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# Effects of moderate-intensity continuous training on physiological health of overweight women

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**Abstract**
**Introduction. The prevalence of overweight has considerably increased worldwide over the last few decades and is a growing concern among young people and adolescents. Overweight, defined as excessive fat accumulation, has a significant impact on the occurrence of obesity. Adolescent obesity is a serious public health concern. The assessment of physical fitness in overweight women provides substantial information that can be used to maintain and improve their health. Aim of Study. The objective of this study was to analyze the effects of the moderate-intensity continuous training (MICT) on the responses of overweight women. Material and Methods. The participants in this study were overweight women (overweight class I with BMI of 23.00-24.90 kg/m²). This study was conducted on 22 healthy women, all of whom were aged 18.95 ± 0.65 years, with height of 158.18 ± 5.43 cm, weight of 60.50 ± 4.07 kg, and body mass index (BMI) of 24.16 ± 0.48 kg/m2. The study assessed physical capacity of the overweight women to determine body weight (BW), resting heart rate (RHR), BMI, body fat (BF), and oxygen consumption before and after a week of MICT. The training heart rate was evaluated at 60-85% heart rate reserve (HRR) for an eight-week period. The following variables were measured: BW, height, BMI, RHR, BF percentage, and oxygen consumption. The BF percentage was measured using a calculated skinfold thickness (ST). The 20-meter multistage fitness test was used to evaluate oxygen consumption. Results. There was a significant difference in BW, RHR, BMI, BF, and oxygen consumption in the MICT group at the end of the training program ($p < 0.05$). Conclusions. The MICT significantly reduced total body composition and improved cardiovascular fitness in overweight individuals. An increase in aerobic physical activity should be considered an important component of a lifestyle modification for prevention and treatment of overweight and obesity in adolescents.**

**KEYWORDS: overweight, physical fitness, moderate-intensity training.**

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## Introduction

The prevalence of overweight has considerably increased worldwide over the last few decades and is a growing concern among young people and adolescents. Overweight, defined as excessive fat accumulation, has a significant impact on the occurrence of obesity. There is evidence that obesity is associated with high blood pressure, dyslipidemia, insulin resistance, or increased liver enzymes [7, 10, 12]. In addition, obesity is associated with an increased risk of multiple metabolic and cardiovascular diseases [11, 13, 19]. The effects of obesity on the increasing risk of cardiovascular diseases such as coronary heart disease and ischemic stroke are primarily due to being overweight. Total body fat (BF) mass, especially visceral adipose tissue, contributes to this association [2, 3, 17]. In conclusion, the primary factors contributing to the obesity epidemic are sedentary lifestyle and high-fat, energy-dense diets, both of which are the consequence of profound societal transformations and behavioral resulting from urbanization and industrialization, as well as disappearance of traditional lifestyles [21]. Contraction of skeletal muscles results in body movement during physical activity, which increases energy expenditure above a baseline [14]. Physical inactivity is a major risk factor for obesity, and individuals who are less active are at the greater risk for obesity and high blood pressure. Moderate exercise programs have a positive impact on lipids, and help reduce blood pressure, as well as im-proves physical fitness. Therefore, physical fitness is an important health factor for children and adolescents. The assessment of physical fitness in overweight women provides substantial information that can be used to maintain and improve their health. The purpose of this study was to analyze the effect of the moderate, continuous training on the overweight women's responses.

## Material and Methods

*Participants*

Before implementing the exercise intervention to determine its effect on the targeted population, it was necessary to calculate the sample size. The present study used the priori power analysis, employing the G*Power 3.1.9.7 software [9]. The participants in this study were overweight women. A total of 22 healthy women were recruited to participate in this study. The inclusion criteria were as follows: a minimum of three months of overweight class I, an age range of 18 to 19 years, and a sedentary lifestyle. The exclusion criteria, such as an injury to muscles, ligaments, and joints at the time of the experiment, were all included in the analysis until their last session of the eight-week period. The World Health Organization has established and classified the criteria for determining overweight class I in Asian people. body mass index (BMI) of 23.00-24.90 kg/m$^2$ falls into the overweight class I, which is the World Health Organization's established and categorized range for being overweight [21]. The study was approved by the Nakhon Phanom University Research Ethics Committee, No. 67/64 Exp.

*Study design*

The experimental design was selected because the study was proposed to determine acute and chronic effects of exercise intensities throughout eight weeks of exercises on resting heart rate (RHR), fat content, and oxygen consumption in overweight women. In this study, patients were randomly assigned to one group to equalize their characteristics.

*Treatment procedures*

An exercise that primarily uses aerobic energy-producing systems can improve capacity and efficiency of these systems and is effective for improving cardiorespiratory endurance. The participants underwent different exercise intensities as a part of the moderate-intensity continuous training (MICT) program over the course of eight weeks, with five sessions per week, 80 minutes each. The exercise protocol was designed to simulate training sessions. This program consisted of performing exercises with intensity and volume close to those of competition. The training regimen included the MICT and intermittent runs (45-45), which involved  45 seconds of running at maximum speed followed by 30 seconds of passive recovery (jogging). The participants had 10-minute warm-up sessions to increase their heart rate reserve (HRR) by 20-30%. The exercises lasted 80 minutes and the work intensity was above 50-70% HRR. The 10-minute cool-down sessions to reduce body temperature and heart rate while maintaining blood circulation were incorporated shortly after the completion of the training interval (table 1).

