# The Effect of Moderate-Intensity Continuous Training and High-Intensity Interval Training on Obesity Complication Parameters

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**Abstract:**
Obesity causes various changes in the biochemical parameters, such as inflammatory mediators and oxidative stress. Inflammatory mediators and oxidative stress are pathways in the pathogenesis of obesity into other diseases, such as metabolic syndrome. Thus, levels of inflammatory mediators such as Tumor Necrotic Factor (TNFα) and levels of oxidative stress such as malondialdehyde (MDA) can be parameters of obesity complications. Physical training such as Moderate-Intensity Continuous Training (CT) is one of the most effective obesity therapies in improving body composition. Likewise, the High-Intensity Interval Training (HIIT) is an alternative to CT. However, the benefits of training on the parameters of obesity complications have not been widely studied. The purpose this study is to determine the effect of MICT and HIIT on TNFα and MDA levels in obese women. This study used a Randomized Controlled Trial (RCT) research design. The subjects were 62 people, divided into two intervention groups for MICT and HIIT using block randomization. TNFα and MDA examinations were performed before and after the intervention using the ELISA method. Data were analyzed by univariate and bivariate. Bivariate analysis used Wilcoxon Signed Rank Test, with a significance level of $p<0.05$. The bivariate analysis results showed the significant differences in MDA levels ($p=0.0001$) and TNFα levels ($p=0.0001$) after the HIIT intervention. There was also a significant difference in TNFα levels ($p=0.024$) after the MICT intervention. However, there was no significant change in MDA levels after the MICT intervention ($p=0.627$). There is an effect of the MICT and HIIT model intervention program in obese women on TNFα levels. There is an effect of the HIIT model intervention program in obese women on MDA levels, but there is no effect of the MICT model intervention program in obese women on MDA levels.

**Keywords:** Moderate-Intensity Continuous Training, High-Intensity Interval Training, MDA, TNFα, Obesity

## Introduction

Obesity is a condition of excess fat accumulation that can increase the risk of disease (Purnell, 2018). A person is declared obese if he has a Body Mass Index (BMI) of more than 25 kg/m2 (World Health Organization, 2000). In 2016, as many as 650 million adults globally were obese (World Health Organization, 2020). Currently, the number of obese people is increasing every year. Increased fat deposits in obesity lead to the impaired metabolic function of fat tissue. The increased fat deposit induces stress on adipocyte cells, resulting in free fatty acids and inflammatory cytokines, such as Tumor Necrosis Factor-α (TNF-α). The release of the inflammatory cytokine TNF- induces local inflammation of adipose tissue, followed by an increase in circulating levels of TNF, resulting in low-grade systemic inflammation caused by obesity (Kern et al., 2019). Chronic low-grade systemic inflammatory conditions contribute to the course of various diseases, such as type 2 diabetes mellitus and other cardiovascular disorders (Davizon-Castilloetal., 2019). In addition, obesity can trigger oxidative stress due to an imbalance between pro-oxidants and antioxidants in the body. Oxidative stress occurs due to obesity, followed by an increase in fat metabolism, which can lead to the production of (ROS) in adipose. Oxidative stress can cause oxidative damage from the cellular tissue to organ levels and result in accelerated aging processes and the emergence of various disease pathogenesis, including cancer (Salmon,

2016). Malondialdehyde (MDA) in plasma is one of the indicators of oxidative stress that has the highest reaction sensitivity. The formation of malondialdehyde is considered a biological indicator to measure the degree of oxidative stress that occurs in an organism because malondialdehyde is a toxic compound resulting from breaking the fatty acid carbon chain in the lipid peroxidation process (Salmon, 2016). Through the inflammatory pathway and increased oxidative stress, obesity can develop into other chronic diseases. Controlling inflammatory mediators and oxidative stress in obese patients also prevents obesity from developing into other chronic diseases, a complication of obesity.

