Physical Performance and Cardiopulmonary Function After 12 Weeks Uchikomi Training with Hand and Leg Weight load Program in Thai Judo Athletes

สมรรถภาพกายและหน้าที่การทำงานของหัวใจและปอดหลัง 12 สัปดาห์ ของการฝึก โปรแกรมยูชิโกมิร่วมกับการเพิ่มน้ำหนักที่แขนและขาในนักกีฬายูโดไทย

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ABSTRACT

Judo is a popular martial arts style and Olympic sport with a rich, though relatively recent history. Beyond being a popular martial art, judo is also a combat sport. The aim of this study was to investigate the effect of 12 weeks Uchikomi training with hand and leg weight load program (UTP) on physical performance and cardiopulmonary function in Thai Judo athletes. In Uchikomi training group (UTG; n= 18), subjects are trained by using normal Judo training program (NJTP) 2 days / week including with the UTP 50 minutes / session (10 minutes warm up, 30 minutes UTP for 60-80% of HRmax, 10 minutes cool down) 3 days / week in consecutive 12 weeks. Subjects in control group (CG; n = 17) were practiced only NJTP. Results of baseline characteristics showed no significantly difference in CG. While, in UTG were shown decrease significantly difference in percentage of total body fat, waist circumference (WC), hip circumference (HC), and heart rate (HR). The results of physical performance and data of cardiopulmonary function test showed improve highly significant difference ($p<0.001$) within UTG, but not within CG when they were compared at week 1, week 7 and week 14. This study shows that UTP is a new Judo training exercise model to be suitable for improvement physical performance and cardiopulmonary function in Thai Judo athletes.

บทคัดย่อ

ยูโดเป็นรูปแบบศิลปะการต่อสู้ที่เป็นที่นิยมและมีในการแข่งขันกีฬาโอลิมปิก เป็นกีฬาที่ค่อนข้างมีประวัติอันยาวนาน นอกจากจะเป็นศิลปะการต่อสู้ที่เป็นที่นิยมแล้วยูโดยังเป็นกีฬาต่อสู้อีกด้วยวัตถุประสงค์ของการวิจัยเพื่อศึกษาผลของการฝึก 12 สัปดาห์โปรแกรมการฝึกยูชิโกมิร่วมกับการเพิ่มน้ำหนักที่แขนและขาต่อ สมรรถภาพกายและหน้าที่การทำงานของหัวใจและปอดใน นักกีฬายูโดไทย ในอาสาสมัครกลุ่มฝึกยูชิโกมิร่วมกับการเพิ่มน้ำหนักที่แขนและขา (N = 18) จะถูกฝึกโดยใช้รูปแบบการฝึกยูโดแบบ ปกติ (NJTP) 2 วันต่อสัปดาห์ และฝึกยูชิโกมิร่วมกับการเพิ่มน้ำหนักที่แขนและขา 50 นาทีต่อครั้ง (อบอุ่นกาย 10 นาที 30 นาที ฝึก โปรแกรมยูชิโกมิ ที่ระดับความหนัก 60 - 80 % ของอัตราการเต้นหัวใจสูงสุด (HRmax) คลายอุ่น 10 นาที) เป็นเวลา 3 วัน ต่อเนื่องกัน 12 สัปดาห์ ขณะที่อาสาสมัครกลุ่มควบคุม (N=17) จะถูกฝึกเฉพาะรูปแบบการฝึกยูโดแบบปกติ (NJTP) ผลการประเมินลักษณะ พื้นฐาน พบว่าไม่มีความแตกต่างทางสถิติในกลุ่มควบคุมในขณะที่ในกลุ่มฝึกโปรแกรมยูชิโกมิพบความแตกต่างอย่างมีนัยสำคัญของ

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เปอร์เซ็นต์ไขมันในร่างกายเส้นรอบเอว (WC) เส้นรอบสะโพก (HC) และอัตราการเต้นของหัวใจ (HR) ผลของสมรรถภาพกายและข้อมูลของการทดสอบหน้าที่การทำงานของหัวใจและปอดพบว่ามีความแตกต่างอย่างมีนัยสำคัญทางสถิติที่ $p<0.001$ ภายในกลุ่มฝึกโปรแกรมยูชิโกมิ ในสัปดาห์ที่ 1, 7 และ 14 การศึกษานี้แสดงให้เห็นว่าการฝึกยูชิโกมิร่วมกับการเพิ่มน้ำหนักที่แขนและขาเป็นรูปแบบการฝึกซ้อมแบบใหม่ของยูโดที่เหมาะสำหรับการปรับปรุงสมรรถภาพกายและหน้าที่การทำงานของระบบหัวใจและปอดในนักกีฬายูโดไทย

