skills (Iermakov et al., 2021; Ivashchenko et al., 2018, 2019). The results of the study of the effectiveness of the formation of motor skills with complex motor coordination indicate the need to take into account the exercise performance modes (Ivanov et al., 2021; Kalistratova & Khudolii, 2021; Bezzub et al., 2021) and the content component (Suprun et al., 2021; Shueva et al., 2021).

In order to obtain unbiased results about the patterns and regularities of the learning process, it is important to plan the experiment (Ivashchenko et al., 2018; Pambudi et al., 2021; Septaliza et al., 2022) and use multivariate statistics (Medko & Khudolii, 2021; Marchenko et al., 2021, 2022).

The effectiveness of factorial experiment plans (Ivashchenko et al., 2018; Marchenko & Taranenko, 2020) and discriminant analysis in studying the patterns and regularities of the learning process of children and adolescents was established (Medko & Khudolii, 2021; Marchenko et al., 2021, 2022). Therefore, the use of factorial experiment plans and discriminant analysis will make it possible to obtain new information about the age-specific features of fundamental movement skills formation in elementary school students.

The purpose of the study was to determine the age-specific features of fundamental movement skills formation in elementary school students.

Materials and Methods

Study Participants

The study participants were boys aged 7 to 10 (24 boys aged 7; 28 boys aged 8; 35 boys aged 9; 36 boys aged 10). The children and their parents or legal guardians were fully informed about all the special aspects of the study and all the parents or legal guardians gave their consent thereto. The study protocol was approved by the Ethics Committee of the University.

Study Organization

The study used analysis and generalization of data from scientific and methodological literature, general scientific methods of theoretical level, such as analogy, analysis, synthesis, abstraction, induction as well as general scien-

Table 1. The age-specific features of FMS formation in boys aged 7 to 10. Group Statistic

Ages 7 to 10		Mean	Std. Deviation	Valid N (listwise)	
				Unweighted	Weighted
7	1. Throwing a ball against the floor	0.8875	0.03378	24	24
	2. Throwing a ball forward-upward standing feet apart	0.7958	0.08065	24	24
	3. Throwing a ball forward-upward standing with the left foot forward	0.8333	0.07614	24	24
	4. Throwing a ball forward-upward standing with the left side to the throwing direction	0.8875	0.11910	24	24
	5. Throwing a ball at a target 3 m away	0.7188	0.08184	24	24
8	1. Throwing a ball against the floor	0.8893	0.03150	28	28
	2. Throwing a ball forward-upward standing feet apart	0.7518	0.08331	28	28
	3. Throwing a ball forward-upward standing with the left foot forward	0.8714	0.05345	28	28
	4. Throwing a ball forward-upward standing with the left side to the throwing direction	0.8714	0.04600	28	28
	5. Throwing a ball at a target 3 m away	0.7446	0.09939	28	28
9	1. Throwing a ball against the floor	0.8071	0.08238	35	35
	2. Throwing a ball forward-upward standing feet apart	0.6871	0.11071	35	35
	3. Throwing a ball forward-upward standing with the left foot forward	0.7229	0.11526	35	35
	4. Throwing a ball forward-upward standing with the left side to the throwing direction	0.6686	0.13289	35	35
	5. Throwing a ball at a target 3 m away	0.7514	0.12455	35	35
10	1. Throwing a ball against the floor	0.8806	0.04014	36	36
	2. Throwing a ball forward-upward standing feet apart	0.8583	0.05000	36	36
	3. Throwing a ball forward-upward standing with the left foot forward	0.6972	0.17194	36	36
	4. Throwing a ball forward-upward standing with the left side to the throwing direction	0.7375	0.11108	36	36
	5. Throwing a ball at a target 3 m away	0.7542	0.11236	36	36

Table 2. Tests of Equality of Group Mean. Boys aged 7 to 10

Content	Wilks' Lambda	F	df1	df2	Sig.
1. Throwing a ball against the floor	0.688	17.965	3	119	0.000
2. Throwing a ball forward-upward standing feet apart	0.607	25.711	3	119	0.000
3. Throwing a ball forward-upward standing with the left foot forward	0.722	15.258	3	119	0.000
4. Throwing a ball forward-upward standing with the left side to the throwing direction	0.584	28.308	3	119	0.000
5. Throwing a ball at a target 3 m away	0.985	0.598	3	119	0.618

tific methods of empirical level: observation, testing, and experiment.

When teaching throwing exercises in class, the proficiency level was assessed using an alternative method ("performed", "failed"), the probability of the exercise performance was calculated ($p = n/m$, where n is the number of successful attempts, m is the total number of attempts).

A method of algorithmic instructions was used in teaching boys aged 7 to 10. The participants proceeded to the next exercise after three successful attempts. Throwing a ball at a vertical target was mastered. The following exercises were mastered: 1. Throwing a ball against the floor; 2. Throwing a ball forward-upward standing feet apart; 3. Throwing a ball forward-upward standing with the left foot forward; 4. Throwing a ball forward-upward standing with the left side to the throwing direction; 5. Throwing a ball at a target 3 m away.

Statistical Analysis

The study materials were processed by IBM SPSS 20 statistical analysis software. A discriminant analysis was carried out to determine the age-specific features of fundamental movement skills formation in boys aged 7 to 10. The level of proficiency in the aforementioned exercises was analyzed.

Results

Tables 1, 2 provide the group statistics of the level of proficiency in motor tasks for boys aged 7 to 10 which show that statistically significant differences in the level of proficiency are observed in exercises 1 to 4. The differences in the level of proficiency in exercise 5 "Throwing a ball at a target 3 m away" are statistically non-significant.

Table 3. Eigenvalues. Boys aged 7 to 10

Function	Eigenvalue	% of Variance	Cumulative %	Canonical Correlation
1	1.381	64.5	64.5	0.762
2	0.738	34.4	98.9	0.652
3	0.023	1.1	100.0	0.150

Table 4. Wilks' Lambda. Boys aged 7 to 10

Test of Function(s)	Wilks' Lambda	Chi-square	df	Sig.
1 through 3	0.236	169.524	15	0.000
2 through 3	0.563	67.572	8	0.000
3	0.978	2.659	3	0.447

Based on the discriminant analysis results, it was established that the first canonical function explains 64.5% of the variation in results, while the second one does 34.4%, which indicates their high informativity ($r_1 = 0.762$; $r_2 = 0.652$) (see Table 3). The materials of the canonical function analysis show the statistical significance of the first and second canonical functions ($\lambda_1 = 0.236$; $p_1 = 0.001$; $\lambda_2 = 0.563$; $p_2 = 0.001$). The first and second functions have a high discriminative ability and value in interpretation with respect to the general population (see Table 4).

