Can eight weeks of judo and taekwondo physical education improve the health-related fitness of male university students?

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Authors' Contribution: A – Study design; B – Data collection; C – Statistical analysis; D – Manuscript Preparation; E – Funds Collection¹.

Abstract

Purpose: This study aimed to determine if Judo and Taekwondo in a physical education (PE) setting could improve the fitness of university students.

Material: Students who registered voluntarily for the courses were considered for the study (n=27, 18-22 years for Judo; n=39, 18-22 years for Taekwondo). The control group (n=32, 20-24 years) was composed of students who were not part of a physical education course. None of the participants were college athletes nor PE students. The duration of the courses was eight weeks, twice a week with 50 minutes per session. Both courses included training for muscular fitness, flexibility, explosive strength, and cardiovascular fitness. The courses also included sparring matches and sport-specific training. The following health-related fitness parameters were measured before and after eight weeks: cardiovascular fitness using the Cooper Test, muscular endurance using 60 seconds curl-up test, trunk flexibility using the sit-and-reach test, and explosive leg strength using the standing long jump test. Parametric tests were applied to detect any effect of the courses on the students. Differences with $p \leq 0.05$ and Vargha-Delaney Common language effect size (VD) $\leq 42\%$ or $\geq 58\%$ were considered as evidence for any improvements in the fitness parameters.

Results: Most of the tested parameters, apart from body composition, improved in both martial arts groups while those of the control group dropped. These changes were significantly different ($p \leq 0.05$ and $VD \leq 42\%$ or $\geq 58\%$). The regular curl-ups and sitting stretch done during the eight weeks improved the muscular endurance and trunk flexibility of the Judo group, respectively. Moreover, continuous practice of the rolling/falling technique may have contributed to the improvement in flexibility of the Judo students.

Conclusions: There is evidence that eight weeks of Judo and Taekwondo in a PE context improves the health-related fitness of male university students.

Keywords: taekwondo, judo, health-related fitness, physical education, university.

Introduction

Judo and Taekwondo are martial arts included in the Olympic Games and are practiced by a multitude of people. These martial arts can provide several fitness benefits to participants [1–3]. This advantage is worth considering when designing activity programs that aim at fighting the negative effects of rising physical inactivity in populations. People are increasingly at risk of losing health-related fitness as they reduce regular participation in physical activity [4]. Moreover, a reduction in physical activity engagement increases the risk of having non-communicable diseases such as cardiovascular disease and diabetes [4].

Physical education (PE) courses can be a possible setting that can be used to improve the physical fitness for young people. PE curricula aim at providing skills to maintain lifelong personal fitness and help young people recognize the importance of health-related fitness. This can be done through classroom lectures and sports practices. For sport practices, students may know how much their fitness has improved after being trained in the sport.

Studies have shown that children can improve their health-related fitness through PE courses, and PE courses have contributed to giving the daily activity needed by

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children to be healthy [5, 6]. Martial arts such as Judo and Taekwondo are suggested as a good activity to include in a PE curriculum due to their fitness benefits [7]. However, according to us, one of the most intimidating aspects of pursuing martial arts is learning enough to understand what works best for each individual. The different forms of fighting style have certain things in common, yet each practice has its own unique philosophy as well as a physical and mental approach. Thus, students and prospective students never get to explore first-hand, and benefit from the range of opportunities in the martial arts. Despite these challenges, it will still be important to steer martial arts training that will focus on the improvement of the health-related fitness of participants especially in a PE setting. In this regard, Lakes et al. [8] have shown evidence that Taekwondo in a PE context is beneficial to the physical fitness and cognitive abilities of adolescents. Unfortunately, this is the only study to our knowledge that examines the effect of a martial art on health-related fitness variables of adolescents in a PE setting.

