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Changes in High-Sensitivity C-Reactive Protein Levels After Two-Weeks of Moderate-Intensity Endurance Exercise in Obese Women

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Authors' Contribution: A – Study design; B – Data collection; C – Statistical analysis; D – Manuscript Preparation; E – Funds Collection

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Abstract

Study purpose. The study purpose was to analyze the effect of moderate-intensity endurance exercise on reducing inflammation in obese women.

Materials and methods. Twenty obese women selected according to the established criteria were used as subjects. Then the subjects were divided into two groups: the control group (G1) and the endurance exercise group (G2). Moderate-intensity endurance exercise was performed by running on a treadmill for 40 minutes, with a frequency of 5 times/week for 2 weeks. Moderate-intensity was performed with 60%-70% HRmax (HRmax formula: 220-age). Blood sampling for inflammation measurement using the biomarker High-sensitivity C-reactive protein (hs-CRP) was performed before and after the intervention for 2 weeks. hs-CRP was measured using the enzyme-linked immunosorbent assay (ELISA) method. A paired sample t-test with a significant level ($p \leq 0.05$) was used for data analysis.

Results. The results showed the mean hs-CRP levels between before and after the intervention in G1 (6.76±4.40 vs. 6.43±4.89 ng/mL, (p=0.641)) and G2 (6.56±3.34 vs. 2.12±1.14 ng/mL, (p=0.004)).

Conclusions. The study indicates that moderate-intensity endurance exercise has been shown to be effective in reducing inflammation levels in obese women, so individuals with obesity are advised to reduce inflammation levels through moderate-intensity endurance exercise.

Keywords: endurance exercise, inflammation levels, obesity, healthy lifestyle.

Introduction

Obesity is a multifactorial disease, that not only has an impact on the emergence of several diseases (Lin & Li, 2021) but also has an impact on risk factors for complications resulting from excess fat mass which can harm health. Obesity is associated with decreased expression of lipogenic markers leading to the development of metabolic complications, such as ectopic lipid deposition in skeletal muscle and liver (Moreno-Indias & Tinahones, 2015). This reduction has a broad effect on accelerating risk factors for inflammation and oxidative stress, as well as reducing overall muscle function (Straight et al., 2021). Reduced muscle function resulting from obesity will contribute to insulin resistance and cardiovascular disease (Van Der Kolk et al., 2019), thus worsening morbidity and mortality (Bozzola et al., 2023). This will harm human resources in the future. Physical exercise is believed to be a strategic method and therapy for obese conditions (Sugiharto et al., 2022). Physical exercise has been widely used to reduce inflammation, thereby preventing complications in obesity (Calcaterra et al., 2022). However, the effectiveness of physical exercise on inflammatory parameters in obesity is still a matter of debate.

Inflammation was found to be high in obese conditions (Khanna et al., 2022), which will have an impact on metabolic disorders, stress, and tissue dysfunction (Andersen et al., 2016). Metabolic disorders have a greater risk of metabolic syndrome, and inflammation is associated with leukocyte activation and dysfunction in metabolic tissues such as adipose tissue, liver, pancreas, and blood vessels (Sheridan et al., 2012). Meanwhile, the occurrence of tissue dysfunction will have an impact on the accumulation

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of fat in primary lymphoid organs, which will damage tissue integrity associated with a large number of leukocytes and an inflammatory phenotype (Vucenik & Stains, 2012). This will increase the risk of developing type 2 diabetes mellitus and is likely to be the main distributor of complications (Longo et al., 2019). In addition, high levels of inflammation in obesity cause neuroinflammation which results in decreased cognitive function (Salas-Venegas et al., 2022) and motor abilities through changes in brain function and the musculoskeletal system (Wang et al., 2016). Therefore, appropriate strategies are needed to reduce risk factors for inflammation in obesity.

Preventing increased inflammation in obesity can be done by limiting calories and physical exercise. According to previous research, calorie restriction using intermittent fasting is considered to have a beneficial impact on reducing inflammation (Hills et al., 2019). However, it requires longer time and consistency and the results are only temporary (Yeoh et al., 2015). Previous research has shown that calorie restriction in humans has not been proven safe and effective for reducing inflammation in obese conditions (Kökten et al., 2021).