**Table 1.** Exercise intervention for moderate-intensity continuous training

| Activity | Time | Intensity (%HRR) | Duration and intensity of rests |
|---|---|---|---|
| Warm up | 10 minutes | 20-30% HRR | |
| Exercise | 60 minutes | Week 1-2 = 50% HRR × 5 sets | 30 sec. rest-work at 50% HRR |
| | | Week 3-5 = 60% HRR × 5 sets | 30 sec. rest-work at 50% HRR |
| | | Week 6-8 = 70% HRR × 5 sets | 30 sec. rest-work at 50% HRR |
| Cooling down | 10 minutes | 20-30% HRR | |
| Total exercise time | 80 minutes | 50-70% HRR | |

Note: HRR - heart rate reserve

*Measurement*

Anthropometric parameters measuring equipment

The direct anthropometric body measurements were taken with the subjects wearing only sportswear, and without shoes. All the measurement were performed by a well-trained technician. Body weight (BW) was measured to the nearest 0.1 kg, using an electronically calibrated scale. Body height was recorded with a manual stadiometer to the nearest 0.1 cm. During the height measurements the subjects were asked to look straight and stand straight with their heels, buttocks, and backs touching a wall. BMI was calculated to assess chronic energy deficiencies, employing the following formula based on the each participant's height and weight measurements:

$$Body\ Mass\ Index\ (BMI) = \frac{Weight\ in\ kg}{Height\ in\ m^2}$$

Body composition measurements
BF (%) was calculated based on skinfold thicknesses (ST). The measurements were conducted, using a Lange skinfold caliper to the nearest 0.1 mm at the following four sites on all subjects: biceps, triceps, subscapular, and suprailiac areas along a right body side. The measurements were repeated two consecutive times and are presented in Table 2. The sum in millimeters of the four ST measurements was calculated [5].

**Table 2.** Skinfold thickness sites for measurements

| ST | Sites for measurements |
|---|---|
| Biceps skinfold | On the front of an upper right arm, directly above the center of a cubital fossa, at the same level as a triceps skinfold. |
| Triceps skinfold | The midpoint of the back of an upper right arm, halfway between an acromion process and an olecranon process. |
| Subscapular skinfold | About 20 mm below the tip of a scapula, at the angle of 45 degrees to the lateral side of a body. |
| Suprailiac skinfold | In a midaxillary line, about 20 mm above an iliac crest. |

Note: ST – skinhold thickness

Cardiorespiratory fitness
The 20-m Multistage Fitness Test (MSFT): The test requires participants to run 20 meters back and forth across a marked track, keeping time with beeps. The MSFT started at a speed of 8.5 km/h, which increased by 0.5 km/h for each completed one-minute stage. The running speed for this test was standardized by prerecorded auditory cues (i.e., the beeps), played from a notebook computer connected to a portable speaker via Bluetooth.

*Data analysis*
All the data was analyzed using the IBM SPSS Statistics software, version 27.0. The data is presented as mean and standard deviation (SD), which were used to describe the demographic variables of the participants such as age, height, BW, and BMI. The level of significance was set at 0.05. The results of the heart rate, BMI, BF (%), and oxygen consumption measurements showed a mean change from a baseline. The comparisons of all variables within the group were analyzed with the paired-sample t-test to evaluate the acute effects after the MICT exercises.

**Results**
Table 3 shows the physical characteristics of the participants before the MICT. The average age of the twenty-two females who took part in the study is 18.95 ± 0.65 years; their average BW is 60.50 ± 4.07 kg, standing height is an average of 158.18 ± 5.43 cm, RHR is 86.68 ± 6.95 beats/min. BMI is 24.16 ± 0.48 kg/m², BF (%) is 32.94 ± 1.93 mm, and oxygen consumption is 22.85 ± 1.11 ml/kg/min.
The paired-sample t-test was conducted to assess the acute effects of aerobic exercises on BW, heart rate, BMI, BF (%), and oxygen consumption in overweight

**Table 3.** Physical characteristics of the participants before the moderate-intensity continuous training

| Variables | Unit | Mean | Variation (minimum – maximum) |
|---|---|---|---|
| Age | year | 18.95 ± 0.65 | 18-20 |
| BW | kg | 60.50 ± 4.07 | 50.70-66.70 |
| Height | cm | 158.18 ± 5.43 | 144-166 |
| RHR | beats/min. | 86.68 ± 6.95 | 78-104 |
| BMI | kg/m² | 24.16 ± 0.48 | 23.31-24.89 |
| BF | mm | 32.94 ± 1.93 | 29.20-38.20 |
| Oxygen consumption | ml/kg/min. | 22.85 ± 1.11 | 21.30-24.60 |

