



## EFFECTS OF CONCURRENT RESISTANCE AND AEROBIC TRAINING ON BODY COMPOSITION, MUSCULAR STRENGTH AND MAXIMUM OXYGEN UPTAKE IN MEN WITH EXCESS WEIGHT

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### Abstract

**The study purpose** was to compare the effects of concurrent resistance and aerobic training to resistance and/or aerobic training alone on body composition, muscular strength and maximum oxygen uptake in overweight and obese men.

**Materials and methods.** Twenty-four overweight and obese (BMI = 23.0 – 29.9 kg/m<sup>2</sup>) volunteers who were male students from Ubon Ratchathani Rajabhat University, aged 19-22 years were assigned into 3 groups: 1) resistance training group (RT), 2) aerobic training group (AT) and 3) concurrent resistance and aerobic training group (RT+AT). The training was 45 minutes per session and 2 days per week. Body composition along with muscular strength (1-RM) and maximum oxygen uptake (VO<sub>2</sub>max) were measured before (2-3 days prior) and after (2-3 days post) a 5-week training period.

**Results.** Waist circumference was significantly decreased in all three groups, but the RT+AT group also found improvement in percentages of fat-free mass (0.49 ± 0.49%, p = 0.021, mean ± SD) and skeletal muscle mass (1.01 ± 0.95%, p = 0.025) when compared to their baseline. Similarly, 1-RM in leg extension was significantly increased in all three groups, while the RT group (47.67 ± 14.85%, p = 0.01) and the RT+AT group (42.08 ± 21.70%, p = 0.039) showed a substantially larger improvement in the 1-RM in leg extension when compared to the AT group (20.37 ± 13.97%). Finally, VO<sub>2</sub>max was significantly increased in all three groups (baseline to post-intervention), though they were not significantly different between groups.

**Conclusions.** Concurrent resistance and aerobic training can reduce waist circumference and increase fat-free mass, skeletal muscle mass, 1-RM and VO<sub>2</sub>max. Therefore, this training strategy may serve as a useful alternative way to improve overall physical fitness and health promotion in overweight to obese male population.

**Keywords:** concurrent training, resistance training, aerobic training, 1-repetition maximum, maximum oxygen uptake, excess weight.

### Introduction

The prevalence of overweight and obesity has increased in children and adolescents due to a decrease in physical activity and an increase in access to dietary diversity (Mistry

& Puthussery, 2015). Convenience and access to food are key contributors to overweight and obesity, indicated by a body mass index that exceeds 23.0 kg/m<sup>2</sup> and a higher tendency of being overweight and obese (WHO, 2020). Exercise can help prevent and reduce overweight and obesity. It is more effective when combined with diet control (Shaw et al., 2006). Resistance and aerobic training contributed to body composition development and physical fitness promotion differently in terms of training styles and outcomes (ACSM, 1995).

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Resistance training is the use of weight as a factor in muscle training. The weights can be body weights, weight plates, or exercise equipment. Increasing muscle size and strength depends on the following factors: mechanical tension, metabolic stress and muscle damage (Schoenfeld et al., 2019). Forms of resistance training have increased in recent years. Traditional resistance training is to select exercise postures to perform for a specific number of sets and reps (ACSM, 2002).

Aerobic training is known to have a positive effect on the heart and circulatory system. It increases energy expenditure. It can be continuous or intermittent exercise. The intensity depends on  $\text{VO}_2\text{max}$ , or heart rates that are divided into different levels (Hunter et al., 2015). The appropriate exercise duration that will cause the body to use fat for energy also depends on the intensity (Carnier et al., 2013).

