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RESEARCH ARTICLE

THE EFFECT OF 6 WEEKS OF PHYSICAL FITNESS TRAINING ON BODY COMPOSITION, ENDURANCE, AND SPECIFIC PERFORMANCE OF 14-17 YEARS OLD TAEKWONDO ATHLETES

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ABSTRACT

Introduction: Taekwondo (TKD) is a popular sport and is generally considered beneficial for health. The present study aimed to compare six weeks of physical fitness training on body composition, endurance, and specific performance of Taekwondo boys aged 14-17. **Methods:** 30 young men (14-17 years old) taekwondo players participated in this study, this number of players was collected in four taekwondo clubs, in the form of available samples and randomly divided into two experimental groups (15 n) and Control (15 n) were divided. This study evaluates the body composition (body fat) from the in-body device, evaluates endurance from the push-up and sit-up tests, and also evaluates the level of specialized performance of taekwondo athletes with the Mitt-kicking and Bag-kicking tests. In this study, the experimental group performed physical fitness exercises for six weeks, three times a week, and for 1 hour. It should be noted that the control group only did their routine Taekwondo exercises and did not participate in any of the training activities. They did not participate in the physical fitness program. In this study, the statistical analysis of 2*2 combined analysis of variance was used using $SPSS_{26}$ software, the significance level in this study is less than 0.05. **Results:** Baseline comparisons revealed no significant differences between groups at baseline testing for all variables. Overall, EG improved significantly between baseline and after six weeks on all variables. On the other hand, the CG improved significantly on Mitt-kicking and Bag-kicking after six weeks. In between-group comparison, the EG scored better than the CG, the 1 Min sit-up, Mitt-kicking, and Bag-kicking. **Conclusion:** The results of the present study showed that six weeks of physical fitness exercises affected the body mass index, the endurance of the core region, and the performance of taekwondo athletes. These exercises can be used for pre-season training.

KEYWORDS

Physical Fitness Exercises, Body composition, Performance, Taekwondo

1. INTRODUCTION

The origin of Taekwondo is the Korean Peninsula, which is famous for kicking techniques and has been an Olympic martial discipline since 2000 (Casolino et al., 2020). Taekwondo competitions are performed in three rounds, each round lasting 2 minutes and 1 minute rest between rounds (Janiszewska, 2015). Athletes who score more points or knock out their opponent win. During a match, athletes use strong and fast kicks and punches on the opponent's torso and sometimes on the legs (Kazemi et al., 2006). These movements are high-intensity aerobic or anaerobic exercises that induce powerful lower limb movements (Kim et al., 2015). In general, performance in taekwondo is determined by the technical, tactical, psychological, physical, and physiological characteristics of a participant (Pieter et al., 2002).

In competitions conducted under pre-2015 rules, taekwondo athletes generally did not use difficult technical approaches, but preferred to use confident movement skills to win the game (Moenig, 2017). However, following changes in competition rules, taekwondo competition tactics now have offensive tactics as the primary approach and counter-attack tactics as the secondary approach (Chen and Chen, 2022). As an important foundation of athletes' competitive ability, physical fitness has also been increasingly highlighted by rule changes (Janowski et al., 2020; Janowski et al., 2021). Therefore, it is necessary to manage physical fitness factors to improve their performance (Seo et al., 2015). In addition to the above, competition categories are divided by body weight, meaning that body composition plays an important role (Ojeda-Aravena et al., 2020).

In terms of physiological characteristics, it has been found that elite taekwondo athletes tend to have low levels of body fat moderate to high levels of cardiorespiratory fitness and high levels of fitness (Kazemi et al., 2006; Bridge et al., 2014). Physiques are aerobic and anaerobic while muscle strength often does not play a key role (Seo et al., 2015; Bouhlel et al., 2006). In terms of specific physical fitness characteristics, successful taekwondo athletes had higher maximum running speed and better performance in 30 m sprint, countermovement jump, lateral movement, and backward walking (Norjali Wazir et al., 2019; Marković et al., 2005). In addition, research on the physical fitness test of teenage taekwondo athletes showed that lower limb strength, power, and endurance are very important in sports results (Norjali Wazir et al., 2019).

However, the above studies are limited by the fact that the physical fitness exercises performed during the training of professional athletes, because of the great difference between training and competition modes for the psychological and physical conditions of professional and semi-professional athletes and or there is a beginner (Bridge et al., 2013; Maloney et al., 2018). Therefore, more studies on the effect of physical fitness training and the competitive performance of athletes are still needed. Based on the mentioned cases, we hypothesized in this study that 6 weeks of physical fitness exercises affect the body composition,

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endurance, and specific performance of taekwondo athletes aged 14 to 17 years. This research hopes to use empirical research to provide a more comprehensive view of the role of physical fitness in taekwondo as a supplement to research on physiological indicators and physical fitness exercises.