Table 5. Standardized Canonical Discriminant Function Coefficients. Boys aged 7 to 10

Content	Function		
	1	2	3
1. Throwing a ball against the floor	0.568	-0.012	0.603
2. Throwing a ball forward-upward standing feet apart	0.358	-0.829	-0.163
3. Throwing a ball forward-upward standing with the left foot forward	0.118	0.541	0.374
4. Throwing a ball forward-upward standing with the left side to the throwing direction	0.698	0.268	-0.537
5. Throwing a ball at a target 3 m away	-0.426	0.057	0.590

Table 6. Structure Matrix. Boys aged 7 to 10

Content	Function		
	1	2	3
4. Throwing a ball forward-upward standing with the left side to the throwing direction	0.664*	0.371	-0.313
2. Throwing a ball forward-upward standing feet apart	0.428	-0.732*	0.101
3. Throwing a ball forward-upward standing with the left foot forward	0.345	0.545*	0.266
1. Throwing a ball against the floor	0.555	-0.150	0.690*
5. Throwing a ball at a target 3 m away	-0.062	-0.057	0.565*

Table 7. Functions at Group Centroids. Boys aged 7 to 10

Ages 7 to 10	Function		
	1	2	3
7	1.223	0.311	-0.252
8	0.887	0.892	0.193
9	-1.734	0.379	-0.037
10	0.181	-1.270	0.054

Table 8. Classification Results. Boys aged 7 to 10

		Ages	Predicted Group Membership				
		7 to 10	7	8	9	10	Total
Original	Count	7	11	9	0	4	24
		8	6	21	0	1	28
		9	0	3	28	4	35
		10	3	0	1	32	36
	%	7	45.8	37.5	.0	16.7	100.0
		8	21.4	75.0	.0	3.6	100.0
		9	0.0	8.6	80.0	11.4	100.0
		10	8.3	0.0	2.8	88.9	100.0
Cross-validatedb	Count	7	11	9	0	4	24
		8	6	21	0	1	28
		9	0	3	27	5	35
		10	4	0	1	31	36
	%	7	45.8	37.5	.0	16.7	100.0
		8	21.4	75.0	.0	3.6	100.0
		9	0.0	8.6	77.1	14.3	100.0
		10	11.1	0.0	2.8	86.1	100.0

a. 74.8% of original grouped cases correctly classified. b. Cross validation is done only for those cases in the analysis. In cross validation, each case is classified by the functions derived from all cases other than that case. c. 73.2% of cross-validated grouped cases correctly classified.

The standardized coefficients of the canonical discriminant functions show that the largest contribution to the overall result is made by exercise 4 “Throwing a ball forward-upward standing with the left side to the throwing direction” (0.698) and exercise 1 “Throwing a ball against the floor” (0.568) (see Table 5).

The structure coefficients of the discriminant functions show that the functions are considerably related to the level of proficiency in exercise 4 “Throwing a ball forward-upward standing with the left side to the throwing direction” ($r=0.664$; the first function), exercise 2 “Throwing a ball forward-upward standing feet apart” ($r = -0.732$; the second function), exercise 5 “Throwing a ball at a target 3 m away” ($r = 0.565$; the third function). The analysis of the coefficients shows that the level of proficiency in exercise 4 “Throwing a ball forward-upward standing with the left side to the throwing direction” has the greatest effect on the process of throwing movement skills formation in boys aged 7 to 10. For boys aged 8 to 10, such an exercise is “Throwing a ball forward-upward standing feet apart”, and for boys aged 9 to 10, such an exercise is “Throwing a ball at a target 3 m away” (see Table 6).

Based on the results of classification of the age-specific features of throwing movement skills formation in boys aged 7 to 10, it was found that objects were correctly classified in 74.8% of cases (see Table 8). The group means (Functions at Group Centroids) for boys aged 7 to 10 show that the results of boys aged 7 are at the positive pole (1.223), while the results of boys aged 9 are at the negative pole (-1.734) (see Table 7). The graphic material provided in Figure 1 shows the density of the objects, a distinct boundary between the classes, and features in throwing movement skills formation in boys aged 7 to 10.

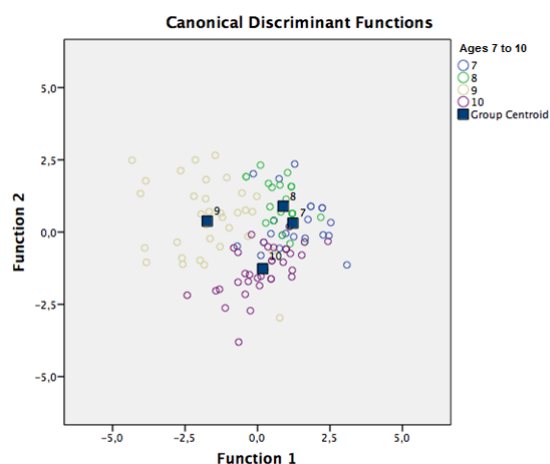


Fig. 1. Canonical discriminant functions. A graphical display of the results of classification of the age-specific features of throwing movement skills formation in boys aged 7 to 10: ■ — centroids for groups aged 7, 8, 9, and 10.

Discussion

The study assumed that discriminant analysis would make it possible to determine the age-specific features of throwing movement skills formation in boys aged 7 to 10. The results obtained allow to accept the assumption that it is possible to use the discriminant function to assess the age-specific features of throwing exercise skills formation in boys aged 7 to 10 and supplement the data on the use of the discriminant function in classifying students by their motor activity (Milić

et al., 2011; Gert-Jan de Bruijn, & Benjamin Gardner, 2011; Lulzim, 2013). Also, as in the studies by Medko and Khudolii (2021), Marchenko et al. (2021, 2022), we observed a high discriminative and prognostic ability of the obtained functions in the assessment of children's motor fitness.

The verification of the canonical functions shows their statistical significance, and the structure coefficients indicate the exercises that have an accentuated effect on throwing movement skills formation in boys aged 7 to 10. The discriminant analysis resulted in obtaining new data showing that the level of proficiency in exercise 4 "Throwing a ball forward-upward standing with the left side to the throwing direction" has the greatest effect on the process of throwing movement skills formation in boys aged 7 to 10. For boys aged 8 to 10, such an exercise is "Throwing a ball forward-upward standing feet apart", and for boys aged 9 to 10, such an exercise is "Throwing a ball at a target 3 m away". This confirms the conclusions of Barnett et al. (2009, 2016), Cools et al. (2011) on the importance of pointing out object control skills (throwing movement skills) as well as of pedagogical approaches in teaching FMS.

The data obtained supplement the results of the studies by Mathisen (2016), Nurulfa et al. (2021), Fernández-Valero et al. (2021) on the importance of ball exercise performance skills development in children, confirm the data of Akbar et al. (2021), Basman (2019), Iermakov et al. (2021) on the importance of FMS formation in children and adolescents as well as the data of Suprun et al. (2021), Shueva et al. (2021), Djordjevic et al. (2021) on the content component of learning.

The use of programmed learning in the process of throwing movement skills formation had a positive effect on both the effectiveness of mastering the movements by and increasing the motor activity of boys aged 7 to 10. The foregoing confirms the data on the need to combine the process of FMS formation with increasing the motor activity of children (Hulteen et al., 2018; Kalaja et al., 2010; Lai et al. 2014).

Conclusions

Discriminant analysis made it possible to determine the age-specific features of throwing movement skills formation in boys aged 7 to 10; answer the questions to which extent the differences in the effectiveness of skills formation in boys aged 7 to 10 are significant; which motor tasks are the most specific to boys aged 7, 8, 9, 10; which class an object belongs to based on the values of discriminant variables.

It was established that the level of proficiency in exercise 4 "Throwing a ball forward-upward standing with the left side to the throwing direction" has the greatest effect on the process of throwing movement skills formation in boys aged 7 to 10. For boys aged 8 to 10, such an exercise is "Throwing a ball forward-upward standing feet apart", and for boys aged 9 to 10, such an exercise is "Throwing a ball at a target 3 m away".