Concurrent resistance and aerobic training may be an alternative form of training used to improve body composition and physical fitness because the basis of concurrent training is to combine resistance and aerobic training in 1 session of training (Geoffrey, 2017). Those performing this type of training may be benefited from the increase in muscle mass from resistance training and the improvement of the cardiovascular system from aerobic training (Pito et al., 2022). A study reported that beginners were more likely to improve their muscle gains faster than regular exercisers. Cardiorespiratory fitness was also increased, which is good for recovery (Antonio et al., 2015). In addition, a study in obese adolescents revealed that concurrent resistance and aerobic training can reduce body fat mass (Monteiro et al., 2015). Resistance training at moderate intensity (55-70% 1RM) to high intensity (70-85% 1RM) combined with aerobic training at moderate intensity (75% of the maximal aerobic speed) can develop 1-RM and  $\text{VO}_2\text{max}$ . Especially, concurrent resistance and aerobic training are more effective in developing muscle strength than aerobic training alone. It is also able to improve  $\text{VO}_2\text{max}$  better than resistance training alone (Khalafi et al., 2022). However, some studies showed that concurrent training can provide increases in the 1-RM upper and lower limb strength similar to resistance training alone. There was no difference in  $\text{VO}_2\text{max}$  between the concurrent training and the aerobic training groups (Pito et al., 2022). However, performing both training sessions at the same time may not affect the development of basic physical fitness. Proper arrangement of training postures for the concurrent training program and quality training duration per training session are important variables in the concurrent training program design.

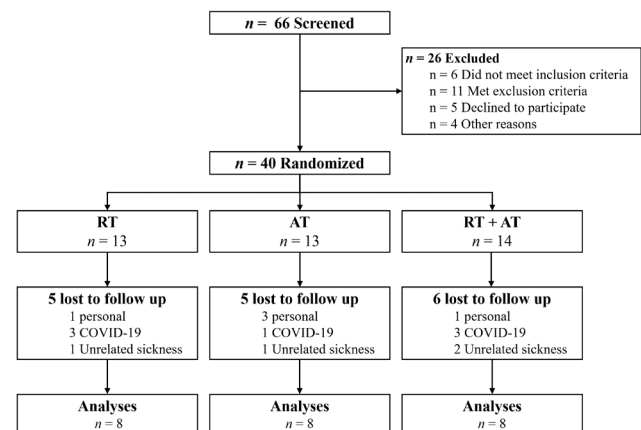
Therefore, the researchers were interested in studying the concurrent resistance and aerobic training to improve overall health, in particular, the improvement of body composition, muscular strength and maximum oxygen uptake among overweight and obese male adolescents with the aim to see whether the concurrent resistance and aerobic training can be an alternative form of training or not.

## Materials and methods

### Study participants

Twenty-four male students from Ubon Ratchathani Rajabhat University (age  $20.17 \pm 0.96$  years) volunteered for

this study. The inclusion criteria were as follows: 1) measured and reported as overweight and obese ( $\text{BMI} = 23.0\text{-}29.9 \text{ kg/m}^2$ ) and 2) likely to be untrained and able to do exercise training or physical activities. Written informed consent was obtained from all the participants after they had been informed about the details, purpose and procedures of the study. The study was approved by Ubon Ratchathani Rajabhat University Human Ethics Committee (HE652060) (Fig. 1).



**Fig. 1.** Training trial profile. COVID-19: Participants lost to follow-up due to COVID-19 infection or close contact with person infected by COVID-19 during the fifth wave of the COVID-19 pandemic. Abbreviations: RT, resistance training; AT, aerobic training; RT + AT, concurrent resistance and aerobic training

### Study organization

The participants were randomly divided into three experimental groups: resistance training group (RT,  $n = 8$ ), aerobic training group (AT,  $n = 8$ ) and concurrent resistance and aerobic training group (RT+AT,  $n = 8$ ). The study duration was 5 weeks of training. All the participants were evaluated at the baseline and the end of the study (Between 2 to 3 days of the last training session) (Fig. 2).

### Training program

The resistance training group followed the resistance training principle (ACSM, 2002) and performed 4 exercises at 60-70% 1RM, 8-15 reps range and 3 sets of each exercise with 1-minute recovery between sets; 1) lat-pulldown (Nautilus OneTM S6LATP, USA), 2) leg extension (Nautilus OneTM S6LE, USA), 3) chest press (Nautilus OneTM S6CP, USA) and 4) leg curl (Nautilus IMPACTS1301, USA). The resistance training consisted of two training sessions per week on non-consecutive days for 5 weeks. The training duration was about 45 min, including warm-up, training and cool down (a total of 90 min-week-1 or 450 min over 5 weeks).

The aerobic training group followed the aerobic training guideline and used the heart rate to monitor (Polar H10, Finland) the intensity (ACSM, 1995). This group performed treadmill (Star Trac 10TRX, USA) incline-walking (2.5 incline level) with a speed of 65-75% of maximum heart rate (MHR) for 35 min continuously. The training duration lasted 45 min, including warm-up, training and cool down (a total of 90 min/week or 450 min over 5 weeks).