2. METHODS

The present study was an experimental-control type, which was registered in the ethics committee of the Islamic Azad University - Tonkabon branch (IR.IAU.TON.REC.1402.050). The present research was conducted in Tunkabon City (IRAN). The number of 30 young men (14-17 years old) taekwondo practitioners who were estimated using Jpower software (statistical power: 0.8, p: 0.05, effect size: 0.55), this number of players in four clubs taekwondo were collected, available as samples and randomly divided into two experimental groups. Inclusion criteria for the present study: age between 14-17 years, male, no spine and lower limb surgery, more than three years of experience, no participation in rehabilitation programs in the past year as well as the exclusion criteria from the present study; Non-participation in training sessions (2 consecutive, three non-consecutive sessions), reporting pain during exercise, and unwillingness to cooperate (Mohammadi Nia Samakosh et al., 2022; Mohammadi Nia Samakosh et al., 2022).

Before the start of the intervention, people were asked to fill out an informed consent form to participate in the study, then about the exercises and also the tests of the current research, which consisted of endurance tests (1-Min push-up), 1-Min sit up, body composition (body fat) and taekwondo-specific performance (1-minute Mitt-kicking and 1-minute Bag-kicking) (Turner, 2009; Amara et al., 2021; Ellis, 2001; Kyle et al., 2003). People's weight and height were measured using an InBody device made in South Korea and a tape measure. The InBody 270 device was used to evaluate the fat percentage, which is an InBody body analysis device that analyzes a person's body using electrical impedance and provides a unique analysis for each person based on this review. Once done, the best diet for weight loss and the exercise program that is specific to each person can be explained to the person and given to him. The InBody body analysis device can be used by everyone from children to the elderly (Tewari et al., 2018). The subjects of the experimental group performed selected physical fitness exercises for six weeks. They participated in the physical fitness training program (PFTP) for six weeks, three sessions per week and each session lasted for one hour. The control group did their daily taekwondo exercises for the same period as the experimental group and did not receive any intervention regarding the PFTP. After the end of the course, a pretest-posttest plan was conducted for all the subjects in all the research variables, in the same environment and with the same method.

Figure 1: InBody device

2.1 Physical Fitness Training Program

The subjects did the physical training program for 6 weeks and 3 sessions of 60 minutes each week. They performed the exercise program in a combined way and rested for 5 minutes between each exercise (MacDonald et al., 2012). The order of their training program in each session was the first 5 minutes of soft running and stretching exercises to warm up, then aerobic exercises for muscle endurance and core stability, and after doing these exercises, cooling down was done after finishing the program. The desired variables were measured during an exercise for six weeks. Aerobic exercises include 10 minutes of running with 65 to 75% heart rate intensity, the intensity of which increased in the following weeks according to the strength of the subjects. Muscle endurance exercises were performed on the abdominal muscles and included sitting and lying down movements. Each training session lasted for 5 minutes, three sets, and each set was 1 minute, with a 30-second rest interval between sets. It increased with the number of movements they could perform in one minute (MacDonald et al., 2012).

Stability training: The core training protocol lasted about 30 minutes in each session. The basis of the exercises used in the protocol of specific exercises for stabilizing the spine, retraining the proprioceptive sense of the lumbar-pelvic region, maneuvering the abdomen in with the contraction of the Multifidus muscle, and then using the dynamic stability obtained in different positions of open palm arch and squatting with Keeping the aforementioned stabilizing maneuver and also adding dynamic components to it (movement, limbs using the ball) was Swiss ball in the next stages. These exercises consisted of three levels, which were based on core stability exercises suggested by Jeffreys. The exercises started from level one, which consisted of static contractions in a fixed position and progressed with slow movements in an unstable environment. Level two exercises included static contractions in an unstable environment and progressed with dynamic movements in a stable environment. Finally, level three exercises included dynamic movements in an unstable environment and progressed with resistance movements in an unstable environment. In these exercises, the athlete used his weight, Swiss balls, and Madison balls (Jeffreys, 2002).

2.2 Statistical Analysis

SPSS26 software was used for data analysis. Data related to subjects' characteristics such as age, height, weight, and body mass index, in addition to variables, were analyzed in two sections of descriptive and inferential statistics. To compare between groups and within groups, the analysis of variance test with 2x2 combined repeated measures was used. The significance level was considered smaller than 0.05 ($P<0.05$).

