The Effect of Applied Plyometric Training Program on Anthropometry, Muscle Strength Test and Flexibility Test in Male Thai Boxing Athletes

ผลของการฝึกพลัยโอเมตริกแบบประยุกต์ต่อการวัดขนาดของร่างกาย การทดสอบความแข็งแรงของกล้ามเนื้อ และการทดสอบความอ่อนตัว ในนักกีฬามวยไทยชาย

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ABSTRACT

Thai boxing is one of the oldest cultural martial art of Thailand. Nowadays, Thai boxing can be applied as an exercise model for health promotion. The aim of this study is to investigate the effect of applied plyometric training (PTP) on anthropometry, muscle strength and flexibility test in male Thai boxing athletes. In applied plyometric training group (PTG; n = 17), subjects are trained by using normal Thai boxing training program (NTP) 5 days / week add with the PTP 50 minutes / session (10 minutes warm up, 30 minutes plyometric exercise of 85-100% HRmax, 10 minutes cool down) for 2 days / week in consecutive 12 weeks. While, subjects in control group (CG; n = 16) are practiced only NTP. Results of baseline characteristics showed no significantly difference both in CG and PTG. Muscle strength test such as hand grips, leg strength and flexibility test were shown increase highly significant difference ($p<0.001$) within PTG, but not within CG when they were compared at pre - test period (week 1), mid - test period (week 7) and post - test period (week 14). However, only result of leg strength test was shown different increase 12.25% from 154.06 ± 16.93 kg to 172.94 ± 21.59 kg ($p<0.001$) at post test (week 14) when it is compared between CG and PTG. It is concluded that PTP has effectiveness muscle strength especially in leg strength in male Thai boxing athletes.

บทคัดย่อ

มวยไทยเป็นศิลปวัฒธรรมที่เก่าแก่ที่สุดอย่างหนึ่งของประเทศไทย ปัจจุบันมวยไทยได้ถูกประยุกต์มาเป็นรูปแบบของการออกกำลังกาย เพื่อการสร้างเสริมสุขภาพ วัตถุประสงค์ของการวิจัยเพื่อศึกษาผลของรูปแบบการฝึกพลัยโอเมตริกแบบประยุกต์ต่อการวัดขนาดของร่างกาย ความแข็งแรงของกล้ามเนื้อ และความอ่อนตัวในนักกีฬามวยไทยชาย ในอาสาสมัครกลุ่มฝึกพลัยโอเมตริกแบบประยุกต์ (17 ราย) จะถูกฝึกโดยใช้รูปแบบการฝึกมวยไทยปกติ (NTP) 5 วันต่อ สัปดาห์ และเพิ่มฝึกพลัย

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โอเมตริกแบบประยุกต์ 50 นาทีต่อครั้ง (อบอุ่นกาย10 นาที ฝึกพลัยโอเมตริกแบบประยุกต์ 30 นาที ที่ระดับความหนัก 85 - 100 % ของอัตราการเต้นหัวใจสูงสุด (HRmax) คลายอุ่น10 นาที) เป็นเวลา 2 วัน ต่อเนื่องกัน 12 สัปดาห์ ขณะที่อาสาสมัครกลุ่มควบคุม (16 ราย) จะถูกฝึกเฉพาะรูปแบบการฝึกมวยไทยปกติ ผลการประเมินลักษณะพื้นฐาน พบว่าไม่มีความแตกต่างทางสถิติในกลุ่มควบคุมและกลุ่มฝึกพลัยโอเมตริกแบบประยุกต์ ความแข็งแรงของกล้ามเนื้อได้แก่การวัดแรงบีบมือ แรงเหยียดขา และความอ่อนตัว พบว่ามีความแตกต่างอย่างมีนัยสำคัญทางสถิติ ($p<0.001$) ภายในกลุ่มฝึกพลัยโอเมตริกแบบประยุกต์ แต่ไม่แตกต่างภายในกลุ่มควบคุม อย่างไรก็ตามมีเพียงความแตกต่างอย่างมีนัยสำคัญทางสถิติ ($p<0.001$) ของความแข็งแรงของขาเพิ่มขึ้น 12.25 % จาก 154.06 ± 16.93 กิโลกรัม เป็น 172.94 ± 21.59 กิโลกรัม หลังการทดสอบ (สัปดาห์ที่ 14) เมื่อเปรียบเทียบกลุ่มควบคุมและกลุ่มฝึกพลัยโอเมตริก แบบประยุกต์ ผลการศึกษาสรุปว่ารูปแบบการฝึกพลัยโอเมตริกแบบประยุกต์ที่สร้างขึ้น มีผลต่อแข็งแรงของกล้ามเนื้อโดยเฉพาะกล้ามเนื้อขาในนักกีฬามวยไทยชายได้