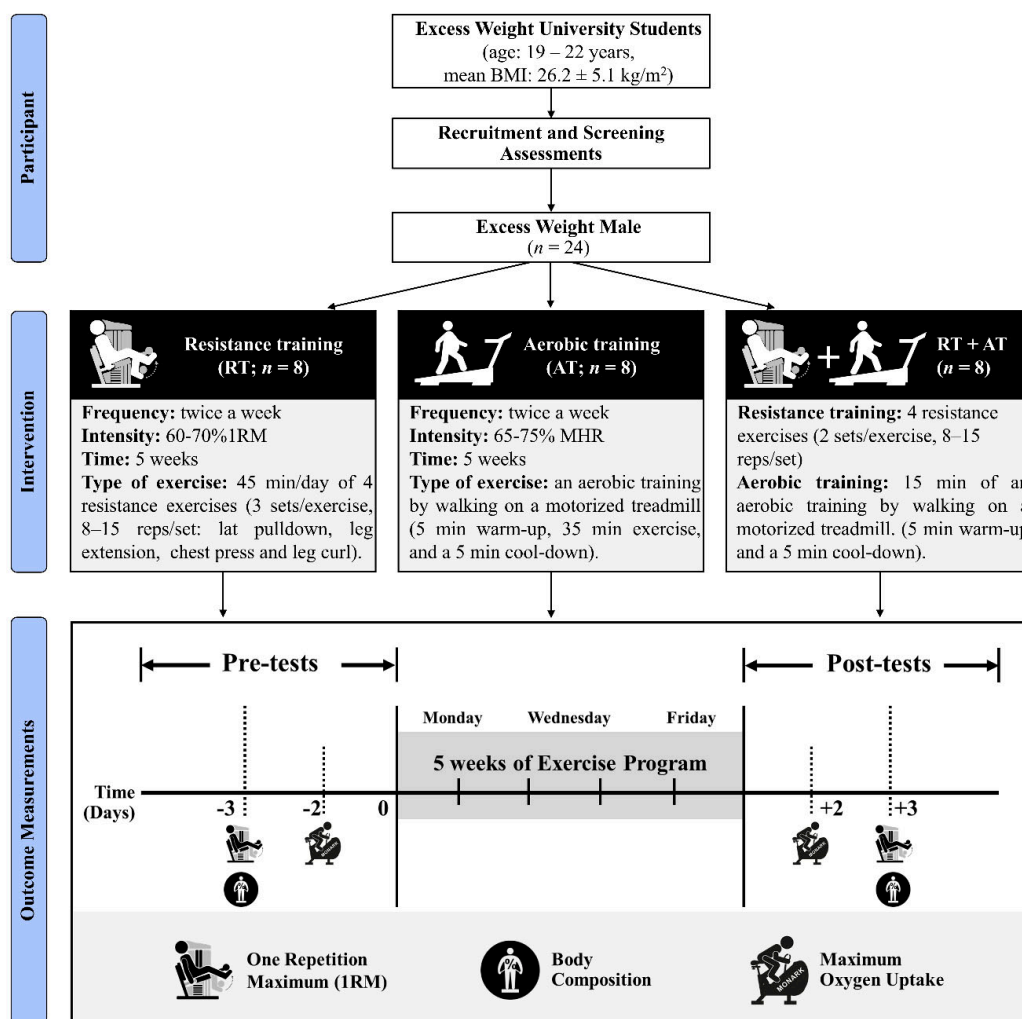


Fig. 2. Outline of training and testing schedule. Abbreviations: reps, repetition; MHR, maximum heart rate

The concurrent resistance and aerobic training group followed both resistance and aerobic training. The exercise and program design were similar to those of the two-intervention by performing resistance training exercises as same as the resistance training group. The only difference was that the training set of each exercise was reduced to 2 sets to reserve the time and move on to the aerobic session after the subjects had done all resistance training exercises immediately. This group performed the treadmill incline-walking with the same incline level and intensity, but the duration was 15 min. The training duration was about 45 min, including warm-up, training and cooldown (a total of 90 min/week or 450 min over 5 weeks).