Keywords: Uchikomi training program, Physical performance, Cardiopulmonary function

คำสำคัญ: โปรแกรมการฝึกยูชิโกมิ สมรรถภาพกาย หน้าที่การทำงานของหัวใจและปอด

Introduction

Judo is a sport which performance explanation is a complex task. It can be determined not only by several physical abilities, but also by technical, tactical and psychological aspects [1]. The main action desired by a Judoka during a Shiai (match in tournament) or Randori (sparring in which both participants practice attacking and defending). It is the throwing of the opponent seeking scores that lead to winning [2]. Judo athletes at both sides use the movement by the dominant personality in the act of self as a way to throw. Athlete at each side has to protect himself from the opponent as well. In the long fight, the athletes lose more energy; get muscle fatigue especially at the arm and lower leg. As a result, Judo athletes take their physical fitness. During Judo competition, there exists some muscle fatigue of the athletes. This arises from inadequate practice of Judo athlete. It produces unpleasant results. Such situation drives the Judo athletes to demonstrate their abilities to hit the target, and the results are unsatisfied. By reasons mentioned above, the researchers emphasize the problem of physical fitness especially muscle strength. One of the problems comes from reducing muscles strength at the arms and legs of the athletes during Judo competition. This stumbling block affect against the abilities of competitive athletes. Therefore, the researchers are interested to establish the suitable the method of using Judo Uchikomi with hand and leg weight load training program (UTP). Uchikomi technique repetition is a traditional exercise used by individual coach. It is particular throwing technique in Judo training for developing physical fitness such as muscle strength, speed, and balance [3].

In this study, the researchers invented the new model of judo training by Uchikomi training with hand and leg weight load program (UTP). From the previous study, Uchikomi with hand and leg weight load training program athlete had never been used before in judo athletes. It is extremely necessary to find the new model of exercise training to develop physical performance especially cardiopulmonary function which was often recorded during judo combat [4]. The aim of this study is to investigate the effect of UTP on physical performance and cardiopulmonary function in Thai judo athletes.

Methodology

The design of this study is a quasi-experiment in human. Thirty-five male and female Thai judo athletes as healthy volunteer regarded as subjects were examined physical examination and complete the confidential health-screening questionnaire by a physician. A standard informed consent including purpose, risks and benefits about this study were explained to each participant. Written informed consent were obtained from all subjects after full explanation. Subjects must be 15-25 years old with experience in judo athletes at least for 1 year and had participated

in judo competition. They were divided into two groups; control group (CG; n=17) and Uchikomi training group (UTG; n=18). A number of subjects were calculated according to previous study [5] with the sample size calculation formula of nd = n/ (1-R); where n = sample size calculated assuming no drop out, nd= sample size required with non-response, R= number of non-responses. CG were trained normal Judo training program (NJTP) for 50 minutes/session (10 minutes/warm up, 30 minutes NJTP for 60-80% of HRmax, 10 minutes cool down) for 5 days/week (Table 1). For UTG, the subjects practiced NJTP for 2 days/weeks including Uchikomi with hand and leg weight load program (UTP) for 50 minutes/session (10 minutes warm up, 30 minute UTP for 60-80% of HRmax, 10 minute cool down) for 3 days/week (Table 2). Both groups practiced within consecutive 12 weeks. Baseline characteristics were investigated at pre-test period (week 1), mid-test (week 7) and post-test period (week 14), both in CG and UTG. All parameters of physical performance were assessed at week 1, week 7 and week 14 consequently. This study was experimented at Vejvichakarn Building, Faculty of Medicine, Khon Kaen University and Rajaphat Phetchabun University, Thailand. Ethical approval has been obtained from the Research Ethical Committee of the University of Khon Kaen, Thailand (Research number HE 581236). Statistical analyses were performed using STATA 12.0 (Statistical software license of Faculty of Medicine, Khon Kaen University). Data were expressed as mean ± standard deviation (SD). An independent sample t - test was used to compare between groups and repeated measures ANOVA was used to compare within the group on anthropometry and physical performance. P - value less than 0.05 was considered to be statistically significant.