Keywords: Applied plyometric training program, Anthropometry, Muscle strength, Flexibility, Thai boxing athletes
คำสำคัญ: การฝึกพลัยโอเมตริกแบบประยุกต์ การวัดขนาดของร่างกาย ความแข็งแรงของกล้ามเนื้อ ความอ่อนตัว นักกีฬามวยไทย

Introduction

Thai boxing or Muaythai is considered as one of the oldest cultural martial art of Thailand. It has a long history of being a close -combat martial arts by using the entire body as a weapon such as hands, feet, knees and elbows [1]. Nowadays, Thai boxing is becoming a wary popular sport and has widespread around the world. It is also used as an exercise model for health fitness promotion and self-defense. Besides, Thai boxing is categorized as a strong, vigorous and powerful exercise. And it is popular mostly in male. Thai boxing fighting requires strength, speed, explosive and powerful movements for an athlete to succeed [2]. Therefore, Thai boxing athletes need to have good physical performance and muscle strength. For improvement of those abilities in male Thai boxing athletes, a group of our researchers tried to establish an applied plyometric training program (PTP) in male Thai boxing athletes. Plyometric, also known as "jump training" or "plyos" and it is an exercise to be produced fast and powerful movement. It is trained as an exercise in which muscles exert maximum force in short intervals of time. It also improves strength, elasticity and innervation of muscle surrounding tissues [3].

The aim of this study is to investigate the effect of applied plyometric training program on anthropometry, muscle strength test and flexibility test in male Thai boxing athletes. PTP that was established as a new pattern in training male Thai boxing athletes, it should improve muscle strength and flexibility. It may push Thai boxing athletes to be the winners in their competition and make names to our country, Thailand in Thai boxing fighting.

Methodology

The design of this study was a quasi-experiment in human. Thirty-three male Thai boxing athletes were divided into control group (CG; n=16) and applied plyometric training group (PTG, n=17) randomly. All volunteered Thai boxing subjects were male, between the age of 18 to 25 with experiences at least 1 year in Thai boxing competition. They were healthy and received a confidential healthy physical examination by a physician. All subjects

are non-regular alcohol drinking or smoking. Number of subjects were calculated according to a previous study [4] and the calculation of sample size uses the formula of nd = n / (1-R); n = sample size calculated assuming no drop out, nd= sample size required with non-response, R = a number of non-responses. All subjects in control group (CG; n = 16) and applied plyometric training group (PTG; n = 17) were practiced normal Thai boxing training program (NTP) 5 days / week in 12 weeks continuously (Table 1). While in PTG, the subjects practiced NTP 5 days per week add with applied plyometric training program (PTP) 50 minutes/session (10 minutes warm up, 30 minutes applied plyometric exercise of 85-100 % HRmax and 10 minutes for cool down) 2 days / week in period of 12 weeks (Table 2). All subjects also maintained their normal lifestyles on their eating and working habits. Baseline characteristics were investigated at pre test period (week 1), mid test (week 14) and post test period (week 14), both in CG and PTG. All parameters of isokinetic test were assessed at pre test period (week 1), mid test period (week 7) and post test period (week 14), consequently. This study was experimented at Vejvichakarn Building, Faculty of Medicine, Khon Kaen University and Rajaphat Phetchabun University, Thailand. A standard informed consent including purpose, risks and benefits of this study were explained to each participant. Written informed consent were obtained from all subjects, after full explanation. Ethical approval has been obtained from the Research Ethical Committee of the University of Khon Kaen, Thailand (Research number HE 581237). 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). Independent sample t - test was used to compare differences in characteristics of all parameters between control and applied plyometric exercise groups. An independent sample t - test was used to compare between groups and repeated measures ANOVA was used to compare within group of anthropometry, muscle strength and flexibility. P - value less than 0.05 was considered to be statistically significant.

