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เทคนิคการแพทย์และกายภาพบำบัด
JOURNAL OF MEDICAL TECHNOLOGY AND PHYSICAL THERAPY

นิพนธ์ต้นฉบับ
ORIGINAL ARTICLE

การฝึกด้วยแรงต้านโดยใช้ความเข้มข้นระหว่างระดับเบาและหนัก ที่มีผลต่อภาวะออกซิเดทีฟสเตรสครีเอตีนไคเนส และอาการปวดกล้ามเนื้อ ในกลุ่มคนเพศชายที่ไม่ค่อยออกกำลังกาย: การศึกษานำร่อง

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Received: *February 26, 2016*
Revised & Accepted: *March 15, 2016*

บทคัดย่อ

วัตถุประสงค์ของการศึกษาครั้งนี้ เพื่อประเมินผลของการฝึกน้ำหนักด้วยแรงต้านที่ความหนักร้อยละ 50 และ 80 ของน้ำหนักที่ทำได้สูงสุดใน 1 ครั้งต่อภาวะออกซิเดทีฟสเตรสครีเอตีนไคเนสและระดับปวดกล้ามเนื้อโดยทำการศึกษาในกลุ่มอาสาสมัครเพศชาย จำนวน 30 รายด้วยการสุ่มให้ฝึกน้ำหนักที่ระดับร้อยละ 50 หรือ 80 ของน้ำหนักที่ทำได้สูงสุดของแต่ละท่า จำนวน 5 ท่าคือ Machine fly, Wide-grip pulldown, Preacher curl, Machine crunch และ Leg extension ทำการประเมินตัวแปรภาวะออกซิเดทีฟสเตรสได้แก่ฤทธิ์ต้านอนุมูลอิสระโดยรวม มาลอนไดออลดีไฮด์ในตริกออกไซด์และครีเอตีน ไคเนสและคะแนนปวดกล้ามเนื้อ เป็นจำนวน 3 ครั้งคือ ก่อน หลังการฝึก 24 ชั่วโมง และหลังการฝึกเป็นเวลา 1 สัปดาห์ผลการศึกษาพบว่า หลังการฝึกที่ระดับความหนักร้อยละ 50 ของน้ำหนักสูงสุด ทั้ง 3 ครั้ง ฤทธิ์ต้านอนุมูลอิสระโดยรวม มาลอนไดออลดีไฮด์ ไนตริกออกไซด์และครีเอตีนไคเนสไม่มีความแตกต่างกันทางสถิติ ในขณะที่หลังการฝึกที่ระดับความหนักที่ระดับร้อยละ 80 ของน้ำหนักสูงสุดเป็นเวลา 24 ชั่วโมง ทำให้ฤทธิ์ต้านอนุมูลอิสระโดยรวม ไนตริกออกไซด์มีค่าต่ำลง ส่วนค่าครีเอตีน ไคเนสและคะแนนปวดเพิ่มขึ้นอย่างมีนัยสำคัญ เมื่อเปรียบเทียบกับก่อนการฝึก แต่หลังจากฝึกไปได้ 1 สัปดาห์ พบว่าฤทธิ์ต้านอนุมูลอิสระ ไนตริกออกไซด์และระดับคะแนนปวดมีค่าเพิ่มขึ้นแต่ค่าครีเอตีนไคเนสมีค่าลดลงอย่างมีนัยสำคัญ แต่หลังการฝึกด้วยระดับน้ำหนักทั้งสองเป็นเวลา 24 ชั่วโมง คะแนนระดับปวดมีค่าเพิ่มขึ้นอย่างมีนัยสำคัญเมื่อเปรียบเทียบกับก่อนการฝึก ในขณะที่กลุ่มที่ฝึกที่ระดับความหนักที่ร้อยละ 80 คะแนนระดับการปวดยังคงสูงอย่างมีนัยสำคัญ แต่หลังการฝึกไปได้ 1 สัปดาห์ คะแนนปวดมีค่าไม่แตกต่างทางสถิติและกลับสู่ใกล้เคียงกับคะแนนก่อนฝึกเฉพาะในกลุ่มที่ฝึกที่ระดับน้ำหนักร้อยละ 50 ดังนั้นจากการศึกษาครั้งนี้แสดงให้เห็นการเปลี่ยนแปลงของภาวะออกซิเดทีฟสเตรส การบาดเจ็บและการปวดกล้ามเนื้อ ทั้งการฝึกแรงต้านด้วยน้ำหนักที่ระดับความหนักร้อยละ 50 และที่ร้อยละ 80 ของน้ำหนักที่ทำได้สูงสุดในการยก 1 ครั้ง