Results

Baseline characteristics

Data of baseline characteristics and anthropometry show no significant difference when they are compared within control group (CG) at week 1 versus week 7 and week 14, week 7 versus week 14. While, within Uchikomi training group (UTG) data of body weight (BW), body mass index (BMI), waist circumference (WC), waist to hip ratio (WHR), systolic blood pressure (SBP), diastolic blood pressure (DBP) show significant difference (p<0.05), when they are compared at week 1 and week 14. Percentage of total body fat show highly significant difference (p<0.001) at week 1 versus week 7 and 14, week 7 versus 14. Data of WC, HC and MAP show high significant difference (p<0.01) at week 1 versus 7, and week 1 versus 14, consequently. Besides, data of HR show decrease highly significant difference (p<0.001) at week versus 7 and 14, week 7 versus 14, consequently (Table 3). Comparative data of percentage of total body fat between CG and UTG show decrease significant difference (p<0.05) at week 7 and high significantly difference (p<0.01) at week14. Besides, those data of heart rate (HR) show decrease high significant difference (p<0.01) at week 7 and highly significant difference (p<0.001) at week 14, consequently (Table 4).

Hand grip test, Leg strength test and Trunk flexibility test

In this study, physical performance assesses hand grip test for arm and hand, leg strength test for leg strength and sit and reach test for trunk flexibility. Within CG, data of physical performance show no significant difference when they are compared between week 1 versus week 7, week 14 and week 7 versus 14. While those parameters within

UTG increased highly significant difference (p<0.001) at week 1 versus week 7 and 14. Besides, those data show increased highly significant difference (p<0.001) at week 7 versus week 14 (Table 5). Data of trunk flexibility test within UTG increased highly significant difference (p<0.001) at week 7 with 57.41 % difference and at week 14 with 70.58 % difference, consequently. Besides, data of hand grip test only show increased high significant difference (p<0.01) at week 14 with 24.21 % difference. All data were tested by independent sample t-test (Table 6).

Cardiopulmonary function

The result of cardiopulmonary function was assessed by six minute walk test (6MWT). All parameters of 6MWT show no significant difference within CG when they are compared at week 1 versus 7 and 14, and week 7 versus 14, whereas data of 6MWT within UTG, before walk heart rate (HR) and distance of 6MWT shown high significant difference (p<0.01) at week 1 versus week 14 and week 7 versus week 14, respectively. Data of stop walk HR and after walk 15 min HR show decrease highly significant difference (p<0.001) at week 1 versus 14, and week 7 versus 14. Besides, data of distance of 6MWT show increase highly significant difference (p<0.001) at week 1 versus week 14 (Table 7). Comparative data of 6MWT between CG and UTG show significant difference (p<0.05) in parameter of stop walk HR, after walk 15 min HR and distance of 6MWT at week 7. Besides, all data of 6MWT show high significant difference (p<0.01) at week 14, compared between CG and UTG (Table 8).

Conclusion

After consecutive 12 weeks of Uchikomi with hand and leg weight load program (UTP), results shown increase on physical performance and cardiopulmonary function in Thai Judo athletes. Therefore, it has enough effectiveness as a new model training program for improvement on physical performance and cardiopulmonary function in Thai Judo athletes.

Discussion

Baseline characteristics and anthropometry

In this study, most of parameters in baseline characteristics and anthropometry such as body mass index (BMI), percentage of total body fat, WC, WHR, SBP, DBP, MAP and HR shown no significant difference when they are compared between control group (CG) and Uchikomi training group (UTG) at pre-test period (week 1). For, the data of percentage of total body fat, WC and WHR, BP and HR show significant decrease in difference in UTG after 12 weeks of UTP. They were co-confidence as the study of Marx [6] and Chumvangvapee [7]. It was possible that they showed decrease percentage of total body fat, waist circumference (WC), hip circumference (HC), and waist to hip ratio (WHR) due to the practice of continuous rotating the hips and waist. It could build body muscle mass. In the similar study of post-exercise, it could change blood pressure, heart rate and rate pressure product at different exercise intensities in normotensive humans [8]. They show decrease in BP and HR due to regular and continuous exercise. It may produce better physical health from stronger cardiovascular. Therefore, it was indicated that after 12 weeks Uchikomi

training with hand and leg weight load program (UTP) could promote better characteristics and anthropometry in Thai Judo athletes.