Results

Baseline characteristics

Baseline characteristics of volunteer subjects in both control group (CG) and applied plyometric training group (PTG) were shown in Table 3. They are no significant difference in those parameters at pre test period (week 1), mid test period (week 7) and post test period (week 14).

Muscle strength test

Muscle strength test such as hand grips, leg strength test were investigated in this study. In control group (CG; n = 16), they were shown no significant difference when compared between week 1, versus week 7, 14 and week 7 versus week 14 (Table 4). While all parameters in applied plyometric training group (PTG; n = 17) were increased highly significant difference ($p<0.001$) at week 1 versus week 7 and 14. Besides, those data were shown increase high significantly difference ($p<0.01$) at week 7 versus week 14 (Table 4, Figure 1). Comparative data of muscle strength test were shown no significant difference between CG and PTG at pre test period (week 1), mid test period (week 7) and post test period (week 14), While the result of leg strength test was only increased highly significant difference at $p<0.001$ at post test period (week 14) (Table 5, Figure 2) when it compare with CG.

Flexibility test

The result of flexibility test were shown no significant difference in CG at pre test period (week 1), mid test period (week 7) and post test period (week 14), while PTG data were shown increase highly significant difference ($p<0.001$) at week 1 versus week 7 and week 14. However, it shown no significant difference between CG and PTG in the result of flexibility test at pre test period (week 1), mid test period (week 7) and post test period (week 14) of experiment.

Conclusion

After consecutive 12 weeks of normal Thai boxing program (NTP) add with applied plyometric training program (PTP) 50 minutes per session (10 minutes warm up, 30 minutes applied plyometric training of 85 -100 % HRmax, cool down 10 minutes). They showed increase muscle strength such as handgrips, leg strength test and flexibility test in PTG at mid test period (week 7) and post test period (week 14) when they compared to control subjects. Therefore PTP has the effectiveness on improvement of muscle strength test and flexibility test but not anthropometry in male Thai boxing 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, waist circumference (WC), waist to hip ratio (WHR), systolic blood pressure (SBP), diastolic blood pressure (DBP), mean arterial pressure (MAP) and heart rate (HR) were shown no significantly difference when they were compared between control group (CG) and applied plyometric training group (PTG) at pre test period (week 1), mid test period (week 7) and post test period (week 14). They were co-confidence as the study of Carey and Heathcock [5] and Goran and co worker [6]. It was possible that most of subjects were professional and amateur Thai boxing or Muaythai athletes. They had trained normal exercise all the time and they might be experienced in Thai boxing competition at least 1 years. Beside, data of anthropometry in PTG were shown good to excellent level in was norm of Thai university athletes [7]. Thus baseline characteristics and anthropometry may be not different after trained PTP.