The World Health Organization (2020) recommends limiting energy intake and increasing physical activity to prevent obesity. Continuous training is one type of aerobic physical exercise that is considered suitable for people who have not been able to do high-intensity exercise, such as obesity. One of the physical exercises that can be done is the traditional endurance physical exercise method or Moderate Intensity Continuous Training (MICT). This physical exercise involves a more prolonged duration at a moderate intensity which is carried out continuously without rest (Wewege et al., 2017). So far, Continuous Training (CT) has been a therapy to treat obesity, but CT is considered less efficient because it takes longer (Hussain et al., 2016). Recently, High-Intensity Interval Training (HIIT) has become an alternative to CT. This refers to HIIT, which involves short, high-intensity physical exercise, which is considered more time-efficient. HIIT's time efficiency makes this type of physical exercise popular because time constraints are also a barrier to physical exercise (Wewege et al., 2017). The benefits of physical exercise on the body composition of obese patients have been proven. However, the benefits of physical exercise on parameters of obesity complications have not been widely studied. Therefore, this study aims to see the effectiveness of physical training on parameters of obesity complications, both MICT and HIIT physical exercise. Obesity complication parameters to be measured are inflammatory mediators such as TNFα and oxidative stress in the form of MDA.

**Material & Methods**

This study was a Randomized Controlled Trial (RCT). The subjects were divided into two groups and were given Moderate-Intensity Continuous Training (MICT) and High-Intensity Interval Training (HIIT) as an intervention. The intervention was conducted for 12 weeks, consisting of two weeks of adaptation and ten weeks of HIIT intervention. A purposive sampling method was used to collect this study population. There was 31 subject in MICT group dan 31 subject in HIIT group.

The inclusion criteria for study subjects were 18–34 years old, had a history of inactive lifestyle for the last six months, were declared healthy and fit for physical exercise, and were willing to be the subjects. Subjects taking weight-loss drugs/supplements were excluded. The dropout criteria were that they could not finish the intervention according to the predetermined program.

*Measurement of Research Variables*

Body Composition measurement on Body Mass Index (BMI) used data on body weight (BW) and height (H) and the formula for body weight (kg)/height (m2) in units of kg/m2. The measurement of inflammatory mediators (TNFα) and oxidative stress (MDA) using the ELISA method, with units of pg/mL. The measure of TNFα and MDA were carried out before and after the intervention.

*Training Intervention*

Training interventions were conducted for 12 weeks, with a frequency of 3 times per week and based on the COVID-19 prevention health protocol. The type of training was cycling. Moderate-Intensity Continuous Training is moderate-intensity physical training with no recovery period. MICT was performed at 60-85% maximum Heart Rate. High-Intensity Interval training is an intermittent period of exercise separated by a recovery period. The two-week training adaptation was performed with an exercise regimen of 3 x 3 minutes intervals (85 - 95% maximum HR) and 4 x 4 minutes of rest/recovery (60% maximum Heart Rate). The ten weeks of intervention was performed with an exercise regimen of 4 x 4 minutes intervals (85 - 95% maximum HR) and 3 x 3 minutes of rest/recovery (60% maximum Heart Rate)(11,12).

*Data analysis*

The body weight, BMI, inflammatory mediators (TNFα), and oxidative stress (MDA) before and after the intervention were analyzed using the Wilcoxon Signed Rank Test as a nonparametric test because the distribution data did not normal. The test results were considered significantly different if $p<0.05$.

*Research Ethics*

The study had received an Ethics Committee Approval from the Medical and Health Research Ethics Committee (MHREC) Faculty of Medicine, Public Health and Nursing Universitas Gadjah Mada-DR. Sardjito General Hospital (Ref. No: KE / FK / 0258 / EC / 2020).

**Results**

Table 1 showed Body Weight, BMI, TNFα, and MDA results before and after an intervention.