#### Measures

##### Body composition measurement

The body composition was measured using a bioelectrical impedance analysis machine (BIA) by body composition analyzer (Seca mBCA, Hamburg, Germany). The outcome variables were body mass index (BMI, kg/m<sup>2</sup>),

waist circumference (WC, cm), fat-free mass (FFM, kg), fat mass (FM, %) and skeletal muscle mass (SMM, kg).

##### 1-Repetition maximum measurement

The 1-repetition maximum was assessed in 4 exercises using a stationary weight machine: 1) lat pulldown, 2) leg extension, 3) chest press and 4) leg curl. The participants were asked to perform these exercises. The demonstration was done before correcting the way of measure by experience resistance training. Every exercise included warm-up for a few sets and rest for at least 2 min. Then the advisor predicted the reasonable weight and asked the participants to go for maximum repetitions. The repetitions were counted by the advisor and calculated as the 1-RM by 1-RM calculator. They had to rest for 2 min before doing the next exercise test, considered alternated upper and lower exercise tests.

##### Maximum oxygen uptake measurement

The maximum oxygen uptake was measured by the Astrand-Rhyning cycle ergometer test by performing

6 min on a cycle ergometer bike (Monark Ergomedic 828E, Vansbro, Sweden). The participants were allowed to warm up for 1 min with 0 loads at 50-55 cadence speed (round per min; RPM). They had to maintain the cadence speed throughout 6 min of the test. The test was started by the increasing load to 75 watts (1.5 kiloponds). The heart rate is attached to the chest to monitor the heart rate being measured every minute. The final heart rate was calculated for maximum oxygen uptake by O2max calculator.

### Statistical analysis

Statistical calculations were performed using SPSS 26 (IBM Corp. IBM SPSS Statistics for Windows, Version 26.0. Armonk, NY: IBM Corp). Descriptive data were shown as means and standard deviation (SD). Data normality was evaluated by using the Shapiro-Wilk test. The one-way analysis of variance (ANOVA) with a post-hoc Bonferroni adjustment was used to evaluate differences in body composition, 1-repetition maximum and maximum oxygen uptake between groups. A paired t-test (comparison between values obtained before and after intervention) was completed. P values < 0.05 was considered to be statistically significant.

### Results

The general characteristics and baseline measured of the resistance training (RT), aerobic training (AT) and concurrent resistance and aerobic training (RT+AT) groups are presented in Table 1. No significant differences existed

**Table 1.** Participants characteristics in the 3 training groups.

Characteristics	RT (n = 8)	AT (n = 8)	RT+AT (n = 8)
Age (y)	20.63±0.92	20.13±1.25	19.75±0.46
Weight (kg)	73.85±10.12	79.08±20.78	78.29±8.69
Height (cm)	174.50±5.04	168.75±7.21	172.13±4.16
BMI (kg/m <sup>2</sup> )	24.29±3.18	27.83±7.57	26.57±3.44
Resting heart rate (b/m)	72.88±5.00	72.00±5.37	68.00±4.90
SBP (mmHg)	124.00±5.68	123.00±6.41	123.25±4.23
DBP (mmHg)	74.00±5.45	71.25±4.65	71.50±5.21

RT – resistance training group, AT – aerobic training group, RT+AT – concurrent resistance and aerobic training group; BMI – body mass index; SBP = systolic blood pressure; DBP = diastolic blood pressure. Values are mean ± SD. No significant difference was found between the 3 groups for any variable

among the three groups for any variables. After 5-week, the waist circumference was reduced in all three groups by -2.59 ± 2.52%, -2.61 ± 2.02% and -2.03 ± 2.12%, respectively. However, the RT+AT group was the only group found significantly increased fat-free mass and skeletal muscle mass by 0.49 ± 0.49% and 1.01 ± 0.95%, respectively compared to the baseline (Table 2).

The 5-week training program significantly increase the 1-repetition maximum indices in all groups when compared to their baseline (Table 3). In particular, the RT group