Conflict of interest

The authors declares that there is no conflict of interest.

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РОЗПІЗНАННЯ ОБРАЗІВ: ВІКОВІ ОСОБЛИВОСТІ ФОРМУВАННЯ ОСНОВНИХ РУХОВИХ НАВИЧОК У ШКОЛЯРІВ МОЛОДШИХ КЛАСІВ

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Авторський вклад: А – дизайн дослідження; В – збір даних; С – статаналіз; D – підготовка рукопису; Е – збір коштів

Реферат. Стаття: 7 с., 8 табл., 1 рис., 37 джерел.

Мета роботи – визначити вікові особливості формування основних рухових навичок у школярів молодших класів.

Матеріали і методи. У дослідженні прийняли участь хлопчики 7-10 років (7 років – 24 чол.; 8 років – 28 чол.; 9 років – 35 чол.; 10 років – 36 чол.). Діти та їхні батьки або законні опікуни були повністю інформовані про всі особливості дослідження, згоду було отримано від усіх батьків. Протокол дослідження був затверджений Етичним комітетом університету.

Досліджувалися особливості навчання метанню м'яча у вертикальну ціль хлопчиків 7-10 років. Рівень навченості кидкових вправ у занятті оцінювався альтернативним методом («виконав», «не виконав»), розраховувалася вірогідність виконання вправи ($p = n/m$, де n – кількість успішно виконаних спроб, m – загальна кількість спроб). У навчанні хлопчиків 7-10 років використовувався метод алгоритмічних розпоряджень. Матеріали дослідження опрацьовані в програмі статистичного аналізу – IBM SPSS 20. Був проведений дискримінантний аналіз.

Результати. Встановлено, що перша канонічна функція пояснює варіацію результатів на 64,5%, а друга – на 34,4%, що свідчить про їх високу інформативність ($r_1 = 0,762$; $r_2 = 0,652$). Матеріали аналізу канонічних функцій вказують на статистичну значущість першої і другої канонічної функції ($\lambda_1 = 0,236$; $p_1 = 0,001$; $\lambda_2 = 0,5633$; $p_2 = 0,001$). Перша і друга функція мають високу дискримінантну здатність і значення в інтерпретації відносно генеральної сукупності.

Висновки. Дискримінантний аналіз дозволив визначити вікові особливості формування кидкових навичок у хлопчиків 7-10 років; дати відповідь на питання наскільки достовірно різняться результативність формування навичок у хлопчиків 7-10 років; які рухові завдання є найбільш характерні для хлопчиків 7, 8, 9, 10 років; до якого класу належить об'єкт на основі значень дискримінантних змінних.

Встановлено, що рівень навченості вправі 4 «Кидки м'яча вперед-угору з вихідного положення стійка лівим боком у бік метання» має найбільший вплив на процес формування навичок кидкових рухів у хлопчиків 7-10 років. Для хлопчиків 8-10 років такою вправою є «Кидки м'яча вперед-угору з вихідного положення стійка ноги нарізно», а для хлопчиків 9-10 років – «Кидки м'яча у ціль з відстані 3 м».

Ключові слова: основні рухові навички, хлопчики, дискримінантний аналіз.

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REVIEW ARTICLE

THE PHILOSOPHY OF SPORT AND PHYSICAL EDUCATION: FOUR DECADE PUBLICATION TRENDS VIA SCIENTOMETRIC EVALUATION

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

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Abstract

The study purpose was to look into the production of scientific publications on the Philosophy of Sports and Physical Education.

Materials and methods. Scopus and Web of Science databases and various bibliometric indicators such as global publication trends, most active authors, number of citations, and author keywords were used to collect publications.

Results. A total of 1103 publications on the philosophy of sport and physical education were found from 1981 to 2021. This review used data in comma-separated values (CSV) format for Scopus, which was then exported to Microsoft Excel and text documents in WoS format, as well as ScientoPy software. The research findings provide information that, from 1981 to 2021, publications experienced a fluctuating trend in quantity. Starting in 2016, publications have reached double digits, with the number of publications reaching 71 documents. The United States is listed as the most productive country with a number of published documents as high as 226 academic scientific works. Ryall, E., University of Gloucestershire, United Kingdom, became the most prolific author with a total of 33 publications. The Department of Philosophy in the United States is at the forefront of publications with 39 documents.

Conclusions. A number of limitations in this study are unavoidable. First, the research method used by researchers is not completely perfect, including how to find documents, categorize documents, and document provider databases, which cannot be ignored. Researchers believe that this scientometric research provides important information about future research directions in the philosophy of sport and physical education.

Keywords: publication trends, sport, physical education, scientometric.

Introduction

Sport is like a drug and an opiate for humans to fulfill some desires in life, such as entertainment, economy, social, and health. Modern sports have become a powerful magnet in the joints of human existence, especially for some groups who believe sports to be a religion (Sofyan et al., 2021). Physical and mental health sustains human life and goes hand in hand with ethics with the aim of fulfilling human beings as best as they can (Bodin & Sempé, 2011). Placing human movement in the context of a complete and meaningful hu-

man life (Letson, 2018). Sport, for many fans, is also more than just playing a game (C. A. Williams, 2014). Fair play forms a subset of general moral or social values that are applied to, and taught through, sport and physical activity (Butcher & Schneider, 1998). Sports (especially team sports) are often presented as effective vehicles for integration in the South (Bain-Selbo, 2008). This shows that the position of sport has become an important element in human life as an essential need.

Today, sports and physical education have become part of the lifestyles of the world's people. Lifestyle Sport Activities (LSA) have a place in contemporary society as a modern part of sports culture (Gilchrist & Wheaton, 2017; Janeckova et al., 2021). Young people's commitment or interest in physical activity or sport is strongly shaped by their school expe-

rience in physical education (Griggs & Fleet, 2021). Sports and physical education are packaged in the educational curriculum and include compulsory subjects at every level of education, from elementary school to high school. This also proves that sports and physical education are on the same level as other subjects and should not be marginalized.

Due to the importance of sport and physical education, research has been carried out on most of the topics related to sport as a drama (Kreft, 2012), transgender athletes (Gleaves & Lehrbach, 2016), national identity formation (Morgan, 1997), competition (Katz et al., 2021; Nguyen, 2017), economics (Davies, 2010; Drewes et al., 2021), culture (Ekholm & Sol, 2020; J. Williams, 2011), education (Fasting et al., 2014; Hager, 2016), marketing (Mackreth & Bond, 2020; Tsiotsou, 2016), management (Chelladurai, 2018; Emery et al., 2012), tourism (Shipway, 2011; Weed, 2020), industry (Vamplew, 2016; Zhan, 2016), politics (Liston et al., 2013; Strittmatter et al., 2018), migration (Maguire, 2008; Orłowski et al., 2016), student-athlete (Monda et al., 2016; Weber et al., 2019), college (Loland & McNamee, 2016; Won et al., 2013), women (AlKhalifa & Farello, 2020; Scelles & Pfister, 2021), children (Hibshman et al., 2021; Karlsson et al., 2021), recreational education (Cottrell & Cottrell, 2020; Rodrigues & Payne, 2015), values (Grohs et al., 2019; Woratschek et al., 2014), drugs (Krieger et al., 2018; Moston et al., 2012), health (Schulenkorf & Siefken, 2018; Walsh et al., 2019). Focus on different aspects depending on the relationship and expertise of each researcher to obtain information that can improve civilization. Therefore, sports and physical education require collaboration from various parties.