Few studies have conducted on the benefit of PE curricula on university students. On the topic of martial arts, Mohammed and Choi [9] showed evidence for the benefits of Judo practice in a PE curriculum at the university setting on trunk flexibility. However, the study was limited by a lack of a control group. Since PE aims to

provide fitness to students, and considering the few studies that exist on the effect of martial art in a PE context on health-related fitness, this study aimed to determine if there was any evidence that Judo and Taekwondo can be useful as PE courses for university students. The hypothesis was that there would be evidence that both martial arts in a PE setting will improve the fitness of students. The study will add to the little available studies that determine the fitness benefits of Judo and Taekwondo on non-athletes.

Materials and Methods

Study Location, Physical Education Context, and Participants

The study was conducted during the first semester of the 2018-2019 academic year at King Fahd University of Petroleum & Minerals (KFUPM), Dhahran, Eastern Province of Saudi Arabia. Students who registered voluntarily for the courses were considered for the study (n=27, 18-22 years for Judo; n=39, 18-22 years for Taekwondo). The control group (n=32, 20-24 years) was composed of students who were not part of a physical education course. None of the participants were college athletes nor PE students.

Informed Consent for Human Participants

The study was conducted in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) and approved by the Research Scientific Committee at the Physical Education Department of KFUPM. The participants signed consent forms.

Training Protocol

Judo course

The Judo course was conducted twice a week for eight weeks with each session lasting 50 minutes. The students were taught routine exercises with different training drills. Fitness training was achieved by 50 push-ups and 100 curl-ups, two sets for each session, at the beginning and end. Stretching exercises, rolling and falling techniques, and ground techniques were trained for flexibility.

Judo's footwork and steps technique were taught to train for agility. For full body strength and endurance, the *randori* (practice game) was applied for the effect of improving explosive power (at any second for throws for *Ippon*) and endurance (to be able to last for a four-minute fight using all muscles let alone lungs). The cardiovascular training was executed with five minutes of circuit training (burpee, jump rope, and jumping jack). Mental training and tactics were also taught through training and the *randori*.

Taekwondo course

The course was conducted twice a week for eight weeks. Each session was 50 minutes and taught different training drills: punching, kicking, forms, steps/stances, and free sparring, etc. Fitness training was achieved by 50 push-ups and 100 curl-ups, two sets for each session, at the beginning and end. Sitting stretches and various kicking techniques were executed to increase flexibility. Footwork/step for all directions and combinations of kicking techniques were taught for speed, agility and reaction time. There were three minutes of free sparring

to train muscular strength and endurance. Cardiovascular training was done with five minutes of circuit training. Mental training and strategies for fighting were also taught through routine training and sparring.

Testing of Selected Health-related Fitness Variables

The following fitness parameters were tested before and after the course: cardiovascular fitness using the Cooper Test, explosive strength using standing long jump, abdominal muscle endurance using 30s curl-up test, trunk flexibility using the sit-and-reach test, and body composition using body mass index (BMI). All parameters except for explosive strength were tested according to the ACSM health-related fitness testing guidelines [10]. Body mass and height were measured with a stadiometer (Seca GmbH & Co. KG, Hamburg, Germany). For the standing long jump test, the students were asked to jump forward from a marked line and land with their two feet. They were asked to place their toes behind the marked line and to swing their arms and bend their knees before they jumped. The measurement was taken using a straight inelastic measuring tape taped to the floor. The length jumped was measured at the back of their heel.

All the fitness tests were demonstrated to the students before they proceeded. The students were encouraged to give their maximum effort during the pre and post tests. They were reassured that the values of the tests would not affect their final grade.

Statistical Analysis

SPSS 16 and R were used for data analysis. R was used whenever some outputs were not available in SPSS. Parametric tests were used to analyze the data. The Welch t-test was used to compare the baseline values between the exercise groups and the control group. The paired t-test was used to detect differences between the pre and post results. The gains analysis was used to determine if the changes during the eight weeks in both exercise groups were significantly different from the changes in the control group during the eight weeks [11]. The Judo and Taekwondo groups were not compared with each other as the aim of the study was only to determine if both courses were useful in a PE setting. The common language effect size improved by Vargha-Delaney (VD) was used to determine the effect size [12]. When comparing within a group, it tells you the probability that a person will experience a change after undergoing an intervention. When comparing between groups, common language effect size determines the probability that a person randomly selected from one group will be different from another person randomly selected from the other group [13]. Differences with $p \leq 0.05$ and $VD \leq 42\%$ or $\geq 58\%$ were considered evidence for any improvements. The VD was calculated using the *orddom* package in R [14].