3. RESULTS

There was no significant difference between the two groups in the pre-test stage in terms of demographic and all variables ($P > 0.05$). The demographic and clinical variables of the participants are presented in full in Table 1. Our study with %100 retention in the study (30 of 30).

Table 2: Demographic Data and Baseline Values of Players.			
Characteristic	CG (n=18)	EG (n=19)	P-Value
Age (years)	15.40 ± 0.91	15.53 ± 1.06	0.71
Body weight (kg)	59.60 ± 7.62	57.26 ± 8.97	0.57
Body height (m)	1.69 ± 0.05	1.68 ± 0.05	0.44
Body Mass Index (kg/m2)	20.75 ± 2.05	20.24 ± 2.78	0.57
History (years)	5.06 ± 0.59	4.86 ± 0.63	0.38

Legend: EG, Exercise group ; CG, Control group.

Table 2: Pre and post-test comparisons of the outcomes assessed in the study and between groups

Dependent Variables	Group	Baseline Mean ± SD	Post 8 weeks Mean ± SD	Δ Pre-Post	Main effect: Time			Main effect: Group			Interaction: Time × Group		
					F	P	ηp2	F	P	ηp2	F	P	ηp2
1 Min push-up (au)	CG	43.53 ± 5.47	43.80 ± 5.75	↑ 0.62 %	80.58	<0.001*	0.74	0.14	0.70	0.14	64.71	0.001*	0.69
	EG	42.20 ± 8.39	47.06 ± 7.96[a]	↑ 11.51 %									
1 Min sit-up (au)	CG	48.46 ± 3.27	48.80 ± 3.18	↑ 0.70 %	68.77	<0.001*	0.71	0.95	0.33	0.03	49.24	0.001*	0.63
	EG	47.80 ± 2.95	51.81 ± 3.91[a,b]	↑ 8.38 %									
Mitt-kicking (au)	CG	29.53 ± 5.73	31.73 ± 5.81[a]	↑ 7.45 %	40.06	<0.001*	0.58	4.85	0.04*	0.14	4.27	0.04*	0.13
	EG	32.06 ± 3.49	36.40 ± 3.04[a,b]	↑ 13.53 %									
Bag-kicking (au)	CG	37.26 ± 4.44	38.06 ± 5.24[a]	↑ 2.14 %	70.73	<0.001*	0.71	0.262	0.615	0.015	31.49	0.001*	0.52
	EG	39.20 ± 3.56	43.20 ± 3.68[a,b]	↑ 10.20 %									
Body fat (%)	CG	16.27 ± 5.37	15.76 ± 5.18	↓ 3.13 %	44.98	<0.001*	0.61	0.262	0.615	0.015	17.43	0.001*	0.38
	EG	16.78 ± 4.29	14.60 ± 3.97[a]	↓ 12.99 %									

Legend: EG, Exercise group; CG, Control group; Δ, percent change (↓decrease, ↑increase); ηp2, partial eta squared (effect size). *Significant differences (P≤0.05).

a; Denotes significant difference from pre to post-training (p < 0.05), b; Denotes significant difference with the CG post-training (p < 0.05).

Table 2 present the analysis of the variance with a 2×2 ANOVA (treatment time × group) test that showed significant group interactions overtime for 1 Min push-up, 1 Min sit-up, Mitt-kicking, Bag-kicking, as well as the Body fat variables (p ≤ 0.05). Baseline comparisons revealed no significant differences between groups at baseline testing for all variables. Overall, EG improved significantly between baseline and after six weeks on all variables. On the other hand, the CG improved significantly in Mitt-kicking and Bag-kicking after six weeks. In between-groups comparison, the EG scored better than the CG, the 1 Min sit-up, Mitt-kicking, and Bag-kicking.

4. Discussion

The results of the present study showed that physical fitness exercises had a significant effect on reducing body fat percentage, improving endurance (swimming and sitting), and specific performance (hitting the punching bag and deadlift). The results of the present study are in agreement with the results of studies who pointed out the effect of running training on the reduction of total body fat mass who indicated (Wewege et al., 2017; Wewege et al., 2017; Swift et al., 2014). The effect of aerobic training and physical fitness on the reduction body weight pointed out the effect of physical fitness training on improving performance and endurance pointed out the effect of physical fitness training on reducing fatigue and improving performance level is aligned (Swift et al., 2014; Lam et al., 2018; Lam et al., 2018; Bogdanis, 2012; Bogdanis., 2012).