Physical performance

Muscle strength is a factor of physical performance parameter. This study used hand grip test to measure the maximum isometric strength of the hand and forearm muscles. And, leg strength test was used to measure the strength of various muscle groups on the leg. Strength is defined as the ability of a muscle group to develop maximal contractile force against a resistance in a single contraction [9]. Results of physical performance show significant increase in difference in hand grip test and leg strength test after they practiced 6 and 12 weeks of Uchikomi training with hand and leg weight load program (UTP) in Thai Judo athletes, when they are compared with pre test (at week 1). It was also in correspondence with the study in walking with swaying hips and hand weight load exercise program [7]. Similarly, strength is defined as the ability of a muscle group to develop maximal contractile force against a resistance in a single contraction [10]. It was an important such that the arm and hands were used for catching, throwing or lifting. Also, as a general rule people with strong hands tend to be strong elsewhere [11]. Anybody who know anything about judo know how important gripping is a these days. In any contest, the judoka with a stronger grip and with more extensive knowledge of grips and grip fighting has the advantage. So, it would be a good idea for all judo athletes to ensure they have a strong grip [12]. Flexibility is an important, yet often neglected, component of physical fitness. Flexibility is the ability of a joint, or series of joints, to move fluidly through a full range of motion (ROM). Standard sit-and-reach or trunk flexibility test was used to assess flexibility in this study. The ACSM recommended using the standard sit-and-reach test to measure of flexibility of the lower back and hamstring muscles [13]. Jackson reported that the sit-and-reach test had excellent criterion-related validity as a test of hamstring flexibility but not only in men [14]. For women, the sit-and-reach test had moderate criterion-related validity as a test of hamstring flexibility but it was poorly related to lower back flexibility. For this reason, the researchers used the sit-and-reach test for the test of flexibility. In this study, flexibility values of post-test (week 14) in Uchikomi training group (UTG) were significantly increased when they were compared with control group (CG) at pre-test (week 1) after 12 weeks of training. These results were coincident with the studies of as Brooks. Which, evidence suggested that the effects of stretching exercise training on muscle performance were dependent on the type of stretching dynamic and static and muscular activity performed. Static stretch with an isometric contraction of the muscle group to be stretched was an effective means of improving muscle relaxation and might enhance the development of flexibility [15]. In this study, Uchikomi training with hand and leg weight load program (UTP) could increase flexibility in UTG due to techniques in warm up and cool down session of our established UTP. Those sessions used static stretching figures in upper and lower body, thus UTP could improve flexibility in Thai Judo athletes. Santos [16] demonstrated that resistance training (8 weeks) at moderate intensity (3 sets of 10-20 reps per exercise) in two different exercise orders (4 exercises for upper limbs and 4 exercises for lower limbs vs. 8 exercises alternating upper and lower body) could increase shoulder and trunk flexibility similarly. Nevertheless, it must be emphasized that independently of exercise order, all resistance training exercises should be performed through the entire range of motion [17]. Presumably, an increase in the range of motion from stretching could also increase the range of motion

in resistance training exercise.The results demonstrated that the resistance training program increased flexibility levels in all of the joints assessed. Therefore, resistance training could provide significant gains in the joint range of motion in judo athletes independently of the exercise order [18].

Cardiopulmonary capacity

This study shown increase of distance 6MWT in Uchikomi training group (UTG) after 12 weeks of Uchikomi training with hand and leg weight load program (UTP) in Thai Judo athletes at weeks 7 and 14. They were co-confidence as the study of Aquino [19], Chumvangvapee [7], and Piwngern [20]. And the results of this study similar to the previous study shown that 6MWT increased during a weight reduction program, indicating improvement of physical fitness and decreased metabolic demand during daily activity in overweight children and adolescents [21]. The original purpose of the six minute walk was to test exercise tolerance in chronic respiratory disease and heart failure. The six-minute walk test (6MWT) is a simple, low tech, safe and well established, self-paced assessment tool to quantify functional exercise capacity in adults. [22].