คำสำคัญ: การฝึกด้วยแรงต้านน้ำหนัก, ออกซิเดทีฟสเตรส, ครีเอตีน ไคเนส, ปวดกล้ามเนื้อ

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Resistance Training between Low and High Intensities on Oxidative Stress, Creatine Kinase and Muscle Pain in Sedentary Males: A Preliminary Study

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Abstract

Aims of this study were to evaluate the effects of initial 1-week resistive weight training between 50% and 80% of 1repetitive maximum (1 RM) on oxidative stress, creatine kinase (CK), and muscle pain. Thirty sedentary male participants were included and randomized into two groups of 50% and 80% of 1 RM in five cycle stations; machine fly, wide-grip pull down, preacher curl, machine crunch, and leg extension. Oxidative stress parameters, as total antioxidant capacity (TAC), malondialdehyde (MDA), nitric oxide (NO) and CK; and muscle pain score were evaluated in three periods, pre, 24hr post first day of exercise and after 1 week post training. The results showed no statistical difference in TAC, MDA, NO, and CK concentration between the three periods in the 50% of 1 RM group. Whereas, training in the 80% of 1 RM showed a statistical difference in all parameters at 24 hr post first day of exercise, with significantly lower levels of TAC, NO and higher CK and Pain level score when compared to pre training, whereas the TAC, NO, and muscle pain scoreparameters increased significantly, as same as the CK level after 1 week's training. Furthermore, pain scores in both groups were significantly higher than those at baseline. However, after 1 week's weight training at 50% of 1RM, the pain level score became non-significant and returned to almost baseline,except at 80% of 1RM presented significant higher level. Therefore, this study suggested the changes of oxidative stress, muscle injury and muscle pain from initial weight training at 50%and 80% of 1RM.

Keywords: Resistive weight training, Oxidative stress, Creatine kinase, Muscle pain

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Introduction

Many young men and teenage boys are currently interested in building their muscles from weight training exercise. The circuit weight training (CWT) machine is a popular tool for individual muscle training, for example, lying down rowing, squat, shoulder and bench press, etc. This training program has fewer effects on the cardiopulmonary system with moderate intensity (65-75% of maximal heart rate)[1]. Weight training for an isolated muscle group is composed of various types of muscle contractions such as concentric, eccentric and isometric contractions that promote muscle hypertrophy with increased muscle mass, fiber size, protein content and protein synthesis[2]. The principle of weight resistive training suggests starting from a low intensity of 45-50% to maximal intensity of 80-85% of maximal weight from one repetitive maximum (1RM), with 8-12 repetitions per section, and 1-3 cycles[3]. A previous study showed the benefits of explosive-type resistive training for strength and power, with leg extension, leg curl, low raw, and chest press for 12 weeks[4]. Basic theory of muscle adaptation from resistive training has been recorded through numerous neuromuscular mechanisms, and muscle strength may increase significantly within the first week of training[5]. Starting at a moderate to high intensity in the weight resistive training program is quite interesting for rapidly building muscle mass in some cases of individual training. On the other hand, heavy-resistive circuit training induce soreness, edema, and performance deterioration[6,7] relating to reactive oxygen species (ROS) production[8]. Furthermore, ROS relates to post-exercise inflammatory response and possible progression to muscle damage[9]. Previous evidence suggested that muscle damage and inflammation relates to over oxidative stress by depressed on total antioxidant capacity (TAC) status as same as degraded glutathione (GSH), and still induced lipid peroxide as malondialdehyde (MDA), nitric oxide (NO) production, and protein oxidation[10]. This phenomenonwas proposed occurring after over-weight resistive training at 80% of 1 RM [11]. In addition, resistive training at both 50% and 80% of 1 RM activates superoxide dismutase (SOD) activity and glutathione peroxidase (GPx) in untrained and trained males[12]. It also causes significantly increased lactate, dyspnea, and heart rate in untrained men after 2 weeks of weight training at a low intensity of 30% of 1 RM[1]. The muscle work in weight resistive training, such as eccentric contraction, provokes muscle damage and releases specific creatine kinase (CK), especially within 8 hours, and peaking at 48 hours[13-15]. Weight resistive training is not only for young people, but also older adults who apply 50% of 1 RM in the first week, and up to 80% in the second one, in order to improve on their ability to balance[16]. An interesting weight protocol currently proposes high volume and high intensity for building muscles in a short time [17], but there is still a lack of scientific evidence to present the advantages or disadvantages, especially regarding oxidative stress. Therefore, the aim of this preliminary study was to evaluate the effects of both acute and one-week latent period weight training on oxidative stress, CK, and muscle pain in healthy young men, during low or heavy intensity of 50% and 80% of 1 RM.