In the context of the importance of body composition in taekwondo athletes, it should be stated that body fat percentage and fat mass are used as basic data for direct and indirect evaluation of the sports performance of athletes (Li et al., 2009; Mudd et al., 2007) and athletes for Performing the best sports performance requires maintaining the appropriate levels of body fat (Linda., 1996). Regarding physical fitness, factors such as agility, strength, endurance, and flexibility are considered very important in taekwondo competitions (Bridge., 2014; Casolino et al., 2012). Since more than 90% of scores are based on kicking skills, in particular, lower limb muscle strength and endurance are required (Santos., 2011; Casolino et al., 2012).

In terms of the effect of exercises on reducing fat percentage, endurance, and performance, the type of exercises used should be mentioned. In this way, the exercises in this study included aerobic exercises and endurance exercises in the core region. In the field of aerobic exercise, reducing fat percentage and endurance, aerobic exercise uses large muscle groups rhythmically and continuously and increases heart rate and breathing for a long time (John and Vasanthi, 2018). On the other hand, these exercises may be associated with an increase in the daily calorie consumption of the participants during aerobic exercise, which is associated with a decrease in fat mass, which was consistent with the findings of (Wills et al., 2012). The results of their review showed that aerobic exercise is an efficient way to reduce body weight and fat (Willis et al., 2012). In their study, they showed that eight weeks of aerobic dance training significantly reduces the body composition parameters of obese sedentary middle-aged women (Willis et al., 2012).

In addition to aerobic exercises, performance improvement can be caused by endurance exercises in the training program. In this context, the characteristics of endurance training and the blind area should be mentioned. In this context, the role of trunk stabilizers is stated to maintain the muscular system, control, coordination, and ideal performance. Lower trunk muscle endurance causes trunk fatigue during intense training or competition, where there is less coordination between the lower and upper limbs, and may also reduce muscle strength. It has been stated that if the strength-to-endurance ratio of trunk muscles is more than 4, it is likely to be the background of lower back problems (Mohammad Pur et al., 2013). Although there is no linear relationship between strength and endurance; as strength increases, endurance increases to a certain extent and then remains constant. Therefore, a decrease in the endurance of the trunk muscles may lead to a decrease in its muscle strength, or on the contrary, a decrease in endurance leads to a

decrease in strength, which also affects the strength of the thigh muscles as one of the effective and integral factors of core stability (Mohammad Pur et al. al., 2013).

A core stability training program involves active participation to improve back stability by restoring the ability to control muscles and movements through muscle strengthening. The core stability training program focuses on stabilizing the back by controlling lumbopelvic joint stress, thereby maintaining back stability, strengthening muscles, increasing endurance, and improving posture (Cho et al., 2014). Typically, during the performance of a specific stabilization exercise, athletes learn how to recruit the deep spinal muscles and gradually reduce the undesirable overactivation of other muscles (Hides et al., 2001). Another benefit of the core stability training program is to restore coordination and control of the trunk muscles to improve control of the lumbar spine and pelvis. The core stability training program controls the tension of the lumbo-pelvic-hip joint, which maintains the stability of the back to strengthen muscles, increase endurance, and correct body posture. Such exercises show similar effects in improving performance. Previous studies explained that pattern modification following core stability exercises can affect the activity of the erector spinae and reduce the activity of the back muscles, thus leading to improved endurance (Butler, 2000).

Also, the precise biological basis for the effectiveness of spinal stabilization exercises has been somewhat elucidated (Hodges et al., 2009). When individuals become accustomed to controlling their trunk muscles during functional tasks, this may explain the improvements observed in daily activities, reduced limitations in activities, and overall feelings of well-being (Hides et al., 2001). There is evidence that these exercises can change the performance of trunk muscles in various tasks (Hodges et al., 2009). In additional proposed mechanisms that explain the effectiveness of movement control exercises to perform better-patterned movements and reduce the likelihood of pain (Hodges and Moseley, 2003; Hodges and Moseley, 2003). These mechanisms include reducing stress on the spine and improving the quality of movement, which is the result of improving the intermuscular coordination of the trunk muscles. These changes influence plastic changes in the motor cortex or elsewhere in the motor system (Tsao et al., 2008). Based on the study, it has been stated that exercises that improve movement control, increase endurance and overall feeling of improvement in athletes are effective and efficient (Costa et al., 2009). Based on the mentioned cases and according to the results of the present research, it is suggested to use physical fitness exercises including aerobic and core stability exercises to improve the BMI, trunk endurance and performance of taekwondo athletes.

5. Conclusion

The results of the present study showed that six weeks of physical fitness exercises affected the BMI, endurance of the core region and the performance of taekwondo athletes. These exercises can be used for pre-season training.

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