**Table 1. Characteristics of Research Subject**

| Variable | n | Mean ± SD | Median | (min-max) |
|---|---|---|---|---|
| Age | | | | |
| MICT | 31 | 22.13±2.79 | 22 | (18 – 28) |
| HIIT | 31 | 23.55±5.16 | 21 | (18 – 34) |
| Body Weight pre-intervention | | | | |
| MICT | 31 | 75.17±11.16 | 72.6 | (55.7 – 92.8) |
| HIIT | 31 | 74.20±12.34 | 74.2 | (51.4 – 104.70) |
| Body Weight post-intervention | | | | |
| MICT | 31 | 72.60±10.13 | 73.90 | (53.10 – 89.60) |
| HIIT | 31 | 72.60±11.50 | 71.90 | (51.3 – 102.60) |
| BMI pre-intervention | | | | |
| MICT | 31 | 30.03±4.42 | 28.8 | (23.9 – 41.8) |
| HIIT | 31 | 29.81±4.90 | 29.1 | (23.10 – 44.7) |
| BMI post-intervention | | | | |
| MICT | 31 | 29.02±10.13 | 28.2 | (22.7 – 38.7) |
| HIIT | 31 | 29.16±4.51 | 28.4 | (22.50 – 43.80) |
| TNFα pre-intervention | | | | |
| MICT | 31 | 3.61±1.04 | 3.40 | (0.95 – 7.42) |
| HIIT | 31 | 4.56±2.06 | 4.09 | (2.65 – 10.58) |
| TNFα post-intervention | | | | |
| MICT | 31 | 3.37±0.55 | 3.21 | (2.84 – 5.61) |
| HIIT | 31 | 3.37±0.73 | 3.15 | (2.33 – 5.36) |
| MDA pre-intervention | | | | |
| MICT | 31 | 556.30±344.84 | 474.49 | (126.11 – 1413.31) |
| HIIT | 31 | 609.95±339.34 | 468.60 | (123.73 – 1451.85) |
| MDA post-intervention | | | | |
| MICT | 31 | 511.56±255.67 | 507.94 | (97.38 – 993.78) |
| HIIT | 31 | 425.65±330.80 | 261.20 | (112.66 – 1507.94) |

**Table 2. The Effect of Training on Body Weight, BMI TNFα and MDA**

| Variable | n | Mean ± SD | p value |
|---|---|---|---|
| **Moderate-Intensity Continuous Training** | | | |
| Bodyweight pre-intervention | 31 | 75.17±11.16 | 0.0001* |
| Bodyweight post-intervention | 31 | 72.60±10.13 | |
| BMI pre-intervention | 31 | 30.03±4.42 | 0.0001* |
| BMI post-intervention | 31 | 29.02±10.13 | |
| TNFα pre-intervention | 31 | 3.61±1.04 | 0.024** |
| TNFα post-intervention | 31 | 3.37±0.55 | |
| MDA pre – intervention | 31 | 556.30±344.84 | 0.627** |
| MDA post-intervention | 31 | 511.56±255.67 | |
| **High-Intensity Interval Training** | | | |
| Bodyweight pre-intervention | 31 | 74.20±12.34 | 0.0001* |

| | | | |
|---|---|---|---|
| Bodyweight post-intervention | 31 | 72.60±11.50 | |
| BMI pre-intervention | 31 | 29.81±4.90 | 0.0001* |
| BMI post-intervention | 31 | 29.16±4.51 | |
| TNFα pre-intervention | 31 | 4.56±2.06 | 0.0001** |
| TNFα post-intervention | 31 | 3.37±0.73 | |
| MDA pre – intervention | 31 | 609.95±339.34 | 0.0001** |
| MDA post-intervention | 31 | 425.65±330.80 | |

**Dependent T-test*

***Wilcoxon Signed Rank Test*

Bivariate analysis was used to determine whether exercise training interventions affect Body Weight, BMI, TNFα, and MDA using Dependent T-test and Wilcoxon Test. Table 2 showed that training significantly reduced Body Weight and BMI with $p<0.05$. Training, both MICT, and HIIT, can improve TNFα (Figure 1). But only HIIT can reduce MDA, MICT did not improve MDA with $p>0.05$ (Figure 2).