Results

Data from 98 students (N=27 for Judo, N=39 for Taekwondo, N=32 for the control group) were analyzed. The age range for the Judo, Taekwondo, and control groups were 18-21 years, 18-22 years, and 20-24 years, respectively. Table 1 shows the pre results. The

students differed in most of the parameters except for cardiorespiratory fitness. Thus, the changes from pre to post were evaluated. Table 2 displays the pre and post results. The students in both courses improved in all parameters except body mass and BMI. Another

exception was that students in the Judo group did not have significant improvements in cardiorespiratory fitness while the Taekwondo group did not improve in flexibility. Table 3 illustrates how the net changes of both martial arts groups differ from that of the control group. The net

Table 1. Differences in baseline data of exercise groups to control group

Variable	Mean (SD)			p-value, 95 % CI (JG vs CG)	VD (JG vs CG)	p-value, 95 % CI (TG vs CG)	VD (TG vs CG)
	Judo (N=27)	Taekwondo (N=39)	Control (N=32)				
Body Mass (kg)	64.8 (12.0)	69.7 (14.9)	76.0 (18.6)	0.01 (-19.6, -2.9)	39.9*	0.120 (-14.2, 1.7)	32.0*
Body Mass Index (kg/m ²)	22.27 (4.21)	22.93 (4.22)	25.41 (6.05)	0.027 (-5.91, -0.37)	37.9*	5.47×10 ⁻² (-5.02, 0.05)	33.5*
Curl Up (number of repetitions)	41 (8)	41 (11)	28 (6)	4.16×10 ⁻⁹ (9, 16)	87.1*	2.98×10 ⁻⁸ (9, 17)	89.9*
Sit and Reach (cm)	32 (7)	33 (7)	29 (5)	0.098 (-1, 6)	64.7*	1.61×10 ⁻² (1, 7)	65.3*
Standing Long Jump (cm)	184.0 (23.4)	185.7 (20.7)	172.2 (24.8)	0.067 (-0.8, 24.5)	67.5*	1.50×10 ⁻² (2.5, 24.5)	66.9*
Cooper Test (m)	1856 (339)	1810 (388)	1830 (338)	0.772 (-151, 203)	44.8	0.823 (-194, 155)	51.7

Note: CI = Confidence Interval, VD = Vargha-Delaney common language effect size, JG = Judo course, TG = Taekwondo course, CG = Control group. *p ≤ 0.05 and VD ≤ 42% or ≥ 58%, meaning significant difference.