**Table 2.** Mean changes in body composition in all 3 training groups after 5-week training

Variables	RT (n = 8)			AT (n = 8)			RT+AT (n = 8)		
	Pre-test	Post-test	% change	Pre-test	Post-test	% change	Pre-test	Post-test	% change
Body composition									
Weight (kg)	73.85±10.12	73.79±10.38	-0.08±2.22	79.08±20.78	77.13±17.96	-2.46±3.93	78.29±8.69	77.88±8.74	-0.52±2.21
BMI (kg/m <sup>2</sup> )	24.29±3.18	24.23±3.32	-0.23±2.23	27.83±7.57	27.13±6.62	-2.52±3.92	26.57±3.44	26.35±3.52	-0.81±2.19
Waist circumference (cm)	82.00±8.80	79.88±6.49	-2.59±2.52*	91.00±18.72	88.63±17.05	-2.61±2.02*	86.38±8.05	84.63±8.77	-2.03±2.12*
Fat-Free mass (kg)	60.57±5.94	60.78±6.05	0.34±3.66	57.94±70.04	57.57±6.64	-0.63±2.09	58.95±2.01	59.24±1.94	0.49±0.49*
Fat mass (%)	17.85±9.58	17.71±10.12	-0.77±14.92	24.71±10.83	23.75±9.98	-3.89±9.96	24.96±5.23	24.60±5.14	-1.43±3.93
Skeletal muscle mass (kg)	29.37±2.91	29.64±3.01	0.92±3.02	28.11±3.81	28.01±3.72	-0.36±1.94	28.39±1.36	28.68±1.55	1.01±0.95*

\*Significant p<0.05 (pre vs post)

**Table 3.** Mean changes in 1-repetition maximum and maximum oxygen uptake in all 3 training groups after 5-week training

Variables	RT (n = 8)			AT (n = 8)			RT+AT (n = 8)		
	Pre-test	Post-test	% change	Pre-test	Post-test	% change	Pre-test	Post-test	% change
<b>1-Repetition maximum</b>									
Lat pulldown (kg)	33.90±4.60	48.96±6.64	44.43±23.77'	27.50±5.92	34.41±6.82	25.14±26.38'	32.50±5.82	43.88±6.99	35.00±23.64'
Chest press (kg)	32.11±7.00	50.54±7.20	57.38±44.36'	24.89±5.27	34.03±7.02	36.77±13.64'	29.53±5.30	44.05±5.76	49.20±28.97'
Leg extension (kg)	60.73±7.17	89.68±8.40	47.67±14.85*#	47.81±10.81	57.55±14.96	20.37±13.97'	46.38±10.39	65.89±15.50	42.08±21.70**
Leg curl (kg)	60.85±8.01	85.40±7.30	40.35±23.31'	47.20±11.35	55.68±12.82	17.96±12.95'	48.04±14.65	66.60±15.08	38.64±31.21'
<b>Maximum oxygen uptake</b>									
VO <sub>2</sub> max (mL/kg/min)	35.35±1.69	37.93±1.35	7.31±4.19'	34.45±6.23	39.00±6.00	13.21±7.72'	41.07±5.96	46.03±6.41	12.09±13.59'

\*Significant p<0.05 (pre vs post), #Significant p<0.05 (RT vs AT), †Significant p<0.05 (RT+AT vs AT)