The development of science and technology in recent years has brought tremendous changes in society (Sajana & Krishnamurthy, 2017). Science can be defined as a social activity oriented towards characterizing a field of knowledge through observation and measurement (Moral-Muoz et al., 2020). Scientific publications are a kind of written material that contains information about scientific activities, both in physical and electronic form, which is equivalent in a computerized database (Davarpanah & Aslekia, 2008).

Public interest in scientometrics has decreased significantly in recent years (Garfield, 2009). Therefore, it is important to conduct many studies related to scientometrics in order to provide researchers with information regarding the publication trend of certain topics in research. This research aims to analyze scientometrics, which is a technique of measuring, evaluating, and analyzing science, technology, and innovation. The combination of scientometrics and social network analysis has made a strong case in favor of research collaboration (Ceballos et al., 2017).

Scientometrics is the development of quantitative research methods for the study of the development of science as an information process (Mingers & Leydesdorff, 2015; Nallimov & Mulcjenko, 1971). Scientometrics is the quantitative study of science, communication in science, and science policy (Hess, 1997; Mohan & Kumbar, 2021). A database system that stores and retrieves structured data (Sofik & Rahman, 2021). Scientometrics has progressed very far from the sociology of science and is closer to library and information science (Leydesdorff & Milojevi, 2015a). Scientometric analysis is needed to gain a deeper understanding (Lai et al., 2017). The new methods (e.g., visualization techniques) developed by these researchers are partly derived from and

have also been adopted by scientometricians (Leydesdorff & Milojevi, 2015b). Scientometrics often uses statistical and mathematical methods to analyze scientific literature quantitatively and qualitatively (Nath & Jana, 2021).

Scientometrics is a powerful tool for investigating trends and the gradual evolution of scientific results (Nyika et al., 2021). Sophisticated analysis in any scientific field is a tedious job that a researcher needs to do at the beginning of developing any topic (Orlova & Titova, 2021). Social network analysis provides the basis for the graphical representation and quantitative analysis of the interactions of complex social systems (Virués-Ortega et al., 2011). Scientometrics describes a comprehensive picture of research activity in the field and is able to present existing trends supported by quantitative data (Ramy et al., 2017). Tang et al. (2020) provide an objective perspective on the transmission and evolution of scientific knowledge at various levels.

Scientometrics analyzes the quantitative aspects of the production, dissemination, and use of scientific information with the aim of achieving a better understanding of the mechanisms of scientific research as a social activity (Chellappandi & Vijayakumar, 2018; Gonzales et al., 2021). Scientometric and bibliometric analysis have many applications in the field of library and information science to observe research trends in terms of subjects, core journals, author productivity and authorship patterns, etc., to create new subscription policies for the future (Velmurugan & Radhakrishnan, 2015). Scientometric data helps in evaluating the scope and progress of scientific research and is also a guide in assessing the standards and excellence of scientific research productivity (Wani & Zainab, 2017). Scientometrics is the systematic study of scientific publications, including their impact and content (Young et al., 2015). Scientometrics is the quantitative analysis of scientific activities' inputs, outputs, and processes using mathematical statistics, computational technology, and other mathematical methods (Zhou et al., 2019).

Although sport and physical education are very important, there are no scientometric analytical studies to analyze the dynamics of research and trends in the publication of the philosophy of sport and physical education globally. Therefore, for this study, the research question considered is what are the main journals, countries, institutions, authors, and authors' keywords on the philosophy of sport and physical education in the research articles published between 1981 and 2021 on the Scopus database and the Web of Science (WoS)?

We consider that this article contributes to expanding knowledge of the latest publication trends in sports philosophy research and physical education, which can be used by readers, researchers, and scholars to enable increased research studies related to the philosophy of sport and physical education. For researchers, this document provides an overview of the research to be carried out related to the philosophy of sport and physical education. This study includes: (1) identifying popular journals, representative countries, and key institutions in the field of research on the philosophy of sport and physical education; (2) analyzing the author's keyword base and influential topics related to the philosophy of sport and physical education; and (3) uncovering how the primary author keyword has evolved over the last few decades in various fields.

Table 1. Documents discovered

Sources	Conference Proceeding	Article	Review	Proceeding Paper	Total
WoS	0 (0.0%)	615 (74.5%)	4 (0.5%)	27 (3.3%)	646 (78.3%)
Scopus	7 (0.8%)	154 (18.7%)	18 (2.2%)	0 (0.0%)	179 (21.7%)

Table 2. Final document

Sources	Conference Proceeding	Article	Review	Proceeding Paper	Total
WoS	0 (0.0%)	613 (85.1%)	4 (0.6%)	27 (3.8%)	644 (89.4%)
Scopus	4 (0.6%)	64 (8.9%)	8 (1.1%)	0 (0.0%)	76 (10.6%)

Materials and methods

The number of publications in any field of study aided in persuading scholars to collect relevant data (Abd Aziz et al., 2021). In bibliometric analysis, the total amount of metadata that must be met in order to be studied varies substantially. The number of metadata numbers that can be used for bibliometric analysis, as well as the minimum and maximum metadata standards that can be evaluated, are not stated (Sofyan, 2022). From a scientometric standpoint, this study employs information framework mapping methods to examine the research situation and organize the current theoretical structure (Abdullah, 2021) in order to properly understand the patterns of philosophy of sport and physical education. It is critical to define the research objectives early on in this review (Abdullah & Abd Aziz, 2021). A scientometric analysis database of research and publications was constructed using the bibliographic repository Scopus and the Web of Science (WoS) (Faisal et al., 2020; Gandia et al., 2019). Scientometric indicators including publication and distribution trends, topics, journals, and articles cited were analyzed (Li et al., 2016). This study used the scientometric methodology (Martynov et al., 2020) and the visualization tool ScientoPy to analyze extensive bibliographic metadata related to research on sports philosophy and physical education. ScientoPy can process datasets from two main bibliographic databases: the Clarivate Web of Science (WoS) and Scopus (Ruiz-Rosero et al., 2019).

ScientoPy is a Python script that automatically generates and reports on the main topic (based on the author's keyword), author and publication country and institution, along with related documents. This automated data synthesis avoids the potential for bias as in individual studies. It has been proven that the results obtained in processing different data have helped researchers a lot (Cruz-Ordóñez et al., 2018; Ruiz-Rosero et al., 2017). The tool used to analyze the bibliography of the document is a different literature review script called ScientoPy (Pabon et al., 2020). However, analysis of author names (such as a primary list of authors) carries a risk of bias in the study due to possible name similarity. The authors of this review acknowledge and warn of possible similarities between the names of the authors of the document, which is part of the limitations of bibliometric studies. Therefore, not all authors and databases currently have a unique author identifier, such as the ORCID, associated with all entries.

Data Pre-processing

Dataset determination of the dataset. The dataset is displayed with the tools that perform the data processing. It is important to define this data as the first step of this process, because it is the source of information processing. For this reason, it was decided to search for scientific publications both in the Scopus database (Burnham, 2006) and in the WoS database (Web of Science) (Cruz-Ordóñez et al., 2018). Next, the search criteria used for the database are displayed: TITLE-ABS-KEY ("philosophy of sport" OR "philosophy of physical education").