Table 2. Baseline vs post comparisons

Variable	Group	Baseline Mean (SD)	Post Mean (SD)	Mean difference	p-value, 95 % CI	VD
Body Mass (kg)	JG	64.8 (12.0)	64.9 (12.1)	0.1	0.749 (-0.6, 0.8)	50.7
	TG	69.7 (14.9)	71.3 (16.3)	1.5	7.72×10 ⁻⁴ (0.7, 2.4)	52.9
	CG	76.0 (18.6)	77.6 (18.9)	1.6	2.99×10 ⁻⁶ (1.0, 2.1)	53
BMI (kg/m ²)	JG	22.27 (4.21)	22.30 (4.18)	0.03	0.804 (-0.20, 0.26)	50.3
	TG	22.93 (4.22)	23.41 (4.63)	0.48	9.29×10 ⁻⁴ (0.21, 0.75)	53.3
	CG	25.41 (6.05)	25.93 (6.15)	0.52	2.73×10 ⁻⁶ (0.34, 0.71)	53.7
Curl Up (number of repetitions)	JG*	41 (8)	54 (10)	14	2.51×10 ⁻¹⁰ (11, 17)	85.3
	TG*	41 (11)	54 (16)	13	8.59×10 ⁻¹² (10, 15)	75.8
	CG*	28 (6)	26 (6)	-2	1.23×10 ⁻⁵ (-3, -2)	38.9
Sit and Reach (cm)	JG*	32 (7)	35 (7)	3	1.16×10 ⁻⁶ (2, 4)	64
	TG	33 (7)	34 (7)	1	3.42×10 ⁻² (0, 2)	54.6
	CG*	29 (5)	28 (6)	-2	3.09×10 ⁻⁴ (-3, -1)	40.2
Standing Long Jump (cm)	JG*	184.0 (23.4)	192.2 (21.8)	8.1	3.85×10 ⁻³ (2.9, 13.4)	59.7
	TG*	185.7 (20.7)	191.7 (22.8)	6.0	1.26×10 ⁻² (1.4, 10.7)	59.2
	CG*	172.2 (24.8)	164.8 (22.8)	-7.5	6.29×10 ⁻⁶ (-10.3, -4.7)	40.8
Cooper Test (m)	JG	1856 (339)	1944 (304)	88	0.102 (-19, 197)	59.8
	TG*	1810 (388)	1990 (422)	180	2.02×10 ⁻⁴ (91, 268)	65.1
	CG*	1830 (338)	1713 (300)	-117	2.10×10 ⁻⁵ (-164, -69)	38

Note: CI = Confidence Interval, VD = Vargha-Delaney common language effect size, JG = Judo course, TG = Taekwondo course, CG = Control group. *p ≤ 0.05 and VD ≤ 42% or ≥ 58%, meaning significant difference.

Table 3. Differences in the changes from baseline to post

Variable	Mean (SD)			p-value, 95 % CI (JG vs CG)	VD (JG vs CG)	p-value, 95 % CI (TG vs CG)	VD (TG vs CG)
	Judo (N=27)	Taekwondo (N=39)	Control (N=32)				
Body Mass (kg)	0.1 (1.8)	1.5 (2.6)	1.6 (1.6)	1.48×10^{-3} (-2.3, -0.6)	46.0	0.921 (-1.0, 0.9)	26.4
Body Mass Index (kg/m ²)	0.028 (0.58)	0.48 (0.84)	0.52 (0.52)	1.09×10^{-3} (-0.78, -0.21)	46.0	0.813 (-0.36, 0.29)	28.0
Curl Up (number of repetitions)	14 (7)	13 (8)	-2 (3)	1.71×10^{-12} (13, 19)	96.3*	1.85×10^{-14} (12, 18)	100.0*
Sit and Reach (cm)	3 (2)	1 (3)	-2 (2)	1.11×10^{-9} (3, 6)	78.8*	9.64×10^{-5} (1, 4)	91.4*
Standing Long Jump (cm)	8.1 (13.3)	6.0 (14.4)	-7.5 (7.8)	3.56×10^{-6} (9.7, 21.4)	78.8*	4.58×10^{-6} (8.1, 18.9)	86.9*
Cooper Test (m)	88 (272)	180 (273)	-117 (132)	9.87×10^{-4} (89, 322)	87.5*	1.51×10^{-7} (197, 395)	79.7*

Note: CI = Confidence Interval, VD = Vargha-Delaney common language effect size, JG = Judo course, TG = Taekwondo course, CG = Control group. * $p \leq 0.05$ and $VD \leq 42\%$ or $\geq 58\%$, meaning significant difference.

changes in the parameters among students who registered for the courses were significantly different from that of the control group, apart from the body mass and BMI.

Discussion

The hypothesis tested was that there would be evidence of improvements in health-related fitness of the students who completed the courses. The results show that there is evidence that the courses improved most of the parameters tested. Moreover, the fitness of the control group reduced after eight weeks. Despite the difference in age between the groups, all the students were 20-29 years; an age range in which their fitness is comparable [10].