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Table 1 Schedule of normal Judo training program (NJTP) in control group for 5 days / week

Monday,Wednesday, Friday	Tuesday,Thursday
1. Warm up 10 minutes	**1. Warm up 10 minutes**
2. Normal Judo program 30 minutes	**2. Normal Judo program 30 minutes**
2.1 Practice in Tachiwaza (Standing techniques), Nagewaza (Throwing techniques), Tewaza (Hand techniques), Ashiwaza (Foot / Leg techniques), and Koshiwaza (Hip techniques).	2.1 Practice in Ne-waza (Ground techniques) Katame-waza (Grappling techniques), Osaekomiwaza (Hold-down techniques) and Kansetsuwaza (Joint locks). These Waza are performed on the ground, and are used to hold an opponent down and disable his movement.
2.2 Practice in TachiwazaRandori (Fight standing techniques)	2.2 Practice in Ground Ne-wazaRandory (Fighting ground techniques)
3. Cool down 10 minutes	**3. Cool down 10 minutes**
Saturday	**Sunday**
- Rest and Recovery	- Rest and Recovery

Table 2 Schedule of normal Judo training program(NJTP)and Uchikomi with hand and leg weight load

      Program (UTP) in Uchikomi training group for 5 days / week

Monday ,Wednesday, Friday	
1. Warm up 10 minutes	
2. Uchikomi with hand and leg weight load program 30 minutes	
2.1 Kuzushi (Unbalancing an opponent)	
2.2 Ipponseoinage (One-arm shoulder throw)	
2.3 Moroteseoinage (Two-arm shoulder throw)	
2.4 Osotogari (Major outer reaping throw)	
2.5 Okuriashiharai (Foot sweep throw)	
3. Cool down 10 minutes	

Tuesday	Thursday
1. Warm up 10 minutes	**1. Warm up 10 minutes**
2. Normal Judo program 30 minutes	**2. Normal Judo program 30 minutes**
2.1 Practice in Tachiwaza (Standing techniques), Nagewaza (Throwing techniques), Tewaza (Hand techniques), Ashiwaza (Foot / Leg techniques), and Koshiwaza (Hip techniques).	2.1 Practice in Ne-waza (Ground techniques) Katame-waza (Grappling techniques), Osaekomiwaza (Hold-down techniques) and Kansetsuwaza (Joint locks). These Waza are performed on the ground, and are used to hold an opponent down and disable his movement.
2.2 Practice in TachiwazaRandori (Fight standing techniques)	2.2 Practice in Ground Ne-wazaRandory (Fighting ground techniques)
3. Cool down 10 minutes	**3. Cool down 10 minutes**
Saturday	**Sunday**
- Rest and Recovery	- Rest and Recovery

Principle of hand and leg weight load in Uchikomi training program

- Subject was assessed heart rate maximum (HRmax) by using this formula

$$HRmax = 220 - \text{age (year) beats/ minutes}$$

- Subject was measured body weight (kg) for weight load by using 2, 4 or 6 lbs. If they had BW 40-60 kg, they would be loaded at 2 lbs on both hands and legs. If they had BW more than 61 lbs, they would be loaded at 4 lbs on both hands and legs.

- Subject were trained Uchikomi (technique repetition) in 5 positions with hand and leg weight load 25-35 times/minutes.

- After they practiced 1 minute, they would be assessed HRmax. If their HRmax were in the range of 60-80%, it would be loaded weight at the same load (2 or 4 lbs depending on body weight) and practiced exercise in consecutive 6 weeks. If their HRmax were higher than 80% they should increase weight load to 4 or 6 lbs. Then they would be trained for further 6 weeks continuously. Subjects must be maintained their HRmax in 60-80% though exercise training period.

- Allsubjectin UTG were trained by using Uchikomi with hand and leg weight load program in consecutive 12 weeks.

Table 3 Comparative data of baselinecharacteristics and anthropometry within Uchikomi training group (UTG; n= 18) at pre-test period (week 1), mid-test period (week 7) and post-test period (week 14).