Materials and Methods

Study design and recruitment of participants

This research protocol was approved by the Human Ethics Committee at the Faculty of Associated Medical Sciences, Chiang Mai University, Thailand (AMSEC-59X-018). Thirty healthy volunteers aged between 18 and 24 years, with a body mass index (BMI) in the required normal range [18.0-24.9 kg/m^2] following the criteria from World Health Organization (WHO) and International obesity task force's guideline (WHO, 2004)[18], were enrolled in this study. None of the volunteers were athletes, and they did not exercise regularly for more than 3 days per week, or refrained from doing resistive training for at least 8 weeks prior to the study, including no any nutrient or vitamin supplementation or any illness within 6 months before started the protocol. All participants were clinical screened with the complete blood count (CBC) test for healthy status, and physical rechecked by a physician. They were instructed to maintain a normal diet and refrain from taking supplementary multi-vitamins or alcohol during the study period**.** They were asked to refrain from commencing any unaccustomed physical activity during the week of the study, but were advised to continue their normal levels of physical activity. Participants were excluded from the study if any of the following contraindications applied; intake of nutrient or vitamin supplements during experimental period.

Experimental design

The 30 participants included in this study were randomized into two groups; 50% and 80% of 1 RM weight training cycle stations. Five stations were composed of 5 specific patterns; machine fly (MF), wide-grip pulldown (WGP), preacher curl (PC), machine crunch (MC), and leg extension (LeE) **(Figure 1)**. The 1 RM was determined in each pattern for all participants before setting and performing intensity weight training at either 50% or 80% of 1 RM once a day for a one week period. Oxidative stress parameters in blood such as total antioxidant capacity (TAC), malondialdehyde (MDA), nitric oxide (NO), CK, and subjective muscle pain score were evaluated pre, 24 hr post first day of exercise, and after 7 days of weight training (1 week).

Blood collection

All volunteers refrained from alcohol and caffeine consumption for at least 24 h, and took no exhaustive exercise for at least 9 h before blood evaluation. 10 mL of peripheral blood samples were drawn from an antecubital vein, and separated each 5 mL to keep in the tube containing and non-containing an ethylenediaminetetraacetic acid (EDTA). Fresh plasma from the blood in EDTA-tube was taken immediately after blood sampling in order to evaluate TAC, after being separated by centrifugation at 5,000 g for 10 min and also to evaluate MDA and NO. Whereas, the serum from the blood in the non EDTA-tube was separated to determine CK.

One repetitive measurement (1 RM)

The protocol measurement of 1 RM followed the standardized protocol[19]. After instructing the subjects to warm up with light resistance that easily allows 5-10 repetitions, a 1-2 min rest period was provided. Firstly, an estimated warm-up load allowed the subjects to complete 3-5 repetitions by adding 10-20 Ib (4-9 Kg) or 5-10% in MF, WGP and PC positions, or 30-40 Ib (14-18 kg) or 10-20% for MC and LeE. Secondly, after a 2-3 min rest period, a conservative estimate of near-maximum load allowed the subjects to complete 2-3 repetitions by adding the load as done previously in warm-up loading. Thirdly, after a longer 2-4 min rest period, the load was increased as in the first test. Finally, the subjects were instructed to attempt 1 RM. If they were successful, a 2-4 min rest period was provided. On the other hand, if the subjects failed, a 2 to 4-min rest period was provided before decreasing the load to 5-10 Ib (2-4 kg) or 2.5-5.0% in MF, WGP, PC, and MC positions, or 15-20 Ib (7-9 kg) or 5-10% forLeE. A single maximal load through the full range of motions in each weight training position was recorded in order to estimate the percentage load at 50% and 80% for the weight resistive protocol.

Weight training pattern

All vital signs such as respiratory rate, oxygen saturation, heart rate and blood pressure were recorded before and after the test. Criteria for stopping the test were reaching 6 minutes testing time and any change occurring from the guideline of the American College of Sports Medicine (ACSM) (2004)[20]. The program of weight training in five series of patterns; MF, WGP, PC, MC and LeE was designed for performing once daily for 7 days.

Machine fly (MF): Sit on a seat with back supported and feet flat on the floor. Grip the handles on both sides of the seat. The shoulder abduction and elbow flexion should be set at 90 degrees before pulling forward **(Figure 1A)**.