The regular curl-ups and sitting stretch done during the eight weeks improved the muscular endurance and trunk flexibility of the Judo group, respectively. Moreover, continuous practice of the rolling/falling technique may have contributed to the improvement in flexibility of the Judo students. These improvements coincide with previous studies that reported improvements of these parameters after at least eight weeks of Judo training in non-athletes [9, 15]. The lack of improvement in flexibility from baseline in the Taekwondo group differs with a previous study [3]. One reason for the difference is because this study considers both statistical significance and effect size as a determinant for significant improvements, while Kim et al. [3] considered only statistical significance. This study and that of Kim et al. [3] agree that Taekwondo induces differences from pre to post if only statistical significance is considered.

Both Judo and Taekwondo courses improved the explosive leg strength of the students as shown from the standing long jump test. Masleša et al. [15] also reported an improvement in explosive leg strength after eight weeks

of Judo training among intellectually disabled people. For Judo students, the randori practice games were most likely the reason for explosive leg strength improvements. Throwing requires not only good upper body strength but also the use of the legs to provide explosive power [16]. As for the Taekwondo course, footwork and kicking drills performed during the course most likely improved the explosive strength of the students. These kicking drills also improved the explosive leg strength of girls who participated in an after-school Taekwondo program [3]. Regular practice of these drills performed during the sparring sessions most likely contributed to improvements in explosive leg strength.

Interestingly, cardiovascular fitness improved among students in the Taekwondo course but not among students in the Judo course. This contrasts with a study from Kim et al. [3] which did not observe changes in cardiovascular fitness after 12 weeks. In terms of the lack of significant improvements in cardiovascular fitness in the Judo students, it may be because the Judo training was highly anaerobic than aerobic. This may have resulted in a limited exercise stimulus for improvement of the high level of $VO_{2\max}$ [17]. Thus, further studies are necessary to examine the effects of Judo training on $VO_{2\max}$. Despite the insignificant improvement in cardiovascular fitness of the Judo students, their change in $VO_{2\max}$ was still significantly better than that of the control group. This result highlights why a physical activity in a PE curriculum for students may be beneficial.

There was no significant improvement in body composition. The measure used for body composition, which was BMI, cannot accurately detect whether the participants lost fat mass or gained lean mass or both. Moreover, the duration of the study was probably short to

perceive significant changes in body composition.

Limitations

This study cannot be generalized because the sample selected for this study were male students. Secondly, the sample size was the minimum. A larger sample size will make this study reliable to detect any significant effects of the courses. Lastly, participants' daily activity was not recorded and compared. The data would have helped to understand if their daily activity played a role in improving the fitness of the students who took the courses.

Perspectives

Given the limitations of this study, further study is necessary as to whether martial arts in a PE context can improve the fitness of female or both male and female university students. This is important for university students who find it difficult to make time to perform regular physical activity due to their course load [18] and are interested in performing a martial arts.

Despite the limitations, the current study also adds information on the beneficial effects of a physical activity in a PE context for university students. What will be important is to properly design the curriculum in order to achieve such benefits as shown in previous systematic reviews [5, 6].

Moreover, the effect of such a curriculum on behavior needs to be considered. It has been shown that behaviors can change when PE courses are implemented at the

university level [19–21]. Moreover, physical activities learned at the university may influence the physical activity lifestyles of students after graduation [22, 23]. Thus, the evidence from our study can be used to encourage students to further engage in physical activity outside of class time and after graduation.

Conclusions

To summarize, this paper determined whether martial arts in a PE context will provide fitness benefits to male university students. The martial arts chosen for the study were Taekwondo and Judo and the study was conducted for eight weeks. The study provides evidence that male university students can benefit from a Taekwondo and Judo program in a PE context if the course is held for at least eight weeks.

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Declaration of interest

The authors reports no conflict of interest.

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