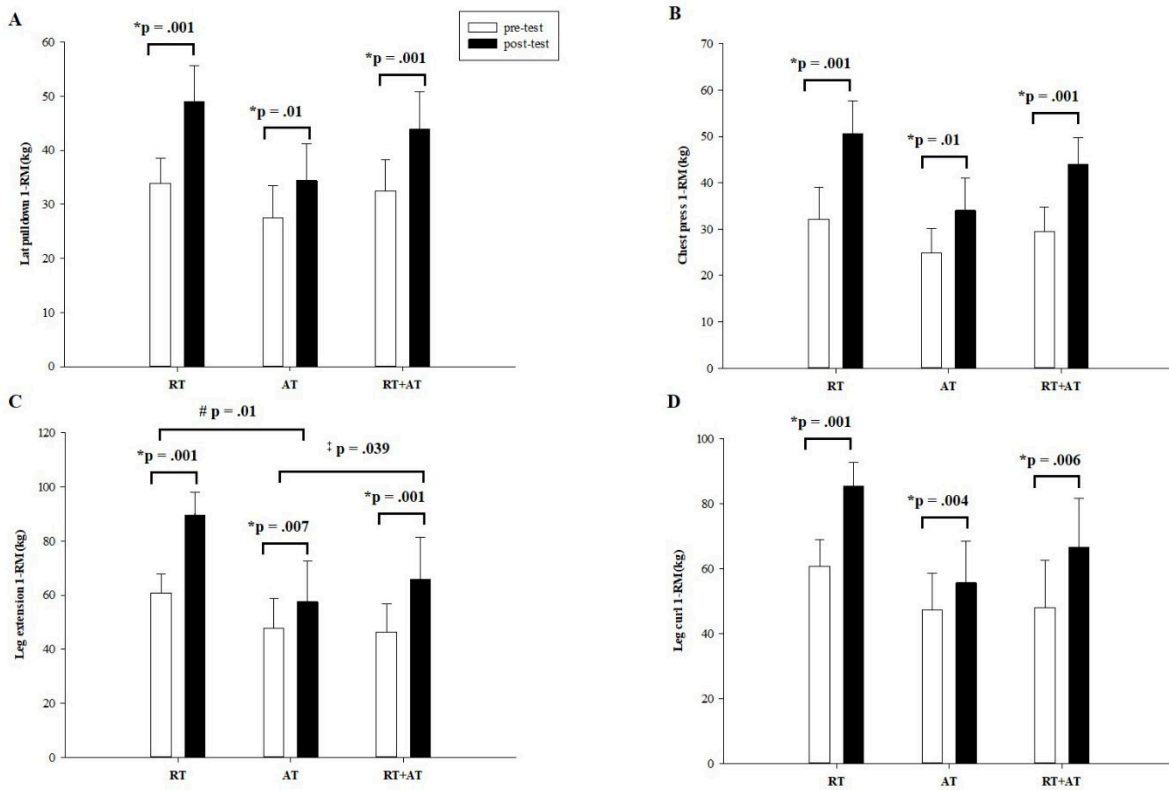


Fig. 3. Change in 1-repetition maximum (A; Lat pulldown, B; Chest press, C; Leg extension and D; Leg curl) before and after 5-week training. Values are present as mean ± SD. \*Significant  $p < 0.05$  (pre vs post), #Significant  $p < 0.05$  (RT vs AT), ‡Significant  $p < 0.05$  (RT+AT vs AT)

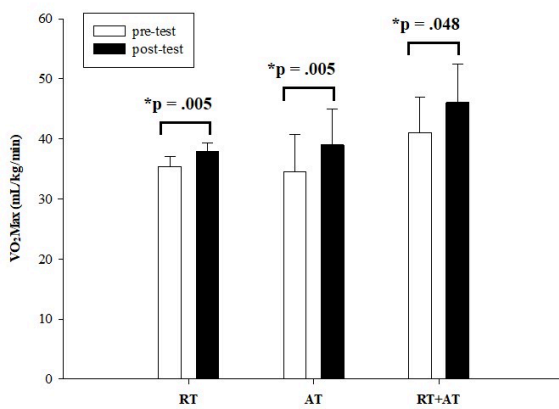


Fig. 4. Change in maximum oxygen uptake before and after 5-week training. Values are present as mean ± SD. \*Significant  $p < 0.05$  (pre vs post)

significantly increased in leg extension 1-RM which was  $47.67 \pm 14.85\%$  compared to the AT group ( $20.37 \pm 13.97\%$ ,  $p = 0.01$ ) and the RT+AT group accordingly significantly increased leg extension 1-RM more than AT group ( $42.08 \pm 21.70\%$  and  $20.37 \pm 13.97\%$ , respectively,  $p = 0.039$ ) (Fig. 3). In general, the O<sub>2</sub>max was significantly increased in all three groups (RT, AT and RT+AT) compared to baseline by  $7.31 \pm 4.19\%$ ,  $13.21 \pm 7.72\%$  and  $12.09 \pm 13.59\%$ , respectively. However, there were no significant differences between the groups (Fig. 4).

## Discussion

The present study examined the effects of concurrent resistance and aerobic training for 5 weeks on body composition, muscular strength and maximum oxygen uptake (VO<sub>2</sub>max) in men with excess weight. Our results findings showed that the changes in waist circumference were observed in all groups after 5 weeks of training in this study, presumably, due to the effects of resistance training, aerobic training and concurrent training. Overweight and obese people can increase their physical activities that consume more energy so that the body burns excess energy from visceral fat in all three forms of exercise. Particularly, concurrent resistance training and aerobic training can increase lean body mass and muscle mass because resistance training causes muscles to contract against resistance. It also increases muscle strength. Over several weeks of training, there is an increase in muscle fibers in number and thickness, an important part of increasing muscle mass and strength (Pito et al., 2022). Concurrent training among overweight or obese people has been demonstrated by Monteiro et al., 2015 this study reported that the concurrent training was performed 3 times per week for 20 weeks. The findings revealed that the body fat can be reduced (Monteiro et al., 2015). Similarly, a study by Dâmaso et al., 2014 reported that the AT + RT group showed better results in terms of decreased body fat mass and visceral fat and increased body lean mass unlike the AT group, which are consistent with the results of the present study. It may be because the development of body composition is related to balance and energy metabolism. As for concurrent training, the body uses