Muscle strength test and flexibility test

Strength is defined as the ability of a muscle group to develop maximal contractile force against a resistance in a single contraction [8]. After PTP training in Thai boxing athletes, they increased highly significant different in hand grip test and leg strength test after they practiced 6 and 12 weeks of applied plyometric training program when they were compared with pre test period (at week1). It is corresponding of the study in plyometric training improve voluntary activation and strength during isometric, concentric and eccentric contractions test [9]. The same result as Effect of cluster vs. traditional plyometic training sets on maximal-intensity exercise performance found plyometric training methods could improved lower body maximal performance [10]. According to the research of Eduardo Saez found plyometric training enhanced strength performance [11]. And the study of Vescovi and co - worker found that

the effects of a plyometric program could help reduced landing force by 17–18% [12]. According to the topic of the role of plyometric exercises in the physical preparation of junior female football players found that plyometric exercise program could improve of strength capacity in the motor, practical and methodological capacity necessary to easily practice the football game [13]. The same as result in the topic of effectiveness and time-course adaptation of resistance training vs. plyometric training in prepubertal soccer players found plyometric training program could improve performance in the 20-m sprint test from subjects and enhaned maximal muscle strength and power (Negra et al., 2016). Thus, applied plyometric training program could be increased hands (such as opponens digiti minimi, opponens pollicis, flexor pollicis longus, flexor digitorum superficialis) and legs muscle strength (such as hamstrings, quadriceps, gastronemiuos mucles and hip region).

Flexibility was the ability of a joint, or series of joints, to move fluidly through a full range of motion (ROM). The ACSM recommended using the standard sit-and-reach test to measure of flexibility of the lower back and hamstring muscles [14]. In this study researcher found applied plyomerric training program (PTP) could increase flexibility in PTG due to techniques in warm up and cool down session of our established PTP. Those sessions used to static stretching figures in upper and lower body, thus PTP could improve flexibility in Thai boxing athletes. The same result as Brooks and co worker 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. They found this method could be improved muscle relaxation and enhance the flexibility [15].

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Table 1 Schedule of normal Thai boxing training program in control group (CG) and applied plyometric training group (PTG) for 5 days / week

Monday	Tuesday	Wednesday	Thursday
- Warm up 10 min - Shadow Thai boxing drills 5 min - Punch and kick on punching bag 10 min - Punch and kick pad drills 10 min - Sit up 90 repetition - Push up 60 repetition - Cool down 10 min	- Warm up 10 min - Shadow Thai boxing drills 5 min - Punch and kick on punching bag 10 min - Sparing Thai boxing 15 min - Sit up 90 repetition -Push up 60 repetition - Cool down 10 min	- Warm up 10 min - Recreation game 30 min - Cool down 10 min	- Warm up 10 min - Shadow Thai boxing drills 5 min - Punch and kick on punching bag 10 min - Close-battle training 15 min - Sit up 90 repetition - Push up 60 repetition - Cool down 10 min
Thursday	**Friday**	**Saturday**	**Sunday**
- Warm up 10 min - Shadow Thai boxing drills 5 min - Punch and kick pad drills 10 min - Close-battle training 15 min - Sit up 90 repetition - Push up 60 repetition - Cool down 10 min	- Warm up 20 min - Shadow Thai boxing 5 min - Punch and kick on punching bag 10 min - Sparing Thai boxing 15 min - Sit up 90 repetition - Push up 60 repetition - Cool down 10 min	- Rest and Recovery	- Rest and Recovery

Table 2 Schedule of applied plyometric training program (PTP) in applied plyometric training group (PTG) for 2 days / week

Day 1: Tuesday	Day 2: Thursday
- Warm up 10 min	- Warm up 10 min
- Applied plyometric training program 30 min	- Applied plyometric training program 30 min
1.1 Plyometric squat jump 3 sets x 8 - 10 reps	2.1 Lateral High Hops 3 sets x 8 - 10 reps
1.2 Over back toss 3 sets x 8 - 10 reps	2.2 Plyometric push up 3 sets x 8 - 10 reps
1.3 Lateral barrier jumps 3 sets x 8 - 10 reps	2.3 Zig zag jumps 3 sets x 8 - 10 reps
1.4 Side throws 3 sets x 8 - 10 reps	2.4 Slams 3 sets x 8 - 10 reps
- Cool down 10 min	- Cool down 10 min