Previous research suggests that physical exercise can reduce inflammation, which is associated with a decrease in fat mass and an increase in muscle mass (Mika et al., 2019). However, appropriate physical exercise is still a matter of debate. Proven by research conducted by Zheng et al. (2019) physical exercise in the form of endurance exercise can reduce inflammation levels in a group of adult women. However, research conducted by Park & Nickerson (2022) stated that physical exercise in the form of endurance exercise could not change inflammation levels in a group of adult women. Other research also states that women who are obese tend to experience higher levels of inflammation than women who have a normal weight (Cohen et al., 2021). However, other studies show opposite results (Accattato et al., 2017). Therefore, The study purpose was to analyze the effect of endurance exercise on reducing inflammation using the biomarker High-sensitivity C-reactive protein (hs-CRP).

Materials and Methods

Participants

This study was a true-experimental with a pretest-posttest control group design. The study used 20 obese women as research subjects selected based on the following criteria: age 20-30 years, BMI 27-35 kg/m², blood pressure (systolic 110/120 mmHg and diastolic 70/80 mmHg), resting heart rate 60-80 bpm, oxygen saturation 96-100%, inactive in exercise, non-smoker, and non-alcohol consumer.

Study Design

Then, the subjects were divided into two groups, namely the control group (G1; n=10), and the endurance exercise group (G2; n=10). Endurance exercise was performed by running on a treadmill for 40 minutes, using moderate intensity (60%-70% HRmax) calculated by the formula (220-age). During endurance exercise, heart rate was monitored using POLAR H10. The entire research procedure was approved by the Research Ethics Committee Universitas Negeri Malang with the number 07.12.2/UN32.20.2.9/LT/2023.

Blood samples were taken to measure inflammation levels before and after endurance exercise intervention, taken from the cubital vein as much as 4 ml. Inflammation levels were analyzed using the ELISA method (Cat.No: E-EL-H0043; Elabsciencer Biotechnology Inc, USA).

Statistical Analysis

Data analysis was performed using the Statistical Package for the Social Science (SPSS) version 21.0. Data that were normally distributed and had homogeneous variance were analyzed using paired samples t-test and independent samples t-test with a significance level of 5%.

Result

Based on the study results, the data on the characteristics of the subjects in this study did not significant differences as presented in Table 1.

Table 1. Characteristics of research subjects

Variable	G1 (n = 10)	G2 (n = 10)	p-Value
Age, yrs	22.70±1.64	23.50±2.17	0.366
Systolic blood pressure, mmHg	113.05±6.19	115.25±3.49	0.344
Diastolic blood pressure, mmHg	70.08±5.66	72.65±7.73	0.407
Heart rate, bpm	76.80±7.87	75.80±3.74	0.723
Height, m	1.55±0.04	1.57±0.05	0.202
Weight, kg	71.04±4.55	73.02±7.99	0.507
Body mass index (kg/m²)	29.85±1.87	29.52±1.81	0.691

Based on the research results, there was a difference in the reduction in inflammation levels between the control group (G1) and the endurance training group (G2), this can be shown in the average reduction in inflammation levels in the control group (G1) and the endurance training group (G2) as in the Figure 1.

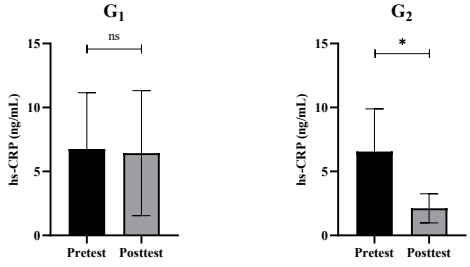

Fig. 1. Pretest and posttest hs-CRP levels (ng/mL) in both groups
Description: (*) The p-value indicates significant results at pretest ($p \leq 0.05$)

The results of the paired sample t-test mean pretest and posttest hs-CRP levels in the control group showed (6.76±4.40 vs. 6.43±4.89 ng/mL, p=0.641) and the endurance exercise group showed (6.56±3.34 vs. 2.12±1.14 ng/mL, p=0.004). These results show that the endurance exercise group significantly reduced inflammation levels, and the control group did not show a significant reduction.