The keyword terminology is familiar and not new, especially for researchers in the fields of sports and physical education. It is possible to find large amounts of published data, such as in other, more well-known topics and fields. The conjunction "OR" has also been used to search for publications whose authors did not use the acronyms "philosophy of sport" or "philosophy of physical education" in terms that matched the terminology. This data was taken on January 8, 2022, and Table 1 shows the total number of documents found in both databases according to the type of document.

Duplication and simplification

It is possible that out of the total documents shown in the previous dataset assignment section, there are duplicates in the database, which means the same documents in both databases. For this, the ScientoPy tool uses a data pre-processing technique that removes all duplicate articles. Table 2 shows that, in total, 704 duplicate samples were found. Another function of this first technique is the simplification of the author's name. A common problem that has been noticed in publications is the inconsistency of the author's name and surname. Through pre-processing, ScientoPy is able to simplify the special characters in names, accents, and abbreviations used. Abbreviations or simplifications of names can also be seen in other topics such as countries, keywords, or institutions, so it is advisable to define each country through one terminus for further processing.

Table 3 shows a brief pre-processing table created by ScientoPy. This table describes the input data set, including in the second column (Number) the number of publications after and before the duplicate removal filter per database, and the third column (percentage) relative percentages (see table description for detailed information on these percentages).

Table 3. Pre-processing of data

Data Retrieval	Document	Percentage
Loaded papers	1103	
Omitted papers by document type	278	2,52%
Total papers after omitted papers removed	825	
Loaded papers from WoS	646	7,83%
Loaded papers from Scopus	179	2,17%
Duplicated removal results:		
Duplicated papers found	105	1,27%
Removed duplicated papers from WoS	2	0,03%
Removed duplicated papers from Scopus	103	5,75%
Duplicated documents with different cited by	50	4,76%
Total papers after rem. dupl.	720	
Papers from WoS	644	8,94%
Papers from Scopus	76	1,06%

Loaded documents represent the total number of documents loaded from both databases. Papers omitted by document type is the number of documents outside the default document type filter (including conference papers, articles, reviews, proceedings papers, and printed articles only). The paper after the omitted document is removed is the number of documents in the default document type filter. Papers loaded from WoS/Scopus are the number of documents from each database after the omitted documents have been deleted. Duplicate documents found are the number of duplicate documents that have been found and deleted. Duplicate documents removed from WoS/Scopus are the number of documents deleted from each database after deletion of

duplications. The total number of documents after double deletion is the number of documents after the deletion of duplicates by pre-processing. Finally, the documents from WoS and Scopus are the total number of documents from WoS and Scopus, respectively, after the deletion of duplication. The delete-duplication filter used by ScientoPy is based on a DOI match or if the DOI is not in the document title and the document's first author's last name matches.

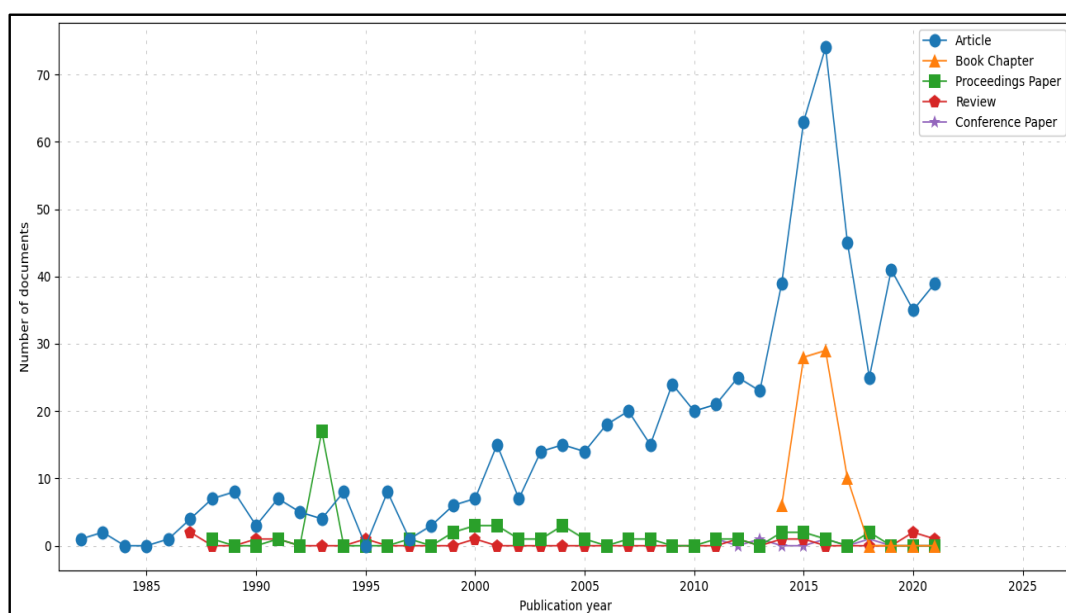
Results

In this section, the researcher conducts and presents an analysis of the process that allows one to understand the current research situation in the field of sports philosophy and physical education and the expected publication trends for future research.

Tracking document types

Figure 1 describes the types of documents that are traced through ScientoPy. This kind of document represents research work with higher SJR (Scimago Journal Rank) and JCR (Journal Citation Reports) indicators. Documents such as book chapters, brief surveys, letters, notes, books, editorials, erratums, reports, retracted documents, meeting abstracts, corrections, software reviews, and hardware reviews are excluded. However, by modifying the ScientoPy global settings file, we can adjust the filter for this document type.

Articles are the most tracked types of documents, with the number of publications as many as 667 manuscripts, with an AGR of 1.0. This indicates that the number of documents published on a topic experiences a negative trend or decreased growth. This means that the type of article document experiences a difference in the average number of documents issued per year compared with the previous year. Book chapters are the second largest type of document, with a total of 73 manuscripts. followed by the third, fourth, and fifth types of documents, namely 45 proceedings papers, 12 article reviews, and four conference papers.

**Fig. 1.** Types of tracked documents

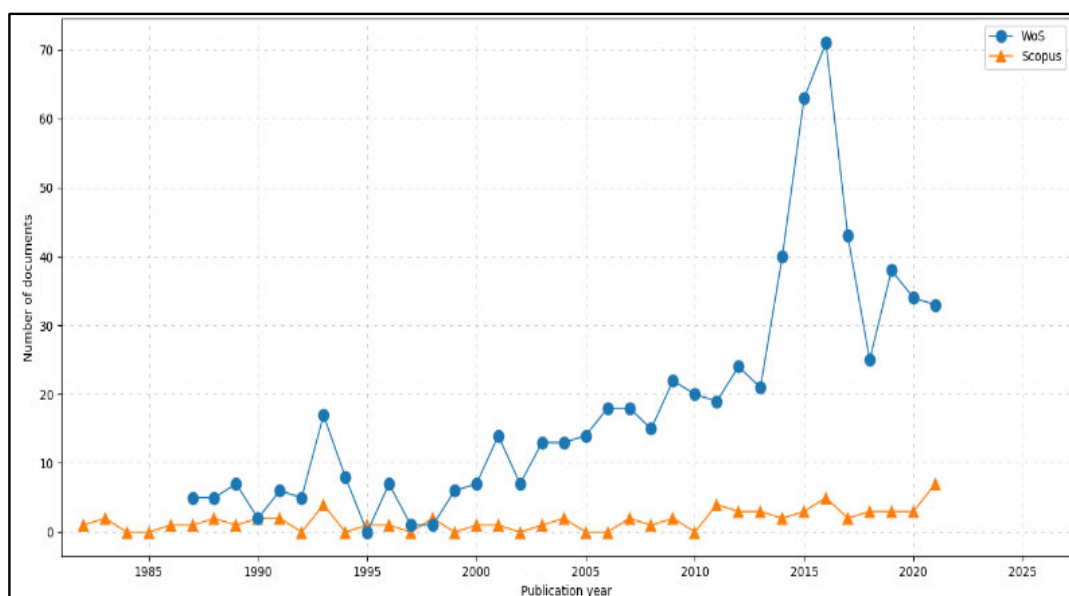


Fig. 2. The growth of publications on the philosophy of sport and physical education