both anaerobic and aerobic energy systems. In terms of the principle of variety, the concurrent training group was given the same exercise posture as the resistance training group, but adding aerobic training made the training less boring than the single-mode training group. To see a clear change effect, the training duration and the frequency per week should be increased. It was also found that exercise training with nutrition control has contributed to an increase in fat-free mass and skeletal muscle mass (Dâmaso et al., 2014).

An increase in the 1-repetition maximum was found the largest in the RT group and the smallest in the AT group while the RT+AT group was similar to the RT group. It may arise because of the resistance training uses weights to put stress on the muscles, resulting in increased thickness and strength in the muscle fibers. This is consistent with a study by Khalafi et al. (2022) found that the concurrent training versus aerobic or resistance training group in which increased upper-muscle maximal strength compared to aerobic training alone. In addition, the maximal strength in the leg extension of the concurrent training group improved better than the aerobic training group which likely involved enhancements in neuromuscular function in the concurrent training group. Moreover, the aerobic training group did not practice leg extension during the program and the neuromuscular strength of this part was not developed (Khalafi et al., 2022). Schoenfeld et al., 2019 reported that training for muscular strength does not require high-volume training. A minimum of 13 min in a strength training session is sufficient for maintaining and developing muscle strength (Schoenfeld et al., 2019). In this study, the concurrent resistance plus aerobic training group had to do resistance training at moderate-volume training, but there was change in 1-RM. This is consistent with the study of Wewege et al. (2017). They found that short-term high-intensity training and moderate-intensity continuous training had no different effect on aerobic training for improvements of body composition (Wewege et al., 2017). That is, the high-intensity training group spent 40% less training time than the moderate-intensity continuous training group. Both high-intensity training and moderate-intensity continuous training showed similar effectiveness across body composition and fat mass reduction. However, in strength training, the training volume did not have much effect on the increase in 1-RM. A study by Krieger (2009) that compared the number of sets in training with increases in muscle strength found that 2-3 sets per exercise increased by 46% greater strength gains than 1 set per exercise. Also, there was no significant difference between 2-3 sets per exercise and 4-6 sets per exercise. Therefore, in this study, the resistance training group with 3 sets per exercise and the concurrent group with 2 sets per exercise gained similar 1-RM. Even the AT group who did not receive resistance training still showed changes which may be due to lifestyle limitations. That is, 62.5% of the AT group was studying in Sports and Exercise Science, so they had to do more forms of physical activity in various courses than general students. In addition, the principle of progression, which gradually increased training intensity, may also affect  $VO_2\text{max}$  (Krieger, 2009).

Concurrent resistance plus aerobic training can develop  $VO_2\text{max}$  because during the resistance training, the fast-twitch fibers of the glycolysis-lactic acid energy system

are used, causing the ATP energy system as well as liver and muscle glycogen, to be used for energy. In moderate-intensity training with 60-90 seconds of rest between sets, muscle fatigue from training increases breathing because the muscles need nutrient- and oxygen-rich blood. In resistance training, the heart rate was found to increase similar to that of aerobic training. When performing continuous aerobic training after a resistance training session, the body is more ready to warm up the muscles. Consistent with the study of Khalid et al. (2019) comparing aerobic interval training and resistance interval training in patients with myocardial infarction. It was found that the group receiving both aerobic interval training and resistance interval training showed an increase in  $VO_2$ (peak oxygen uptake) after 6 weeks of training. In addition, the resistance training did not impair  $VO_2\text{max}$  in any way (Khalid et al., 2019). A study by Khalafi et al. (2022) also showed that there was a difference in  $VO_2\text{max}$  in the concurrent resistance and aerobic training group compared to the resistance training group. This indicates that  $VO_2\text{max}$  can be enhanced by concurrent resistance and aerobic training. That is, if continuous resistance training is combined with aerobic training, it will not adversely affect the improvement of  $VO_2\text{max}$ . However, the aerobic training group showed slower improvement in the  $VO_2\text{max}$  (Khalafi et al., 2022). Increasing  $VO_2\text{max}$  alone cannot make a person develop all aspects of physical fitness. The duration of training, intensity and frequency of training must be considered to suit each individual. Especially among overweight and obese people, concurrent resistance and aerobic training is an effective and safe alternative, which can be performed easily, to improve physical fitness and promote overall health.