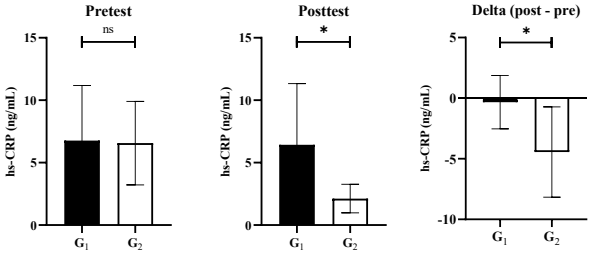

Fig 2. Pretest, posttest, and delta hs-CRP levels in both groups (G1 vs G2). Description: (ns) Not significant ($p \geq 0.05$). (*) Significant with a control group (G1) ($p \leq 0.05$)

Discussion

Obesity is often associated with inflammation which plays a role in the occurrence of complications (Marseglia et al., 2014), therefore it is important to reduce inflammation in conditions of obesity, one of which is endurance exercise. Based on the results of research that has been conducted, there is a difference in reducing inflammation levels between the control group (G1) of 0.33 ng/mL and the endurance training group (G2) of 4.44 ng/mL. The results showed a significant decrease occurred in the endurance training group (G2) compared to the control group (G1) (Table 1). The decrease in inflammation levels in (G2) was caused by endurance exercise. The endurance exercise used in this study reduced levels of circulating inflammation in the blood 2 weeks after exercise. These results are in line with research conducted by Fedewa et al. (2017) reported that endurance exercise can reduce inflammation >2 weeks after treatment. The results of previous research conducted by Gonzalo-Encabo et al. (2021) reported that endurance exercise can reduce inflammation levels in obesity cases.

This research involved subjects with obesity. In conditions of obesity, reducing body fat mass can improve mitochondrial function in adipocytes and reduce cytokine production which plays an important role in controlling inflammatory responses, endothelial function, and immunity (Bianchi, 2018). This can be proven in previous research conducted by Pranoto et al. (2023) reported that a decrease in inflammation occurred as a result of endurance exercise. Endurance training in this study is thought to increase anti-inflammatory activation which is influenced by increasing IL-10, IL-1RA, and sTNFr, thereby causing a decrease in inflammation such as IL-6, then IL-6 will increase the differential uptake of energy released in myocytes by increasing muscle insulin sensitivity and down-regulates inflammation (Kistner et al., 2022). These results are associated with research conducted by Leal et al. (2018) said endurance exercise can induce myocytes that can modulate adipose tissue to produce increased gene expression and secretion of IL-6, and there is an increase in IL-10, IL1-ra, and TNF-a, which is characterized as an anti-inflammatory effect.

The decrease in inflammation is thought to be due to the effects of endurance exercise. Muscle contractions caused by endurance exercise cause an increase in energy requirements using body fat by simulating lipolysis in adipose tissue, resulting in the release of free fatty acids (FFA) into the circulation and oxidation in the muscles (Mika et al., 2019) which can reduce the amount of fat mass in the body (Wedell-Neergaard et al., 2019). In addition, the reduction in inflammation is thought to be caused by the infiltration of immune cells such as macrophages which can be suppressed, and a phenotypic shift from M1 macrophages as inflammatory to M2 macrophages as anti-inflammatory which can be accelerated through endurance exercise (Saltiel & Olefsky, 2017). Macrophages activated via IL-10 indicate that M2 macrophages promote the early stages of proliferation myogenesis (Trendelenburg et al., 2012) which shows a change in macrophage phenotype during skeletal muscle regeneration with suppression of p38 MAPK signals followed by an increase in IL-10, so that it can work on M1 macrophage polarization to inhibit inflammation (Costamagna et al., 2015).

