Jurnal SPORTIF: Jurnal Penelitian Pembelajaran
Vol. 9 No. 1, April 2023, pp. 160 - 171
https://doi.org/10.29407/js_unpgri.v9i1.19923

A single bout of endurance exercise decreases oxidative stress in young adults with overweight

Yasep Setiakarnawijaya[1abcf], Muhamad Syamsul Taufik[2abd], Widiastuti[1def], Kuswahyudi[1cef], Septyaningrum Putri Purwoto[3def]

[1]Department of Sport Science, Faculty of Sport Science, Universitas Negeri Jakarta, East Jakarta, Special Capital Region of Jakarta 13220, Indonesia.

[2]Department of Physical Education, Health and Recreation, Faculty of Teacher and Education, Universitas Suryakancana, Cianjur, West Java 43216, Indonesia.

[3]Department of Physical Education, Sekolah Tinggi Keguruan dan Ilmu Pendidikan PGRI Bangkalan, Bangkalan, East Java 69116, Indonesia.

Received: 5 April 2023; Revised: 26 April 2023; Accepted: 30 April 2023; Available online: 30 April 2023.

Abstract

Exercise has a dual effect of producing free radicals and anti-radicals. Therefore, it is necessary to consider appropriate precautions when applying it. This study aims to prove the effects of a single bout of endurance exercise on decreased oxidative stress in young adults with overweight. This study used the true experimental method with a pretest-posttest control group design. The subjects in this study were obtained using the consecutive sampling technique, obtaining 20 participants. Twenty overweight women between the ages of 20 and 23 were recruited from college students and randomly divided into two groups: CON (n = 10, control group without exercise) and EEx (n = 10, endurance exercise group). The endurance exercise intervention is carried out once by running on a treadmill with an intensity of 60-70% HR_{max} for 40 minutes/exercise sessions. Malondialdehyde (MDA) levels as a biomarker of oxidative stress were measured 30 minutes pre-exercise and 24 hours post-exercise using the Thiobarbituric Acid Reactive Substance (TBARs) method. Data analysis using an independent sample t-test with a significant value of 5%. The results showed that MDA levels significantly decreased in the endurance training group compared to the control group. Results of analysis of MDA levels between pre-exercise and post-exercise in CON (819.00±66.47 vs. 853.00±113.55 ng/mL; ($P > 0.05$)), EEx (810.00±120.19 vs. 596.00±67.57 ng/mL; ($P < 0.05$)). Based on the results of this study, it was concluded that a single session of endurance exercise at an intensity of 60-70% HR_{max} for 40 minutes reduces oxidative stress in overweight adolescent females.

Keywords: Endurance exercise, oxidative stress, overweight, moderate-intensity.

How to Cite: Setiakarnawijaya, Y., Taufik, M. S., Widiastuti, W., Kuswahyudi, K., & Purwoto, S. P. (2023). A single bout of endurance exercise decreases oxidative stress in young adults with overweight. Jurnal SPORTIF : Jurnal Penelitian Pembelajaran, 9(1), 160-171. https://doi.org/10.29407/js_unpgri.v9i1.19923

Authors contribution: a – Preparing concepts; b – Formulating methods; c – Conducting research; d – Processing results; e – Interpretation and conclusions; f - Editing the final version

Correspondence author: Yasep Setiakarnawijaya, Universitas Negeri Jakarta, Indonesia.
Email: yasep.s@unj.ac.id

INTRODUCTION

Exercise induces metabolic changes in the organism, activating adaptive mechanisms to establish a new dynamic balance (Accattato et al., 2017). One of the most significant changes in this regard occurs in muscle tissue, where the increased post-exercise energy requirements result in greater oxygen utilization by mitochondria (Barbieri et al., 2012). Skeletal muscle is a leading source of oxygen-free radical species because, during muscle contraction, increased transfer of unpaired electrons from complexes I and III in the electron transport chain leads to the production of superoxide radical (O^{2}-), a leading member of the reactive oxygen species (ROS) (Accattato et al., 2017). This toxic product of contractile activity is converted to hydrogen peroxide (H_2O_2) by superoxide dismutase (SOD), which is the first line of defence against radicals and, respectively, is detoxified by other enzymes such as catalase, glutathione peroxidase (GPX) and glutathione reductase (GR) (Sakellariou et al., 2014; Powers et al., 2011).