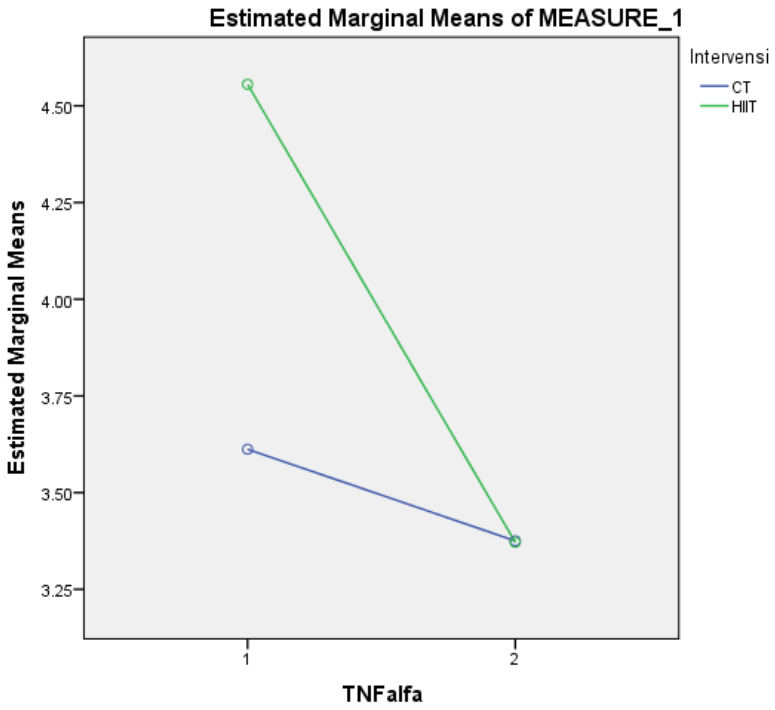


Figure 1. The effect of training to TNFα

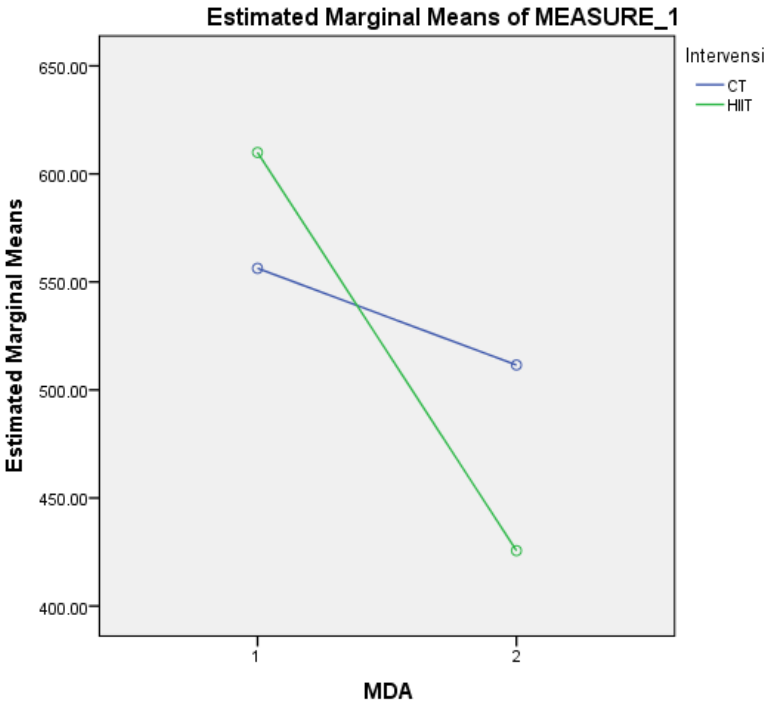


Figure 2. The effect of training to MDA

**Discussion**

This study was conducted on female subjects with obesity. Obesity is a chronic low-grade inflammatory condition characterized by an increase in inflammatory mediators, such as TNFα. TNFα as an inflammatory mediator is associated with obesity complications that begin with chronic inflammation and long-term insulin resistance. In addition to the inflammatory pathway, fat accumulation in obese patients also increases oxidative stress (Sanchez, 2011).