Variables	Thai judo athletes								
	Uchikomi training group(UTG; n =18)								
	Week 1	Week 7	% Difference	Week 1	Week 14	% Difference	Week 7	Week 14	% Difference
Age (years)	19.8 ± 1.26	19.8 ± 1.26	0	19.8 ± 1.26	19.8 ± 1.26	0	19.8 ± 1.26	19.8 ± 1.26	0
Body weight (kg)	62.56 ± 15.15	61.78 ± 13.62	-1.25	62.56 ± 15.15	59.89 ± 13.14 [a]	-4.36	61.78 ± 13.62	59.89 ± 13.14	-3.10
Height (cm)	167 ± 0.08	167 ± 0.08	0	167 ± 0.08	167 ± 0.08	0	167 ± 0.08	167 ± 0.08	0
BMI (kg/m^2)	22.3 ± 4.06	22.07 ± 3.67	+1.36	22.3 ± 4.06	21.39 ± 3.58 [a]	-4.16	22.07 ± 3.67	21.39 ± 3.58	-3.12
Total body fat (%)	14.22 ± 3.71	11.62 ± 3.67.28 [aaa]	-20.12	14.22 ± 3.71	9.52 ± 3.67 [aaa]	-39.59	11.62 ± 3.67.28	9.52 ± 3.67 [bbb]	-19.86
WC (Inch)	29.44 ± 4.08	28.89 ± 4.21 [aa]	-1.89	29.44 ± 4.08	29.03 ± 4.1 [a]	-1.40	28.89 ± 4.21	29.03 ± 4.1	+0.48
HC (Inch)	34.61 ± 3.5	33.61 ± 3.66 [aaa]	-2.93	34.61 ± 3.5	33.75 ± 3.66 [aa]	+2.51	33.61 ± 3.66	33.75 ± 3.66	+0.42
WHR	0.85 ± 0.05	0.86 ± 0.05	+1.17	0.85 ± 0.05	0.86 ± 0.06 [a]	+1.17	0.86 ± 0.05	0.86 ± 0.06	0
SBP (mmHg)	121 ± 5.6	120.39 ± 5.66	-0.83	121 ± 5.6	119.83 ± 4.19 [a]	-1.66	120.39 ± 5.66	119.83 ± 4.19	-0.84
DBP (mmHg)	78 ± 6.86	76 ± 5.32	-2.60	78 ± 6.86	76 ± 4.31 [a]	-2.60	76 ± 5.32	76 ± 4.31	0
MAP (mmHg)	92 ± 5.53	91 ± 4.39	-1.09	92 ± 5.53	90 ± 3.25 [aa]	+2.2	91 ± 4.39	90 ± 3.25	-1.10
HR (beats/min)	69 ± 5.85	65 ± 4.09 [aaa]	-5.97	69 ± 5.85	61 ± 4.58 [aaa]	-12.30	65 ± 4.09	61 ± 4.58 [bbb]	-6.35

Data were presented as mean ± standard deviation (SD). BMI; Body mass index, WC; Waist circumference, HC; Hip circumference, WHR; Waist to hip ratio, SBP; Systolic blood pressure, DBP; Diastolic blood pressure, MAP; Mean arterial pressure and HR; Heart rate.

All data were tested by repeated measures ANOVA.

[a], [aa], [aaa] Significant difference at p<0.05, p<0.01, p<0.001, at week 1 versus week 7 and 14, consequently.

[bbb] Significant difference at p<0.001, at week 7 versus week 14, consequently.

Table 4 Comparative data of baseline characteristics and anthropometry between control group (CG; n= 17) and Uchikomi training group (UTG; n= 18) at pre-test period (week 1), mid-test period (week 7) and post-test period (week 14).