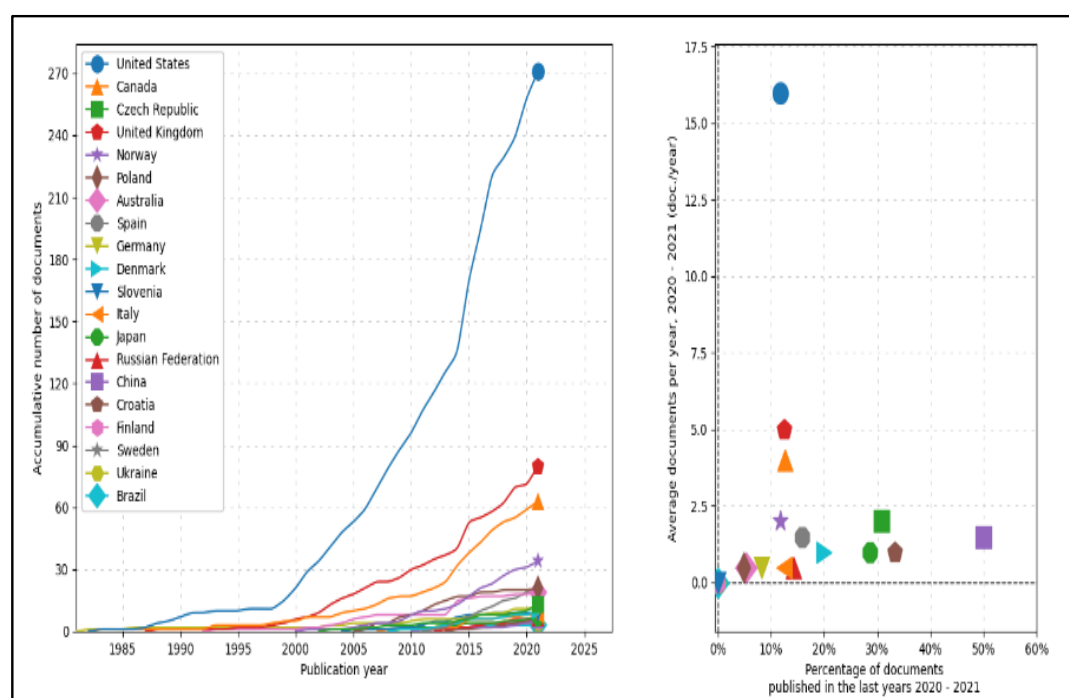


Fig. 3. The 20 most influential countries in the field of sports philosophy and physical education and the largest number of documents

The growth of publications on the philosophy of sport and physical education

Figure 2 depicts the expansion of both databases and demonstrates the strength of research in the fields of sports philosophy and physical education.

This encourages researchers to continue to invest in ways of thinking and perspectives related to the study of the philosophy of sport and physical education, so that an open discussion space is possible for thinkers, researchers, and practitioners of sports and physical education. It

can be clearly noted that the publication contribution to the WoS database experienced a positive publication trend when compared to the Scopus database. This means that the trend of publications in WoS tends to increase even though it fluctuates, but it is not significant. The peak of publication occurred in 2016, when 71 documents were published. Meanwhile, the trend of publications in Scopus tends to be flat, and there has never been a number of publications exceeding ten documents per year. However, Scopus is a database that publishes academic work related to the philosophy of sport and physical education.

The most productive countries in article publication

A list of countries with the most related publications has been created. Figure 3 shows the top ten countries, along with the number of documents issued per year. Country analysis makes it possible to determine which country has the most influence on the philosophical themes of sports and physical education. The figure shows that among the countries with the most publications on sports philosophy and physical education, the United States has 266 publications with an average growth rate (AGR) of 1.5% per year. This shows how the number of documents published on a topic has grown (positive number), meaning that the United States of America experienced a difference in the average number of documents issued per year compared with the previous year. Second, England, with 79 publications, and Canada, with 62 publications. Only these three countries have published academic scholarly works of more than 50 documents each. However, the Czech Republic has shown a favorable and influential trend in recent years.

The most active institution and with the most publications

Each author appearing in a publication is associated with an institution. Scientopy also makes use of this information in the process. Being able to identify which institution is most representative in the thematic area is an aid for researchers in selecting a research station or joining some of their academic programs or research projects. This analysis gives prestige to the institution and encourages others to continue to publish it to achieve an outstanding position. Figure 4, 5 shows the main institutions that have published on the theme of sports philosophy and physical education. The Department of Philosophy in the United States of America became the leader in terms of publication with 39

documents with an average growth rate (AGR) of 0.0 per year. This shows how the number of documents published on a topic did not have significant growth, meaning the Department of Philosophy Philosophy does not experience a difference in the average number of documents issued per year compared to the previous year. The average document per year (ADY) also did not experience a positive or negative trend, meaning that the average number of documents published within the time frame for a particular topic did not change significantly. The percentage of documents in recent years (PDLY) also did not experience a positive or negative trend.

The second position is held by Pennsylvania State University, from the United States, with a total of 25 documents with an AGR of 1.5. This shows how the number of documents published on a topic experienced a negative trend or decreased growth. This means that Pennsylvania State University experienced a difference in the average number of documents published per year compared with the previous year. ADY of 1.0 experienced a positive trend, meaning that the average number of documents published within the time frame for a particular topic increased. Meanwhile, PDLY experienced a positive trend and a surge, with a value of 8.0.

The third position, Norwegian School of Sport Sciences, from Norway, with a total of 14 documents with an AGR of -0.5. This shows how the number of documents published on a topic experiences a negative trend or decreases growth. This means that the Norwegian School of Sport Sciences experienced a difference in the average number of documents published per year compared with the previous year. An ADY of 1.5 experienced a positive trend, meaning that the average number of documents published within the time frame for a particular topic increased. Meanwhile, PDLY experienced a positive trend and a significant spike, with a value of 21.4.