Table 3 Baseline characteristics and anthropometry in male Thai boxing subjects in applied plyometric training group (PTG; n = 17) at pre test period (week 1), mid test period (week 7) and post test period (week 14)

Variables	Male Thai boxing subjects		
	PTG (n=17)		
	Week 1	Week 7	Week 14
Age (years)	21.24± 1.15	21.35 ± 1.06	21.41 ± 1.00
Body weight (kg)	59.25 ± 7.35	60.94 ± 8.38	61.22 ± 8.80
Height (cm)	170.06 ± 5.06	170.18 ± 5.11	170.24 ± 5.13
BMI (kg/m^2)	20.43 ± 1.69	20.97 ± 1.96	21.05 ± 2.14
Total body fat (%)	14.96 ± 5.51	15.05 ± 5.46	15.17 ± 4.68
WC (Inch)	29.41 ± 2.94	29.35 ± 2.45	29.35 ± 2.45
HC (Inch)	35.18 ± 2.43	34.41 ± 2.72	34.14 ± 2.30
WHR	0.84 ± 0.05	0.85 ± 0.06	0.87 ± 0.05
SBP (mmHg)	120.82 ± 6.89	121.82 ± 10.41	123.06 ± 5.70
DBP (mmHg)	76 ± 7.14	76.35 ± 4.27	76.56 ± 9.93
MAP (mmHg)	90.94 ± 6.04	91.51 ± 5.44	92.08 ± 6.99
HR (beats/min)	64.12 ± 7.94	63.94 ± 8.54	63.24 ± 7.93

Data were presented as mean ± SD. Body mass index (BMI), waist circumference (WC), hip circumference (HC), waist to hip ratio (WHR), systolic blood pressure (SBP), diastolic blood pressure (DBP), mean arterial pressure (MAP), heart rate (HR). All data were tested by repeated measures ANOVA.

No significant difference between week 1 versus week 7,14 and week 7 versus week 14.

Table 4 Comparative data of muscle strength and flexibility within control group (CG; n = 16) and applied plyometric training group PTG; n = 17) at pre test period (week 1), mid test period (week 7) and post test period (week 14)

Variables	Male Thai boxing subjects					
	CG (n=16)			PTG (n=17)		
	Week 1	Week 7	Week 14	Week 1	Week 7	Week 14
Hand grip test (kg)	42.00 ± 6.53	41.38 ± 7.77	42.13 ± 7.52	38.58 ± 5.36	42.24 ± 5.47[aaa]	44.53 ± 7.04[aaa bb]
Leg strength test (kg)	154.13 ± 18.79	154.63 ± 19.86	154.06 ± 16.93	148.24 ± 17.12	163.29 ± 17.17[aaa]	172.94 ± 21.59[aaa bb]
Trunk flexibility test(cm)	14.63 ± 4.87	14.56 ± 4.60	14.38 ± 4.86	14.50 ± 5.71	16.56 ± 5.44[aaa]	17.35 ± 5.09[aaa]

Data were presented as mean ± SD. All data were analyzed by repeated measures ANOVA

[aaa] Highly significant difference at $p<0.001$ between week 1 versus week 7 and week 14

[bb] High significant difference at $p<0.01$ between week 7 versus week 14

Table 5 Comparative data of muscle strength and flexibility between control group (CG; n = 16) and applied plyometric training group (PTG; n = 17) at pre test period (week 1), mid test period (week 7) and post test period (week 14)