Variables	Thai judo athletes								
	Week 1			**Week 7**			**Week 14**		
	CG	**UTG**	**% Difference**	**CG**	**UTG**	**% Difference**	**CG**	**UTG**	**% Difference**
Age (years)	19.71 ± 0.77	19.8 ± 1.26	+0.45	19.71 ± 0.77	19.8 ± 1.26	+0.45	19.71 ± 0.77	19.8 ± 1.26	+0.45
Body weight (kg)	59.53 ± 11.9	62.56 ± 15.15	+4.96	59.59 ± 11.9	61.78 ± 13.62	+3.61	60.4 ± 11.59	59.89 ± 13.14	-0.85
Height (cm)	165 ± 0.06	167 ± 0.08	+1.20	165 ± 0.06	167 ± 0.08	+1.20	165 ± 0.06	167 ± 0.08	+1.20
BMI (kg/m^2)	21.8 ± 3.25	22.3 ± 4.06	+1.05	21.81 ± 3.18	22.07 ± 3.67	+1.18	22.17 ± 3.38	21.39 ± 3.58	-3.58
Total body fat (%)	14.04 ± 4.59	14.22 ± 3.71	+1.27	14.49 ± 4.56	11.62 ± 3.67 [a]	-21.98	14.07 ± 4.17	9.52 ± 3.67 [aa]	-38.57
WC (Inch)	30.53 ± 4.39	29.44 ± 4.08	-3.64	30.96 ± 4.47	28.89 ± 4.21	-6.92	30.85 ± 4.29	29.03 ± 4.1	-6.07
HC (Inch)	35.71 ± 4.33	34.61 ± 3.5	-3.13	36.42 ± 4.27	33.61 ± 3.66	-8.03	35.79 ± 4.15	33.75 ± 3.66	-5.87
WHR	0.85 ± 0.03	0.85 ± 0.05	0	0.85 ± 0.04	0.86 ± 0.05	-1.17	0.86 ± 0.04	0.86 ± 0.06	0
SBP (mmHg)	120 ± 8.00	121 ± 5.6	+0.83	121 ±8.36	120 ± 5.66	-0.83	120 ± 2.7	120 ± 4.19	0
DBP (mmHg)	77 ± 7.59	78 ± 6.86	+1.29	78 ± 7.82	76 ± 5.32	-2.60	79 ± 6.32	76 ± 4.31	-3.87
MAP (mmHg)	91 ± 6.74	92 ± 5.53	+1.09	92 ± 7.05	90 ± 4.39	-2.20	93 ± 4.62	90 ± 3.25	-3.27
HR (beats/min)	69 ± 7.27	69 ± 5.85	0	72 ± 6.25	65 ± 4.09 [aa]	-10.21	70 ± 5.14	61 ± 4.58 [aaa]	-13.74

Data were presented as mean ± standard deviation (SD). BMI; Body mass index, WC; Waist circumference, HC; Hip circumference, WHR; Waist to hip ratio, SBP; Systolic blood pressure , DBP; Diastolic blood pressure,

MAP; Mean arterial pressure and HR; Heart rate.

All data were analyzed by independent sample t-test.

[a], [aa], [aaa] Significant difference at $p<0.05$, $p<0.01$, $p<0.001$ at week 1, week 7 and week 14.

Table 5 Data of hand grip, leg strength and trunk flexibility test within Uchikomi training group (UTG; n= 18) at pre-test period (week 1), mid-test period (week 7) and post-test period (week 14).

Variables	Thai judo athletes								
	Uchikomi training group (UTG; n= 18)								
	Week 1	Week 7	% Difference	Week 1	Week 14	% Difference	Week 7	Week 14	% Difference
Hand grips test (kg)	34.33 ± 9.39	38.06 ± 9.61^{aaa}	+10.30	34.33 ± 9.39	43.06 ± 9.56^{aaa}	+22.56	38.06 ± 9.61	43.06 ± 9.56^{bbb}	+12.32
Leg strength test (kg)	137.28 ± 34.52	143.11 ± 34.54^{aaa}	+4.16	137.28 ± 34.52	150.06 ± 34.96^{aaa}	+8.89	143.11 ± 34.54	150.06 ± 34.96^{bbb}	+4.74
Trunk flexibility test (cm)	5.08 ± 2.67	10.94 ± 2.46^{aaa}	+73.15	5.08 ± 2.67	14.28 ± 2.97^{aaa}	+95.04	10.94 ± 2.46	14.28 ± 2.97^{bbb}	+26.48

Data were presented as mean ± standard deviation (SD). All data were analyzed by repeated measures ANOVA.

^{aaa} Significant difference at p<0.001, at week 1 versus week 7 and 14, consequently.

^{bbb} Significant difference at p<0.001, at week 7 versus week 14, consequently.

Table 6 Comparative data of physical performance between control group (CG; n= 17) and Uchikomi training group (UTG; n= 18)at pre-test period (week 1), mid-test period (week 7) and post-test period (week 14)

	Thai judo athletes								
Variables	**Week 1**			**Week 7**			**Week 14**		
	CG	**UTG**	**% Difference**	**CG**	**UTG**	**% Difference**	**CG**	**UTG**	**% Difference**
Hand grip test (kg)	33.76 ± 9.69	34.33 ± 9.39	+1.67	33.59 ± 9.43	38.06 ± 9.61	+12.47	33.76 ± 9.22	43.06 ± 9.56^{aa}	+24.21
Leg strength test (kg)	136.65 ± 38.85	137.28 ± 34.52	+0.45	137.35 ± 36.17	143.11 ± 34.54	+4.10	137.88 ± 35.96	150.06 ± 34.96	+8.46
Trunk flexibility test (cm)	5.35 ± 2.71	5.08 ± 2.67	-5.18	6.06 ± 2.95	10.94 ± 2.46^{aaa}	+57.41	6.83 ± 3.24	14.28 ± 2.97^{aaa}	+70.58

Data were presented as mean ± SD. Data were tested by independent sample t-test.