Note: BW – body weight, RHR – resting heart rate, BMI – body mass index, BF – body fat

**Table 4.** Weight, resting heart rate, body mass index, body fat (%), and oxygen consumption before and after the moderate-intensity continuous training

| Variables | Unit | Before | | After | | Change | t | p-value |
|---|---|---|---|---|---|---|---|---|
| | | Mean | SD | Mean | SD | | | |
| BW | kg | 60.50 | 4.07 | 58.58 | 4.24 | 1.92↓ | 13.16 | 0.00* |
| RHR | beats/min. | 86.68 | 6.95 | 78.91 | 5.51 | 7.77↓ | 12.06 | 0.00* |
| BMI | kg/m² | 24.16 | 0.48 | 23.42 | 0.56 | 0.74↓ | 10.31 | 0.00* |
| BF (%) | mm | 32.94 | 1.93 | 31.87 | 1.85 | 1.07↓ | 3.73 | 0.00* |
| Oxygen consum-ption | ml/kg/min. | 22.85 | 1.11 | 23.59 | 1.10 | 0.74↑ | 6.25 | 0.00* |

* p-value at < 0.05 level, significant difference
Note: BW – body weight, RHR – resting heart rate, BMI – body mass index, BF (%)– percentage of body fat based on the sum of the four skinfold measurement

women. Table 4 shows that there is a significant difference in BW, RHR, BMI, BF (%), and oxygen consumption in the overweight women ($p < 0.05$).

**Discussion**

Physical activity decreases dramatically during adolescence, and only 19% of adolescents worldwide are sufficiently active [4, 20]. The purpose of this study was to analyze the effects of the moderate, continuous training on overweight women's responses. The measurements of overweight women's BW, RHR, BMI, BF (%), and oxygen consumption were conducted before and after the training program. The characteristics of the various anthropometric parameters of the 22 participants indicated that they their overweight was categorized as class I because of the BMI value between 23 and 24.99 kg/m$^2$. The findings were as follows:

*Effects of exercises on BW, RHR, BMI, and BF (%) in overweight women*

Body composition is an important component of health-related physical fitness. Excessive BW can lead to obesity and a lack of adequate physical activity. Lifestyle choices have a significant impact on the size, BW, and composition of body parts that contribute to obesity. Controlling the body's energy balance, specifically food intake and energy expenditure, is essential for managing body weight and preventing overweight, ultimately reducing the risk of obesity. The study showed that aerobic exercises cause a decrease in BW, RHR, BMI, and BF (%) A program of 30-60-minute moderately intense exercises, three to seven days per week, leads to a reduction in total body mass and visceral adiposity in overweight children and adolescents [18]. Ana et al. suggest that strength training should be incorporated into high-intensity interval aerobic training to improve body composition in adults by reducing BF after eight weeks [1]. These findings indicate that the effects of aerobic exercises on a BMI value and a BF percentage may depend on changes in BW. In addition, after eight weeks of the MICT, there might be improvements in the oxidative metabolism-dependent energy system and qualitative changes in a skeletal muscle fiber type, metabolic capacity, and cardiorespiratory fitness. The RHR values decreased as a result of the acceleration mechanism in the parasympathetic nervous system activity. Regular aerobic exercises can affect parasympathetic nerve, thereby increasing stroke volume and lowering RHR, which has a positive effect on reducing cardiovascular diseases [16].

*Effects of exercises on oxygen consumption in overweight women.*

The oxygen consumption improved significantly after eight weeks of the MICT. This increase in oxygen consumption following the training has been shown to be a result of the increase in both of its components: i.e., oxygen consumption is the product of cardiac output (Q) and an arteriovenous oxygen difference (a-$VO_2$ diff) [15]. However, the primary contribution of the increase in oxygen consumption between the central (i.e., Q) and peripheral (i.e., a-$VO_2$diff) components depends on training duration [6]. After the MICT, the improvements in oxygen consumption may be associated with important changes in oxygen delivery. Nevertheless, it has also been demonstrated that submaximal aerobic capacity is a crucial factor in repeated-sprint performance. It is evident that aerobic capacity plays an important role in the restoration of oxygen to myoglobin, the resynthesis of phosphocreatine, and the oxidation of lactate, particularly between exercises [8].

**Conclusions**

The MICT resulted in the significant decrease in BW, RHR, BMI, and BF (%). Oxygen consumption improved by the significant amount after eight weeks. If trainers plan to increase physical fitness of overweight adolescents, the MICT, which is characterized by 50-70% of HRR, 45-second runs followed by 30-second rest in a form of jogging, is an effective strategy for an improvement of health-related physical fitness in a short time. Therefore, overweight adolescents, who wish to maximize the effect of exercises on these variables, should perform aerobic exercises. An increase in aerobic physical activity should be considered an important component of a lifestyle modification for prevention and treatment of overweight and obesity in adolescents.

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**Conflict of Interest**

The author declares no conflict of interest.

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