Variables	Male Thai boxing subjects					
	Week 1		Week 7		Week 14	
	CG	PTG	CG	PTG	CG	PTG
Hand grip test (kg)	42.00 ± 6.53	38.58 ± 5.36	41.38 ± 7.77	42.24 ± 5.47	42.13 ± 7.52	44.53 ± 7.04
Leg strength test (kg)	154.13 ± 18.79	148.24 ± 17.12	154.63 ± 19.86	163.29 ± 17.17	154.06 ± 16.93	172.94 ± 21.59 [aaa]
Trunk flexibility test (cm)	14.63 ± 4.87	14.50 ± 5.71	14.56 ± 4.60	16.56 ± 5.44	14.38 ± 4.86	17.35 ± 5.09

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

[aaa] Highly significant difference at $p<0.001$ between CG and PTG at week 14

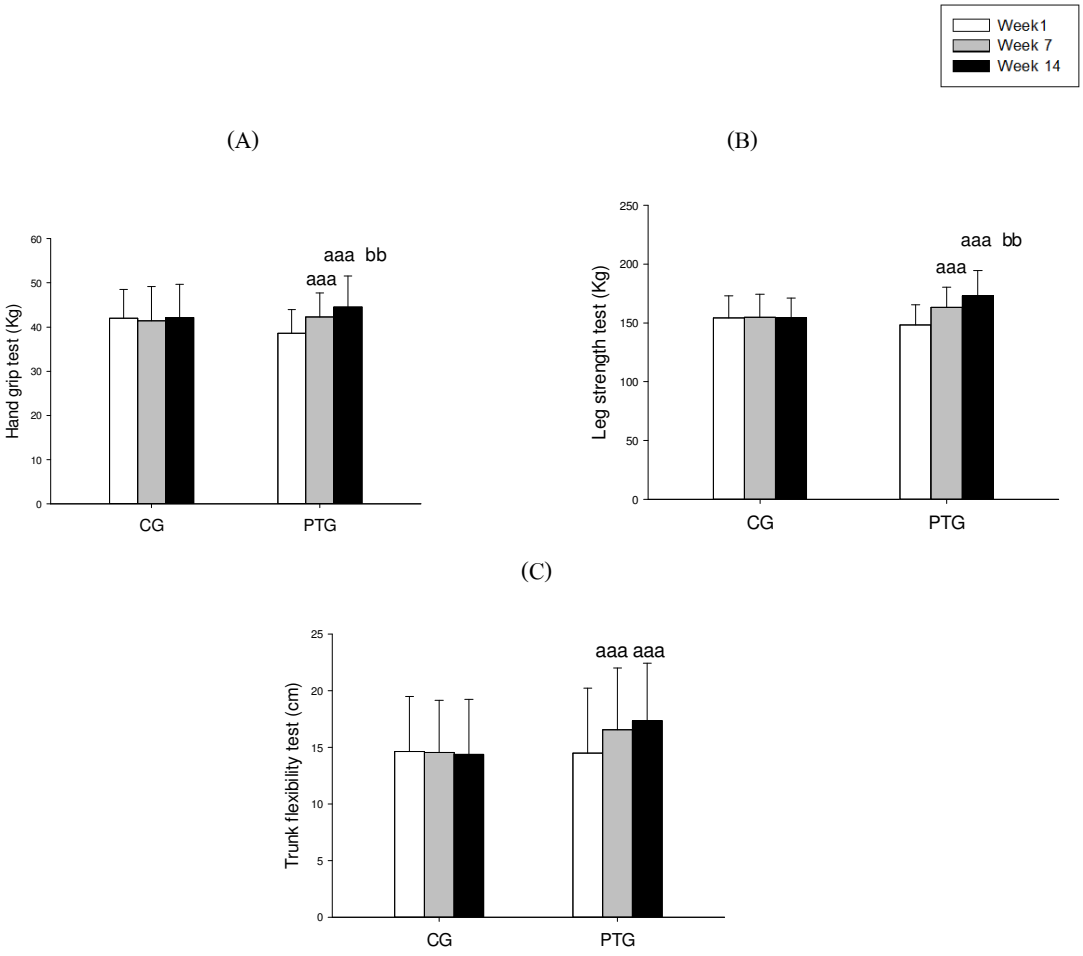

Figure 1 Data were presented as mean ± SD. (A) Hand grip test, (B) Leg strength test, (C) Trunk flexibility test in control (CG) and plyometric training group (PTG) at week 1, 7 and week 14. All data were tested by repeated measures ANOVA.