Wide-grip pulldown (WGP): Sit on a seat facing the machine with thighs under pads and feet flat on the floor. Grasp the lateral pull down bar with a closed, pronated grip that should be wider than shoulder-width. Pull the bar down and toward the upper chest with the torso leaning backward slightly until the bar touches the chest. Then allow the elbows to extend slowly back to the starting position **(Figure 1B)**.

Preacher curl (PC): Set the height of the preacher curl bench so that the armrest is slightly below shoulder level when sitting down. Place the upper arms over the armrest and grasp the bar bell with an underhand grip. Extend the elbows fully before flexing **(Figure 1C)**.

Machine crunch (MC): Sit leaning back with both legs locked by holding at the ankles. Rest the head on the head support and grip the handles beside the head. Then flex the trunk as much as possible and release to the starting position **(Figure 1D)**.

Leg extension (LeE): Adjust the back of the seat and foot pad for the LE machine, so that when the knees are at the edge of the seat, the ankles are just below the rollers. Sit with back leaning against the back of the seat. Grip the handles behind the hips and keep the upper body stable while extending the legs in a smooth movement until fully extended. Then, lower the weight under control to the starting position **(Figure 1E)**.

It was suggested that all volunteers practice each pattern in 3 cycles of 10-12 repetitions, with 3 min rest periods before changing the pattern. The series is continuous from MF, WGP, PC, MC, to LeE, consecutively.

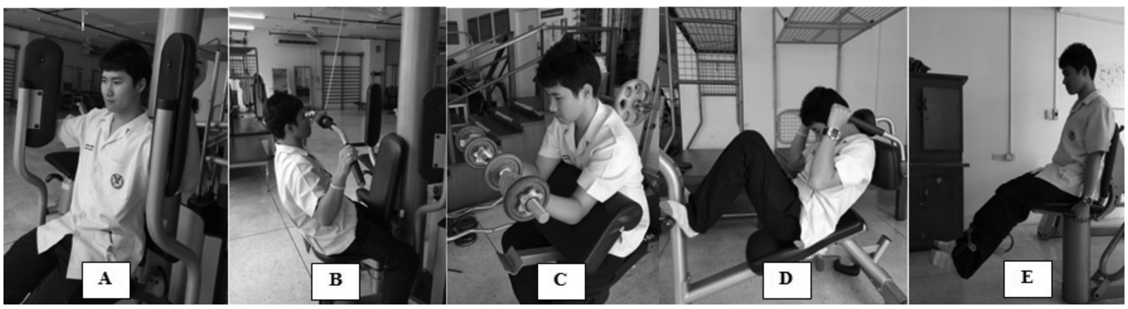

Figure 1 Weight training patterns; Machine fly (A), Wide-grip pulldown (B), Preacher curl (C), Machine crunch (D), and Leg extension (E).

Blood oxidative stress evaluation

Ten mL of blood was taken from the anterior cubital vein and put into heparin-containing tubes. Fresh plasma was separated by centrifugation at 5,000 rpm for 10 min and 10 μL of plasma was assayed immediately for TAC (21,22), followed by NO determination from 100 μL of Griess reagent (23). Two hundred μL of residual plasma was separated into microcentrifuged tubes and restored at -80 degrees Celsius for determining MDA from the thiobarbituric acid (TBA) reagent protocol (24). Concentration of TAC, MDA and NO parameters were evaluated using spectrophotometry at λ734, 532, and 512 nm, respectively, and compared with the standard Trolox, tetramethoxypropane, and sodium nitrite (Sigma, USA).

Muscle pain and creatine kinase evaluation

The participants were asked to rate the sensation of pain from muscle soreness felt during everyday activity. Pain level score was measured using a 10 cm visual analogue scale (VAS) with terminal descriptors; 'no pain (score =0)' and 'maximal pain (score =10)'. Distance from the 'no pain' descriptor to maximum of 10 was measured in centimeters[25]. CK serum samples were obtained as a marker of muscle damage, and evaluated using a Reflotron Plus machine (Roche Diagnostics Corp, Roche Cobas # 11731432, Germany), at the AMS Clinical Center Service at Faculty of Associated Medical Sciences, Chiang Mai University, Thailand.

Statistical analysis

All parameters of oxidative stress and CK were presented in mean and standard deviation, and statistically analyzed with the repeated measurement protocol and Turkey test in the Statistical Package for Social Sciences Version 10.0 (SPSS Inc, Chicago, IL, USA). Whereas, the non-parameteric Friedman Test and Wilcoxon Signed Ranks test were used for the statistical difference of muscle pain score presented from the data, with the median and percentile at 25% and 75%. Significance was set at p = 0.05.