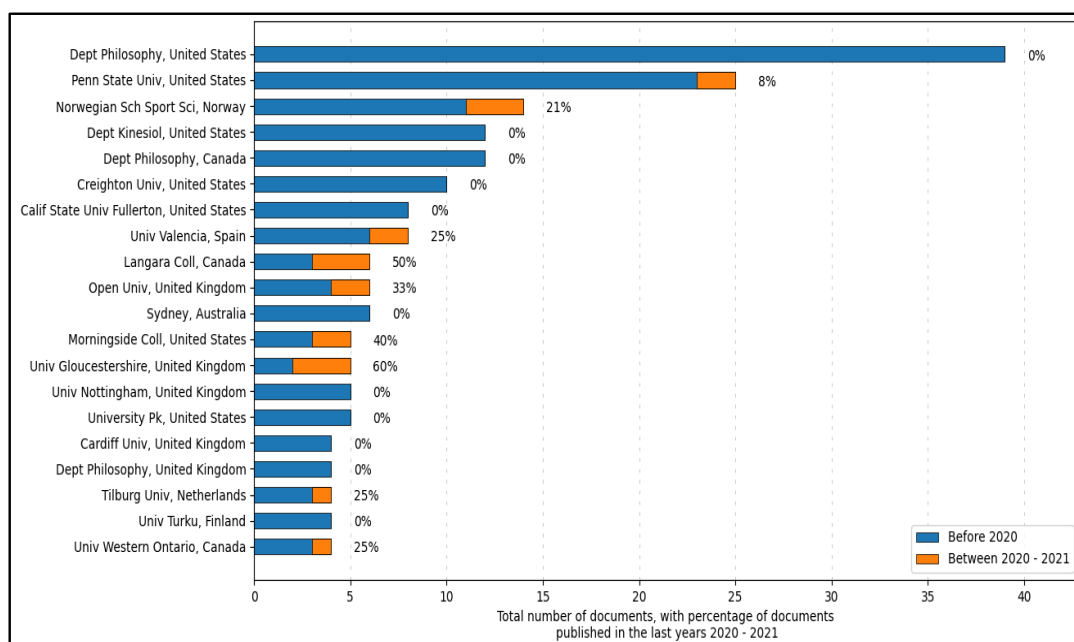


Fig. 4. The most influential institutions in the publication of the philosophy of sport and physical education

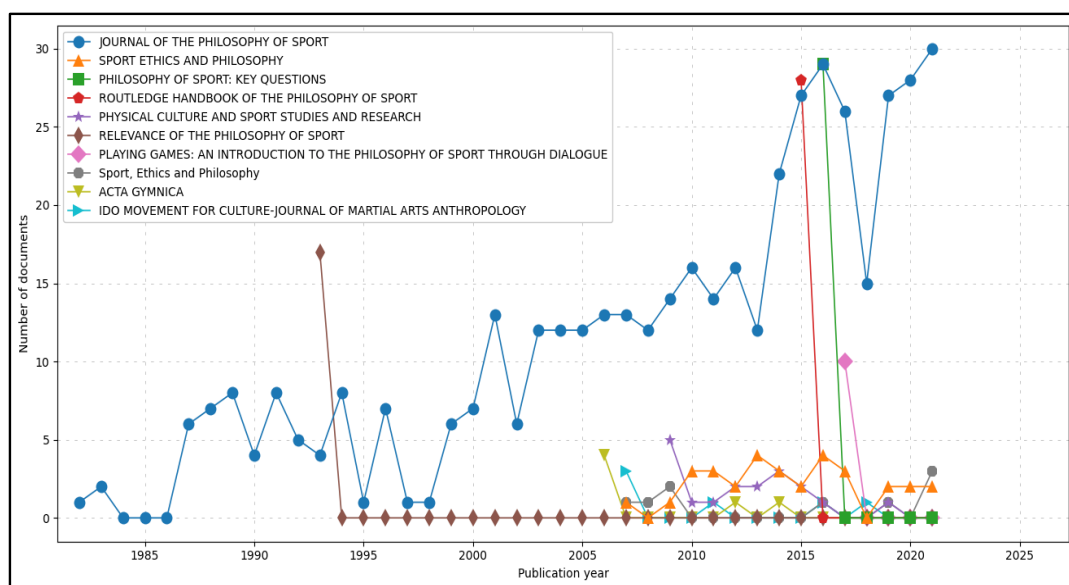


Fig. 5. Reputable scientific sources

Authentic scientific sources

Reputable scientific sources are certainly the goal of researchers to include their scientific works or research that has been carried out so that their work gets high appreciation and has a high impact on the development of science, especially in the philosophy of sports and physical education. Reputable scientific sources also have a high impact.

The Journal of the Philosophy of Sport from the Taylor and Francis Group is the scientific source with the highest number of publications, namely 445 documents. In this scientific source, Simon, R.L., from the United States, is the author with the highest number of citations, namely 107 citations in 2000 with the article title "Internalism and internal values in sport". Sport Ethics and Philosophy from the Taylor and Francis Group is in second place with 32 publications. In this scientific source, Kretchmar, S., from the United States, is the author with the highest number of citations, namely 17 citations in 2007 for the article "Dualisms, dichotomies, and dead ends: limitations of analytic thinking about sport". While in third place is "Philosophy of Sport: Key Questions from Bloomsbury, London," with a total of 29 publications.

The most prolific author on the topic of sports philosophy and physical education

ScientoPy can also help researchers find the most representative authors on their topics and cite them in their contributions or have references for related works. Table 4 shows the top ten most prominent authors for their contributions to the philosophy of sport and physical education. The table also determines the growth rate (AGR) and h-index of each individual. The opportunity to cite important authors in our investigation facilitates this dissemination, as well as scientific recognition. Among the main authors is Ryall, E., of the University of Gloucestershire, UK, with a total of 33 documents published.

Discussion

As described above, ScientoPy has the ability to provide information in terms of the total number or percentage of documents, as well as some topics or search arguments from publications, such as keywords that appear in each publication. Please note that, as a researcher, keywords and citations generate links to other related publications. Figure 6 shows another way to graphically represent using a ScientoPy tool called WordCloud. This graph is made possible thanks to Python, which has a library that allows you to randomly draw word clouds, giving them the most significant size. In this section, the main keywords defined in the philosophy of sport and physical education will be analyzed. For this reason, it is advisable to group similar terms into groups, such as "sports" and "sport", or singular and plural words such as "games" and "game". This type of manual exercise helps organize information better and avoid duplication in terms of usage.

Based on the picture, the three most used keywords are "sport philosophy", with 66 keywords, "sport" with 64 keywords, and "game" with 29 keywords. We present 18 important keywords that serve as an aid in knowing which to choose for the document in our investigation. ScientoPy makes it possible to visualize any desired number of keywords.

Using VOSviewer, this study investigated the emergence of the author's keywords and produced a graphical visualization (see Figure 7). The way keywords are related or appear together in a data set is referred to as co-occurrence. This analysis is critical for researchers to comprehend the genesis of keywords and interpret the results in the context of a specific research question. In general, network visualization, overlay visualization, and density visualization can be used to depict term co-occurrence. 1087 keywords have been detected. The minimum number of occurrences of the keyword is at least four times. Found 28 keywords meeting the threshold.