## Conclusions

Concurrent resistance and aerobic training improved body composition by reduction in the waist circumference, increasing fat-free mass and skeletal muscle mass and improving the 1-repetition maximum similar to that of resistance training. It also improved  $VO_2\text{max}$  in overweight and obese students. Therefore, the concurrent resistance and aerobic training was not interfering with either muscular strength or cardiovascular endurance development. This training method could be an alternative training program for improving and enhancing protective factors to promote the health and well-being for excess weight students.

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## Conflict of interest

The authors declare that they have no conflict of interest.

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## ВПЛИВ ОДНОЧАСНИХ СИЛОВИХ ТА АЕРОБНИХ ТРЕНУВАНЬ НА КОМПОЗИЦІЮ ТІЛА, М'ЯЗОВУ СИЛУ ТА МАКСИМАЛЬНЕ СПОЖИВАННЯ КИСНЮ В ЧОЛОВІКІВ ІЗ НАДМІРНОЮ ВАГОЮ

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Авторський вклад: А – дизайн дослідження; В – збір даних; С – статаналіз; D – підготовка рукопису; Е – збір коштів

Реферат. Стаття: 7 с., 2 табл., 4 рис., 16 джерел.

**Метою дослідження було** порівняти вплив одночасних силових та аеробних тренувань із лише силовим та/або аеробним тренуванням на композицію тіла, м'язову силу та максимальне споживання кисню в чоловіків із надмірною вагою та ожирінням.

**Матеріали та методи.** Двадцять чотири добровольці з надлишковою вагою та ожирінням ( $IMT = 23,0-29,9$  кг/м<sup>2</sup>), віком 19-22 роки, чоловічої статі, які були студентами університету Убон Рачатані Раджабхат (Таїланд), були розподілені на 3 групи: 1) група силових тренувань (СТ), 2) група аеробних тренувань (АТ) і 3) група одночасних силових та аеробних тренувань (СТ+АТ). Тренування тривало 45 хвилин на заняття та 2 дні на тиждень. Композицію тіла разом із м'язовою силою (1-RM – 1-повтор максимум) та максимальним споживанням кисню ( $VO_{2max}$ ) вимірювали до (за 2-3 дні) і після (через 2-3 дні) 5-тижневого періоду тренувань.

**Результати.** Окружність талії значно зменшилася в усіх трьох групах, але група СТ+АТ також виявила покращення у відсотках маси тіла без жиру ( $0,49 \pm 0,49\%$ ,  $p = 0,021$ , середнє значення  $\pm$  стандартне відхилення) та маси скелетних м'язів ( $1,01 \pm 0,95\%$ ,  $p = 0,025$ ) порівняно з їхнім базовим рівнем. Аналогічно, показник 1-RM під час розгинання ніг значно зріс в усіх трьох групах, тоді як група СТ ( $47,67 \pm 14,85\%$ ,  $p = 0,01$ ) і група СТ+АТ ( $42,08 \pm 21,70\%$ ,  $p = 0,039$ ) продемонстрували значно більше покращення показника 1-RM під час розгинання ніг порівняно з групою АТ ( $20,37 \pm 13,97\%$ ). Нарешті, показник  $VO_{2max}$  значно збільшився в усіх трьох групах (від початкового рівня до рівня після завершення експерименту), хоча ці показники статистично значущо не відрізнялися між групами.

**Висновки.** Одночасні силові та аеробні тренування можуть зменшити окружність талії та збільшити масу тіла без жиру, масу скелетних м'язів, показники 1-RM та  $VO_{2max}$ . Таким чином, ця стратегія тренувань може слугувати корисним альтернативним способом покращення загальної фізичної форми та зміцнення здоров'я чоловіків із надмірною вагою та ожирінням.

**Ключові слова:** одночасні тренування, силові тренування, аеробні тренування, 1-повтор максимум, максимальне споживання кисню, надмірна вага.

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