Results

All the sedentary male volunteers in this study were divided randomly into two groups for weight training: 50% of 1 RM and 80% of 1 RM. **Table 1** shows the age, height, weight and normal body mass index (BMI) in both groups [50% of 1 RM (n =15), and 80% of 1 RM (n = 15)]. There was no statistical difference in any of the characteristics of the parameters between the two groups (p>0.05) **(Table 1)**. Furthermore, a CBC screening test before the study showed the health status of all volunteers as being normal **(Table 2)**.

Table 1 Characteristics of 30 sedentary male volunteers between training at 50% and 80 % of 1 RM

Characteristics	**Group 50% of 1 RM (n=15)**	**Group 80% of 1 RM (n = 15)**	***p*-values**
Age (years)	22.0 ± 0.93 (20-23)	22.1 ± 1.03 (20-24)	0.83
Height (m)	1.68 ± 0.03 (1.61-1.72)	1.70 ± 0.04 (1.64-1.73)	0.81
Weight (kg)	63.7 ± 2.28 (6.0-66.0)	62.5 ± 1.55 (61.5-66.0)	0.95
BMI ($kg.m^{-2}$)	22.65 ± 1.06 (21.11-24.38)	22.18 ± 0.85 (20.85-23.88)	0.16

Value presents the mean ± SD (min-max). Independent pair t-test was used for statistical comparison between the two groups.

Table 2 Complete blood count (CBC) of all 30 sedentary male volunteers before the implement the training program

CBC	(Reference range)	Values
WBC	Men =5-10 x10^3 /μL	6.45 ± 1.02 (4.2 - 9.8)
RBC	3.8-5.3 x10^6 /μL	4.32 ± 0.45 (3.67 - 4.05)
Hb	Men = 10-16 gm/dL	11.9 ± 1.56 (10.5 - 14.5)
Hct	Men = 36-50 %	41.5 ± 1.95 (36.8 - 48.5)
PLT	140-440 x10^3/μL	247 ± 46 (155 - 420)

Value presents the mean ± SD (min-max). WBC = white blood cells, RBC = red blood cells, Hb = hemoglobin, Hct = hematocrit, PLT =platelet. Values are mean ± SD (min-max) for each variable.

Before starting weight training in each pattern; all 30 sedentary volunteers were measured for 1 RM, and the results shown in **Table 3** present the maximum weight of all patterns; MF, WGP, MC, PC and LeE, respectively.

Table 3 Maximal weight at one-repetition maximum (1 RM) measurement of all 30 sedentary male volunteers before randomized into training either 50% or 80% of 1 RM

Weight training patterns	1 RM (Kg)
Machine fly	35.15 ± 4.69 (27.3 - 40.9)
Wide-grip pulldown	44.87 ± 4.16 (36.4 - 50.0)
Machine crunch	12.17 ± 0.84 (10.5 - 14.0)
Preacher curl	7.70 ± 1.13 (5.50 - 9.25)
Leg extension	43.05 ± 4.16 (36.4 - 50.0)

Values are mean±SD (min-max) for each weight training pattern.

Oxidative stress status, Creatine kinase and Muscle pain

Three parameters from the results of oxidative stress (TAC, MDA, and NO) were evaluated and results shows in **Table 4**. Fifteen volunteers in the 50% of 1 RM group showed no statistical difference in 24 hr post single bout exercise, and 1 week post training compared to pre training. These results were similar to the CK level between pre, 24 hr post single bout exercise and 1 week post training. Therefore, either short or prolonged weight training showed no any statistical difference in the 50% of 1 RM group.

Interestingly, results of weight training in the 80% of 1 RM group **(Table 4 and Figure 2)**, show adverse effects at significantly lower levels of TAC and NO after 24 hr post single bout exercise, when compared to pre training. At 1 week post training, the 80% of 1 RM group showed a significant increase in TAC and NO when compared to 24 hr post single bout exercise (p < 0.01, 0.01). However, TAC was significantly lower than the baseline (p < 0.01), whereas NO level significant increased (p < 0.01). Whereas, MDA levels showed a non-significant decrease 1 week post training, when compared to 24 hr post single bout exercise and baseline (p = 0.52) **(Table 4 and Figure 2)**.