Fig. 6. Keywords that appear frequently

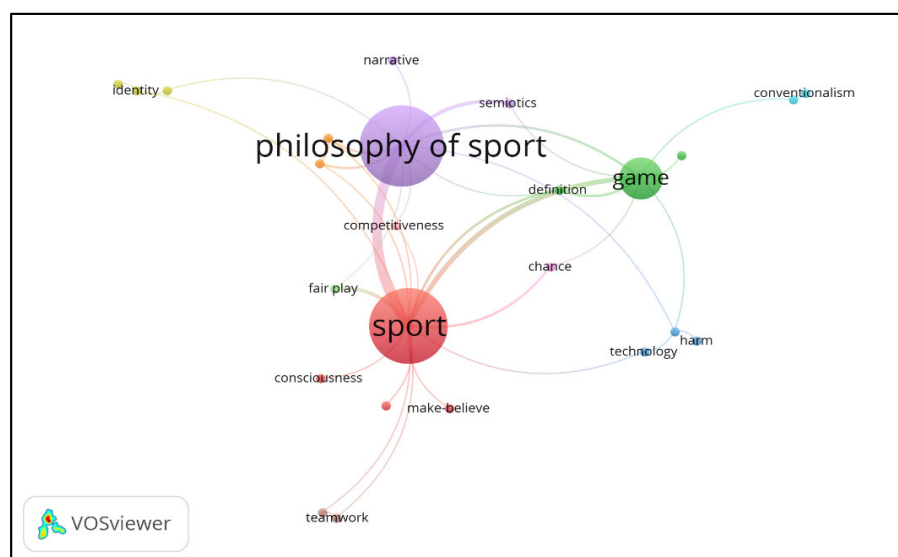


Fig. 7. Overlay visualisation of Authors' Keywords

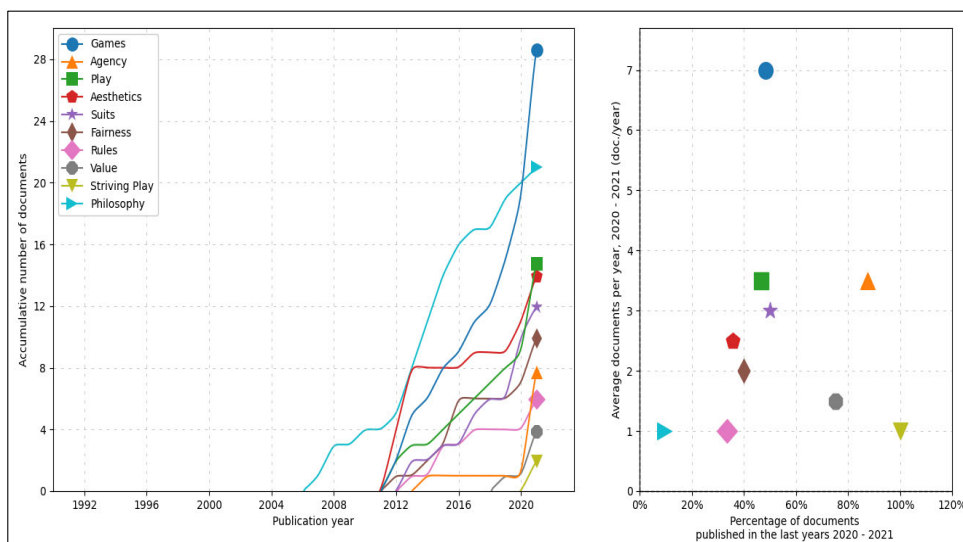


Fig. 8. Top 10 trending topics based on the author's keyword

By analyzing the top author's keywords with the highest AGR, this software can find trending subjects (Sofyan & Abdullah, 2022). Figure 8 depicts a plot of the evolution of the most popular trending topics in philosophy of sport and physical education. This evolution plot plots the cumulative number of documents (on a logarithmic scale) versus the year of publication on the left side. Figure 8. Top 10 trending topics based on the author's keyword.

Thus, the first row on the X-axis represents the year the topic research began, and the last line on the Y-axis represents the total number of documents published for each topic. The Y-axis on the right represents each topic's AGR for the 2020–2021 period, and the X-axis represents the PDLY. We can use this graph to determine which topics have a higher AGR and a higher PDLY. As a result, the trending topic with the greatest absolute growth is “games,” while the trending topic with the greatest relative growth is “striving play”.

Conclusions

The philosophy of sport and physical education is a growing theme that has generated research impact in recent years, especially on the topics of philosophy of sport and sport and play. Thanks to the ScientoPy tool, the goal has been achieved through scientometric analysis based on WoS and Scopus databases.

The country with the most research contributions to the philosophy of sport and physical education was the United States. The keyword most used by the authors was “philosophy of sport,” and the author with the most contributions was Ryall, E., University of Gloucestershire, UK. The philosophy of sport and physical education represents an important trend in all areas, and it is hoped that the research curve will continue to grow. Bibliometric analysis contributes to the art of new works, in addition to acknowledging the different contributions made by authors, institutions, and countries.

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Conflict of interest

The Author declared that there is no conflict of interest in writing this article.

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ФІЛОСОФІЯ СПОРТУ ТА ФІЗИЧНОГО ВИХОВАННЯ: ОЦІНКА ТЕНДЕНЦІЙ У ПУБЛІКАЦІЯХ ЗА ЧОТИРИ ДЕСЯТИЛІТТЯ МЕТОДАМИ НАУКОМЕТРИЧНОГО АНАЛІЗУ

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Авторський вклад: А – дизайн дослідження; В – збір даних; С – статаналіз; D – підготовка рукопису; Е – збір коштів

Реферат. Стаття: 13 с., 4 табл., 8 рис., 87 джерел.

Метою цього дослідження було вивчення випуску наукових публікацій на тему філософії спорту та фізичного виховання.

Матеріали та методи. Для збору публікацій використовували бази даних Scopus та Web of Science (WoS), а також різні бібліометричні показники, як-от: глобальні тенденції в публікаціях, найактивніші автори, частота цитування та авторські ключові слова.

Результати. За період із 1981 до 2021 рр. було знайдено загалом 1103 публікації на тему філософії спорту та фізичної культури. У цьому огляді використовували дані у форматі значень, розділених комами (CSV), що застосовується для

бази даних Scopus, які потім експортували до таблиць Microsoft Excel та текстових документів у форматі бази даних WoS, а також ПЗ для наукометричного аналізу ScientoPy. Результати дослідження показують, що в період із 1981 до 2021 рр. публікації зазнавали мінливої тенденції щодо їхньої кількості. Починаючи з 2016 року, обсяги випуску публікацій сягнули двозначних чисел, коли кількість публікацій становила 71 документ. У списку найпродуктивніших у цьому сенсі країн перше місце посідають США, де кількість опублікованих документів становить 226 науково-дослідних праць. Найпліднішим автором, у якого загалом 33 публікації, став Ryall, E., Університет Глостершира, Сполучене Королівство. Лідером за кількістю публікацій – 39 документів – є факультет філософії в США.

Висновки. У цьому дослідженні неминуче наявна низка обмежень. Насамперед, метод дослідження, який використовували автори дослідження, не зовсім досконалий, у тому числі способи пошуку документів, класифікації документів, а також бази даних постачальників документів, що не можна не брати до уваги. Автори дослідження гадають, що це наукометричне дослідження надає важливу інформацію щодо майбутніх напрямків науково-дослідної діяльності у сфері філософії спорту та фізичного виховання.

Ключові слова: тенденції в публікаціях, спорт, фізичне виховання, наукометричний.

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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 відхилили 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 редакторів 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 недобросовісності, 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.

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