Bivariate analysis using the Wilcoxon Signed Rank Test showed that both MICT and HIIT training improved the inflammatory mediator TNFα. However, only HIIT was able to improve MDA oxidative stress levels. The results on the MICT showed that there was no significant decrease in MDA. The results of this study are in accordance with the research of Chadorneshin et al. (2019). Chadorneshin et al (2019) investigated the effect of HIIT on TNF- levels in overweight young adult women. The exercise program in this study used the running method. HIIT is considered to have a significant effect on reducing TNF- levels with a decrease of 5.57% after the intervention for eight weeks. The results of this study have a higher reduction of levels possible due to a more extended exercise period, which is for ten weeks. The results of this study are also in accordance with Allen et al. (2017) research. The research of Allen et al. (2017) investigated the effect of HIIT on TNF- levels in overweight adults. The exercise program in this study used the cycle-ergometer method. HIIT is considered to have a significant effect on reducing TNF- levels with a decrease of 18.1% after nine weeks of intervention. This study has different results from previous studies by Fatouros (2004), which examined levels of oxidative stress and antioxidant status at rest and after MICT in sedentary older men. In the Fatouros study, there were significant changes in MDA levels before and after physical exercise. Moderate-intensity continuous training (MICT) is effective in reducing MDA levels from 1.01 ± 0.11 mM to 0.85 ± 0.12 mM after 16 weeks of physical exercise. Differences in results may be caused by differences in the length of the training. Oxidative stress conditions are influenced by two things, namely, an increase in the formation of reactive oxygen species (ROS) and a decrease in antioxidant activity in inhibiting oxidative stress.

Physical training, both MICT, and HIIT, reduce body weight and body fat mass by increasing fat oxidation during and after exercise (Turk et al., 2017). Aerobic physical training plays a significant role in preventing

chronic disease in obesity by reducing circulating levels of inflammatory mediators and oxidative stress (Duzova et al., 2016).

The decrease in circulating levels of inflammatory mediators occurs because regular physical exercise has an anti-inflammatory effect. There are three possible mechanisms by which physical activity can exert an anti-inflammatory effect: decreased visceral fat mass, increased production and release of proinflammatory cytokines induced by muscle contraction, and reduced expression of Toll-like receptors (TLRs) on monocytes and macrophages. Two possible mechanisms of decreasing circulating TNF- after HIIT intervention are reduced visceral fat mass and reduced expression of TLRs in monocytes and macrophages (Gleeson et al., 2011).

Regular training can stimulate the body's antioxidant defenses against ROS in the oxidative stress pathway, thereby balancing oxidative stress (Bouzid, 2018; He et al., 2016). Both MICT and HIIT, if carried out regularly, will be able to increase endogenous antioxidants to reduce oxidative stress levels. In this study, HIIT was able to reduce MDA levels, but MICT had not improved MDA levels. This is possible because the MICT tends to generate free radicals that can increase oxidative stress. HIIT, implemented using the interval method, gives the body time to recover so that fewer free radicals are produced. Research by Kawamura (2018) shows that oxidative stress levels are also influenced by several factors such as diet and exercise status. Dietary foods containing antioxidants and consumption of antioxidants have a significant effect in reducing levels of oxidative stress. Research by Sumida et al. (1989) showed that consumption of vitamin E for four weeks at a dose of 300 mg/day could reduce MDA levels after physical exercise. However, the limitations of this study were not explored in depth regarding the diet consumed by the subjects, so it was not possible to assess its correlation directly to MDA levels after the intervention. Controlling of TNFα and MDA levels in obese patients will prevent obesity from developing into a chronic disease.

**Conclusion**

The research concludes that the 12-week training, both MICT and HIIT interventions improve inflammatory mediators by reducing TNFα in obese women. HIIT also can enhance oxidative stress by lowering MDA. HIIT can be used to treat obese patients, mainly to prevent obesity complications by reducing inflammatory mediators and oxidative stress.

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