In the results of training at 50% 1 RM, the CK level presenting muscle injury was not statistically different between baseline and 24 hr post single bout exercise, or baseline and 1 week post training. Whereas, weight training in the 80% of 1 RM group induced the CK level significantly at both 24 hr post single bout exercise (p < 0.05) when compared to baseline, and slightly reduced after 1 week post training but this still higher than at baseline (p< 0.05) and lower than at 24 hr period (p < 0.05).

Table 4 shows significant pain score from post-24 hr of training in the 50% and 80% of 1 RM groups (median = 3 & 3), when compared to baseline (0 & 0) (p< 0.05). After 1 week of training, the pain score reduced (median = 1) to a non-significant difference from the baseline (p= 0.65). However, the pain score was significantly higher 1 week post training in the 80% of 1 RM group (median = 4) when compared to the baseline or 24 hr post period (p< 0.05).

Table 4 Blood oxidative stress, creatine kinase (CK), and muscle pain in all 30 volunteers from both groups

	50% 1 RM (n = 15)			80% 1 RM (n = 15)		
	Before	Post-24 hr	Post-1 week	Before	Post-24 hr	Post-1week
Oxidative stress						
TAC	1.02±0.08	0.96±0.07	0.92±0.06	1.23±0.09	0.40±0.04*	0.75±0.05*#
(mmolTrolox)	(0.65-1.55)	(0.55-1.45)	(0.56-1.34)	(0.53-1.67)	(0.22-0.67)	(0.45-1.12)
MDA	0.20±0.01	0.19±0.01	0.20±0.01	0.19±0.01	0.21±0.01	0.17±0.01
(μmol/L)	(0.11-0.31)	(0.11-0.25)	(0.14-0.29)	(0.11-0.23)	(0.15-0.29)	(0.11-0.26)
NO	33.80±1.30	35.33±0.93	35.73±1.25	31.60±1.21	25.53±0.95*	39.40±1.27*#
(μmol/L)	(24-42)	(29-41)	(29-44)	(23-41)	(21-32)	(31-46)
Creatine kinase and muscle pain						
CK	124.7±4.7	129.1±4.2	138.3±4.2	130.1±4.2	167.8±3.9*	145.1±3.9*#
(U/mL)	(110-165)	(101-162)	(111-171)	(106-156)	(117-199)	(144-198)
Pain score	0.00 [0-0]	3 [2-3]*	1 [1-1.75]	0.00 [0-0]	3 [3- 4]*	4 [4-5]*,#
	(0-0)	(2-4)	(0-2)	(0-0)	(2-5)	(3-5)

Value of TAC, MDA, NO, and CK is mean ± SD (min-max), whereas pain score presents a median [25% - 75% of percentiles] and (min-max). TAC = total antioxidant capacity, MDA = malondialdehyde, NO = nitric oxide, CK = creatine kinase. * p< 0.05 compared to the baseline, and #p<0.05 compared to 24 hr post period.