Comparative data between CG and UTG at week 1, week 7 and week 14.

[aa], [aaa] Significant difference at $p<0.01$, $p<0.001$, consequently.

Table 7 Data of six minute walk test (6MWT) within Uchikomi training group (UTG; n= 18) at pre-test period (week 1), mid-test period (week 7) and post-test period (week 14).

Variables	Thai judo athletes								
	Uchikomi training group (UTG; n= 18)								
	Week 1	Week 7	% Difference	Week 1	Week 14	% Difference	Week 7	Week 14	% Difference
Before walk HR beats/min)	68.22 ± 5.48	66.83 ± 4.57	-2.05	68.22 ± 5.48	63.5 ± 3.54^{aa}	-7.16	66.83 ± 4.57	63.5 ± 3.54	-5.11
Stop walk HR (beats/min)	128.39 ± 7.08	125 ± 8.72^{aaa}	-2.68	128.39 ± 7.08	122.78 ± 3.86^{aaa}	-4.47	125 ± 8.72	122.78 ± 3.86 ^{bbb}	-1.79
After walk 15 min HR (beats/min)	91.06 ± 6.67	82.94 ± 7.13	-9.33	91.06 ± 6.67	68.33 ± 3.96^{aaa}	-28.52	82.94 ± 7.13	68.33 ± 3.96 ^{bbb}	-19.31
6MWT (m)	690.83 ± 52.81	698.33 ± 47.19	+1.07	690.83 ± 52.81	761.94 ± 33.83^{aaa}	+9.79	698.33 ± 47.19	761.94 ± 33.83 ^{bb}	+8.71

Data were presented as mean ± standard deviation (SD). Heart rate (HR), Six minutes walk test (6MWT). All data were analyzed by repeated measures ANOVA.

^{aa},^{aaa} Significant difference at p<0.01,p<0.001, at week 1 versus week 7 and 14, consequently.

^{bb},^{bbb} Significant difference at p<0.01,p<0.001, at week 7 versus week 14, consequently.

Table 8 Comparative data of six minute walk test (6MWT) between control group (CG; n= 17) and Uchikomi training group (UTG; n= 18)at pre-test period (week 1), mid-test period (week 7) and post-test period (week 14)

	Thai judo athletes								
Variables	**Week 1**			**Week 7**			**Week 14**		
	CG	**UTG**	**% Difference**	**CG**	**UTG**	**% Difference**	**CG**	**UTG**	**% Difference**
Before walk HR beats/min)	70.41 ± 6.53	68.22 ± 5.48	-3.16	71.06 ± 6.75	66.83 ± 4.57[aa]	-6.13	70.41 ± 7.99	63.5 ± 3.54[aa]	-10.32
Stop walk HR (beats/min)	128.12 ± 6.35	128.39 ± 7.08	+0.21	127.88 ± 5.16	125 ± 8.72[a]	-2.28	127.76 ± 5.11	122.78 ± 3.86[aa]	-3.97
After walk 15 min HR (beats/min)	90.65 ± 4.83	91.06 ± 6.67	+0.45	89.06 ± 4.93	82.94 ± 7.13[a]	-7.12	88 ± 5.85	68.33 ± 3.96[aa]	-25.16
6MWT (m)	679.41 ± 38.97	690.83 ± 52.81	+1.66	680 ± 35	698.33 ± 47.19[a]	+2.66	678.24 ± 36.44	761.94 ± 33.83[aa]	+11.62

Data were presented as mean ± SD. Heart rate (HR), Six minutes walk test (6MWT). Data were tested by independent sample t-test.

Comparative data between CG and UTG at week 1, week 7 and week 14.

[a], [aa]   Significant difference at $p<0.05$, $p<0.01$, consequently.