Endurance training can induce fatty acid metabolism through oxidation in muscle mitochondria to produce large amounts of ATP (Muscella et al., 2020) thereby triggering the activation of the adenosine monophosphate-activated protein kinase (AMPK) pathway which plays a role in conserving ATP by inhibiting the biosynthetic pathway and anabolic (glycogen and protein synthesis), as well as stimulating catabolic pathways by increasing glucose transport and fat metabolism (Egan & Zierath, 2013). Apart from that, endurance training can increase the number of mitochondria, an increase in mitochondria will cause biogenesis which will activate muscle cells by releasing myokines so that they can secrete irisin to increase energy expenditure by encouraging browning in white adipose tissue (Yano et al., 2021) and acts as an anti-inflammatory in the long term and helps restore inflammatory disorders in obesity conditions (Gonzalez-Gil & Elizondo-Montemayor, 2020).

The endurance training carried out in this study also paid attention to the intensity used because the subjects of this study were women with obesity. Endurance training performed at high intensity will result in major tissue damage and initiate excessive inflammatory and immunosuppressive reactions (Cavalcante et al., 2017). Meanwhile, endurance exercise performed at moderate intensity will reduce inflammation and increase fibrinolysis (Chen et al., 2014). Therefore, previous research recommends that moderate-intensity endurance exercise can reduce fat mass and reduce inflammation (Geliebter et al., 2015). Exercise intensity plays a role in determining the main energy source. The energy source used at high intensity will use the oxidation of carbohydrates, while at medium intensity the oxidation of FFA is more dominant. Therefore, this study was given endurance exercise with moderate intensity which is suitable for obesity conditions (Rejeki et al., 2023).

The results of this research can be used as a way to reduce inflammation levels in obesity through endurance exercise. However, this research has limitations, such as the research was only carried out on obese women, and endurance exercise was only carried out for 2 weeks so adaptation had not occurred. Therefore, it is recommended that further research be carried out on male subjects who are obese and in different age groups so that it can be generalized.

Conclusion

Based on research results, it was found that endurance exercise using moderate intensity (60%-70% HRmax) carried out for 2 weeks showed a decrease in inflammation levels in obese women, so this research recommends that individuals with obesity do endurance training consistently, taking into

account the intensity used. The results of this research can be used as a reference for future research by providing different exercise interventions and adding new parameters.

Conflict of Interest

The authors declares that there is no conflict of interest.

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Зміни показників С-реактивного білка високої чутливості після двох тижнів тренувань на витривалість помірної інтенсивності у жінок з ожирінням

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Авторський вклад: A – дизайн дослідження; B – збір даних; C – статаналіз; D – підготовка рукопису; E – збір коштів

Реферат. Стаття: 7 с., 1 табл., 2 рис., 41 джерела.

Мета дослідження. Метою дослідження було проаналізувати вплив фізичних вправ на витривалість помірної інтенсивності на зменшення запалення у жінок з ожирінням.

Матеріали та методи. Об'єктом дослідження стали двадцять жінок з ожирінням, відібраних за встановленими критеріями. Потім досліджувані особи були розподілені на дві групи: контрольну (G1) та групу, що займалася фізичними вправами на витривалість (G2). Вправи на витривалість помірної інтенсивності виконувалися шляхом бігу на біговій доріжці протягом 40 хвилин, з частотою 5 разів на тиждень протягом 2 тижнів. Помірна інтенсивність виконувалася при показниках 60%-70% МЧСС – максимальної частоти серцевих скорочень (формула МЧСС: 220 – вік). Забір крові для оцінки запалення за допомогою біомаркера С-реактивного білка високої чутливості (hs-CRP) проводили до і після інтервенції протягом 2 тижнів. Показник hs-CRP визначали методом імуноферментного аналізу (ELISA). Для аналізу даних використовували t-критерій парних вибірок зі значущим рівнем ($p \leq 0,05$).

Результати. Отримані результати показали середні рівні С-реактивного білка високої чутливості до і після інтервенції в групах G1 (6,76±4,40 проти 6,43±4,89 нг/мл, p=0,641) і G2 (6,56±3,34 проти 2,12±1,14 нг/мл, p=0,004).

Висновки. Проведене дослідження свідчить про те, що фізичні вправи на витривалість помірної інтенсивності виявилися ефективними для зниження рівня запалення у жінок з ожирінням. Таким чином, особам з ожирінням рекомендується знижувати рівень запалення за допомогою фізичних вправ на витривалість помірної інтенсивності.

Ключові слова: фізичні вправи на витривалість, рівні запалення, ожиріння, здоровий спосіб життя.

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