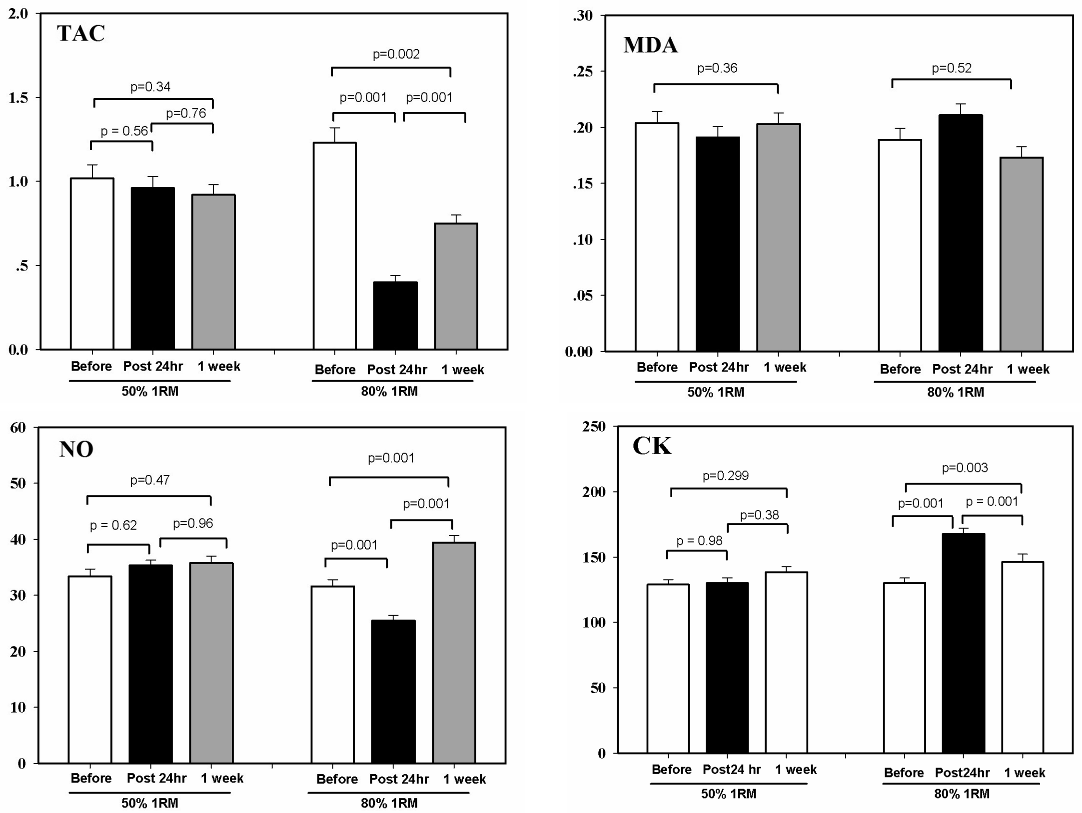

Figure 2 Oxidative stress markers; total antioxidant capacity (TAC), malondialdehyde (MDA), nitric oxide (NO), and creatine kinase (CK) between weight exercise training at 50% and 80% of 1 RM. Repeated measurement and the Turkey test were used.

Discussion

This study was preliminary trial studied for initial weight training within one week, with low and maximal intensity in healthy young sedentary male volunteers (20-24 years old). Normally, a weight resistive training program is suggested; starting from low to maximal intensity in 8-12 weeks[3]. This study designed a protocol for healthy sedentary volunteers who were not athletic or exercised for less than 3 days per week, which included never doing weight cycle training before. Starting weight training at maximum seemed more interesting in the 80% of 1 RM group than beginning at low intensity in the 50% of 1 RM group, with individual designs.

Much evidence shows adverse effects from over-weight training by way of inducing soreness, edema, performance deterioration[6,7], and increased oxidative stress[8] related to muscle damage[9]. Over-weight training is not the only negative influence, but low intensity training at 30% of 1 RM for 2 weeks also presents adverse effects by increasing lactate, dyspnea and heart rate, especially in untrained men[1].

This study showed the different effects of weight resistive exercise on the 80% and 50% of 1 RM groups. There is no any statistical difference in all parameters, TAC, MDA, NO, or CK (p> 0.05) in a low weight at 50% of 1 RM group **(Figure 2)** either at post 24 hr or after 7 days training.

Whereas in the heavy weight training at 80% of 1 RM group showed the significant decrease on TAC and increase on CK at the post 24 hr when compared to before training. Thus this result is possible explained with the previous evidence that proposed to the oxidative injury and muscle injury from an acute bout of heavyweight exercise[26]. In addition, previous reviewed evidence proposed that free radicals were produced during post-exercise inflammatory response, which possibly propagates acute muscle damage[9]. Whereas the significant lower of NO and non-significant slightly increases of MDA level after post 24 hr weight training, is still unclear and controversial result of free radical pathway. Because of the previous evidence showed that over-weight resistive training at 80% of 1 RM induced muscle damage and inflammation related to conditions of oxidative stress[11] such as degraded glutathione (GSH) and higher MDA releasing from lipid peroxidation[10]. Moreover, the NO level significant reduced after post 24 hr exercise is still unclear because it should be excreted significantly during oxidative stress, therefore, the result_is needed more evaluation.

After weight resistive training exercise for 1 week at 80% of 1 RM showed significant reversed phenomena in TAC and NO, but not significantly reduced at the MDA level, when compared to the post24 hr of exercise. This may be possibly explained with the muscular adaptation_that is similar to Vincent's suggestion, which indicated that chronic resistance training may provide a protective effect on oxidative stress, the same as in aerobic exercise[27]. In addition that the muscle adaptation has been suggested in a previous report by Azizbeigi (2014), who found that resistive training at induced the superoxide dismutase (SOD) and glutathione perioxidase (GPx) activities in untrained and trained males[12], therefore, free radicals has been buffered and reduced as well as the antioxidant GSH is be enhanced. This results is possible consistency to a previous study that found the significantly reversed TAC after weight resistive training at 70% of 1 RM on bench press, squat, snatch, hang clean, dead lifts, barbell curls, and rowing for 3 weeks[10]. Moreover, this study found the over-reversed level of NO after 1 week post training when compared to the baseline or post-24 hr exercise. Possible reason of this change can be proposed with vascular adaptation as same as in the previous study in 7 healthy subjects that found the endothelial nitric oxide synthase (eNOS) response after resistance exercise training for 8 weeks[28]. Therefore, the higher NO level possibly relates to its remarkable ability as a vasodilator in distributing blood to muscle fiber[29].