$^{aaa}p<0.001$ Highly significant difference between week 1 versus 7 and week14.

$^{bb}p<0.01$ High significant difference between week 7 versus 14.

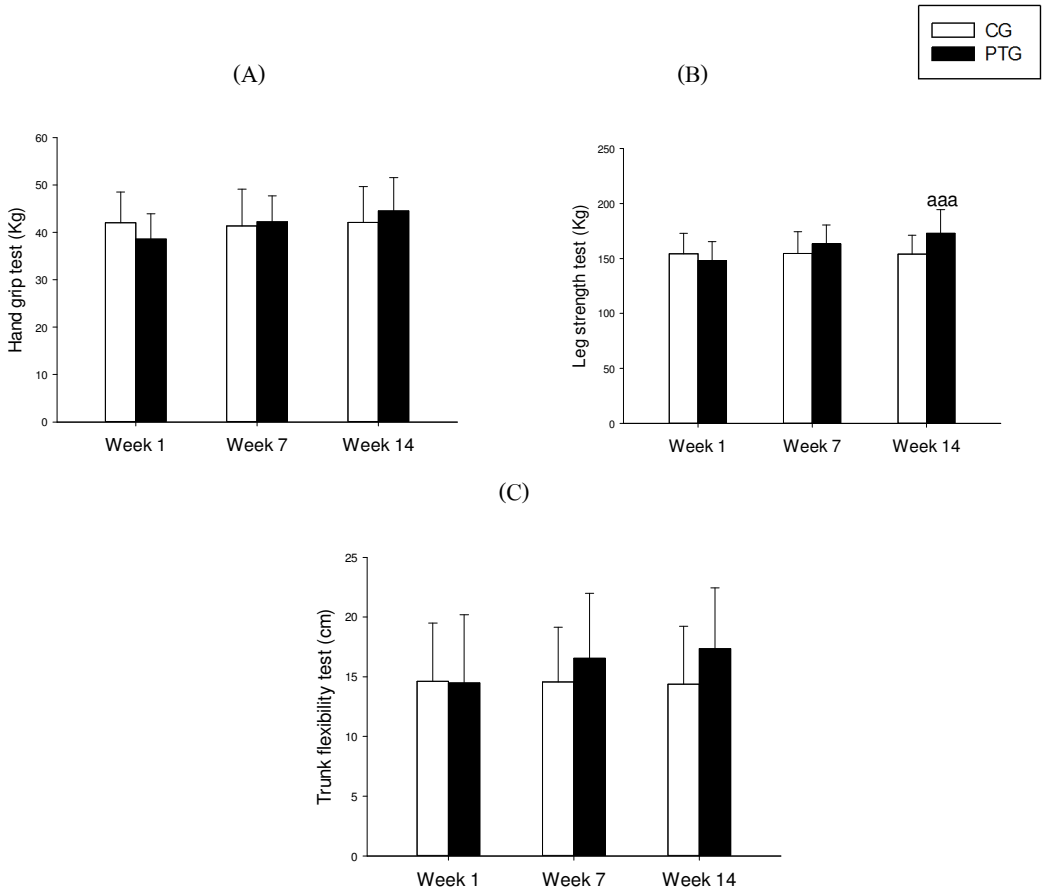

Figure 2 Comparative data were presented as mean ± SD at pre test period (week 1), mid test period (week 7) and post test period (week14). (A) Hand grip test, (B) Leg strength test, (C) Trunk flexibility test in control (CG) and applied plyometric training group (PTG) at week 1, 7 and week 14.

Data were tested by independent sample T-test.

[aa] $p<0.01$ High significant difference at week 14.