Moreover, the results of CK production, either at post-24 hr of exercise or after 7 days weight training when compared to before training. Although slightly lower of CK level at after 7 days training comparing to at post-24 hr of exercise, but it still significant higher than at before training ($p< 0.05$). Thus, weight training at 80% of 1 RM still suggested the higher muscle injury, and prolonged during 7 days of weight training. This result is similar to a previous study that presented the release of CK enzymes (creatine phosphokinase, CPK-MB isoenzyme) after a bench-stepping test, with eccentric one leg stepping, related to pain and tenderness from micro-muscle injury within 8 hours, and peaked at 48 hours (CPK, CK-MB)[13-15].

Finally, from the statistical analysis of muscle pain score after a normal test, the Shapiro-wilk statistic found non normal distribution, and the data were shown with a median and percentile of 25% and 75%. In case of weight training at 50% or 80% of 1 RM groups, the Friedman Test and Wilcoxon Signed Ranks test used different analyses for identification. Data showed that weight training exercise at 24 hr post single bout exercise was significantly higher in pain scores ($p < 0.05$) in either the 50% or 80% of 1 RM groups, when compared to each baseline period. Whereas, after 1 week exercise, the pain score in the 50% of 1 RM group reduced with significant difference to nearly baseline. On the other hand, the pain score was still significantly high in the 80% of 1 RM group, when compared to baseline, and similar to 24 hr post single bout exercise. Thus, these muscle pain score and CK level are possible response to over muscle damage.

Although there have been recommendations from the ACSM (2009)[20], it summarizes muscle at 70-85% of 1 RM with 8-12 repetitions per set for 1-3 sets per exercise, or at 70-100% of 1 RM with 1-12 repetitions per set for 3-6 sets per exercise[30]. Current research is interested in weight resistive training within a short period of time and building muscular size with a quick response rather than the previously slow protocol. The updated study of Mangine et al (2015)[17] had high-volume at 70% of 1 RM via 4x10-12 repetitions, and 1-min rest intervals (n = 14). It also had high intensity at 90% of 1 RM via 4x 3-5 repetitions, and 3-min rest intervals (n = 15). The 14 resistive trained men in that study showed that within 3 weeks high-intensity resistance training stimulates greater improvements in some measures of strength and hypertrophy in resistance-trained men. This is in contrast to the conventional theory of muscular building, which proposes that muscle strength is increased significantly within the first week of training[5], and to increase muscle across a sectional area should take longer training time[31,32]. In addition, the time course of hypertrophy becomes evident within the first 6 weeks of training[33]. However, it may be possible to choose either high volume or high intensity for muscle building in practice with a trainer. Furthermore, progression of weight resistance training also has had controversial results between untrained or well-trained men or women, and more study is needed in the future. Although this study had 3 cycles with 10-12 repetitions and 3 min rest periods before changing the pattern within the five being performed, there seemed to be a high volume training protocol at both low (50% of 1 RM) and high intensity (80% of 1 RM). This protocol is challenged by starting weight intensity at a high level of 80% of 1 RM, and as found in this study, over-oxidative stress and muscle injury or pain, is cause for concern. In contrast, a future research design with a the longer period of 3-8 weeks, and heavy weight training at 80% of 1 RM, also is interesting, as it could discover muscular adaptation, especially regarding the oxidative stress system and other parameters.

Conclusion

From this study, the results show the less adverse effect from the low intensity at 50% of 1 RM after weight training during five stations training both on oxidative stress which detected from total antioxidant capacity (TAC), lipid peroxide (malondialdehyde; MDA), nitric oxide (NO), and muscle injury from creatine kinase (CK) or soreness either at acute or after 1 week periods. Whereas, heavy intensity at 80% of 1 RM both acute and prolong training for 1 week induces more oxidative stress and muscle injury or pain. But some results shows the possible changes by slightly increasing in total antioxidant capacity and markedly nitric oxide releasing as same as CK reducing after prolong 1 week training when compared to acute training. But this phenomenon should be confirmed and more study in a large sample size, including longer periods that possible shows the biochemical adaptation on oxidative stress and muscle characteristic.

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