The balance between ROS production and expression of antioxidant enzymes is critical to maintaining muscle redox homeostasis and maintaining ROS below threshold levels to maintain their function as signalling molecules while reducing their toxic effects (Powers et al., 2020; Schieber & Chandel, 2014). On the other hand, the activity and capacity of ROS and antioxidants are correlated, so they can be used as surrogate markers of oxidative stress (Sharifi-Rad et al., 2020 Katerji et al., 2019). Blood antioxidant status may reflect increased oxygen demand in muscle tissue during exercise (Thirupathi et al., 2021; Kawamura & Muraoka, 2018). Therefore, circulating levels of this marker of oxidative stress increase after acute and regular exercise (Shibata et al., 2021; Accattato et al., 2017), possibly as a redox-mediated adaptation mechanism to protect against cellular oxidative damage (Kawamura & Muraoka, 2018; He et al., 2016; Ceci et al., 2014). However, the influence of different exercise protocols on antioxidant balance has yet to be fully elucidated. While some studies have reported that overweight individuals have

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grander increases in oxidative biomarkers after acute exercise compared to normal-weight individuals (Thirupathi et al., 2021; Manna & Jain, 2015; Farinha et al., 2015), other studies have shown conflicting results (Huang et al., 2015). However, Pranoto et al. (2023) reported that 30 minutes of treadmill exercise reduced oxidative stress in obese women. This study's results are expected to solve the obesity problem and reinforce the insight that exercise can be a safe way to reduce obesity rates.

Therefore, how the effect of acute exercise on reducing oxidative stress is still being debated, for this reason, the purpose of this study is to prove the effects of a single bout of endurance exercise on decreasing oxidative stress in young adults with overweight.

METHOD

This is a true experimental study with a pre-test-post-test control group design using 20 overweight students as subjects, a female gender, aged 20-23 years, with body mass index (BMI) 25-27.5 kg/m^2, normal blood pressure, heart rate rest normal, normal oxygen saturation (SpO_2), body temperature normal This study used a true-experimental design with a pretest-posttest control group. The subjects in this study were obtained using the consecutive sampling technique, obtaining 20 participants. The characteristics of the subjects in this study, including obese students, had an age range of 20 to 23 years, had a BMI range of 25 to 27.5 kg/m^2, had normal blood pressure, had normal resting heart rate, had saturation, had normal oxygen saturation, and have normal body temperature. Then, all subjects were randomly divided into two groups using the matching technique. and randomly divided into two groups: CON (n = 10, control group without exercise) and EEx (n = 10, endurance exercise group). Before participating in the study, all subjects had obtained information about the research both orally and in writing and stated that they were willing to participate in this study, as evidenced by filling out and signing informed consent, which was carried out without any coercion and was carried out in a conscious state. All procedures applied in this study have obtained approval from the Health Research Ethics Committee (KEPK),

https://doi.org/10.29407/js_unpgri.v9i1.19923
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Faculty of Medicine, Airlangga University, with registration number: 309/EC/KEPK/FKUA/2019.

Endurance exercise interventions are carried out by running on a treadmill with an intensity of 60-70% HR_{max} for 40 minutes/exercise sessions. Exercise intensity is controlled using the Polar H10 heart rate sensor (Polar Electric, Inc., Bethpage, NY, USA) (Pranoto et al., 2023). The acute aerobic exercise intervention was carried out at 08.00 WIB – finished using the Richter Treadmill Semi-Commercial Evolution.

Data was collected by measuring body height using a portable stadiometer seca 213 (Seca-213, Hammer Steindamm 3–25 22,089 Hamburg Germany) (Rejeki et al., 2023). Then, Body weight measurement using digital scales OMRON Model HN-289. BMI is calculated using body weight (kg) divided by Body height (m^2). Blood pressure measurement using the OMRON model HEM-7130L digital tension meter. Body temperature was measured using a digital thermometer OMRON MC – 245.

Blood was collected in the cubital vein with as much as 3 ml. At the time of blood sampling, the subject was in a sleeping position. Blood sampling was carried out two times, namely pre-exercise and 24 hours post-exercise (Pranoto et al., 2023). Blood was centrifuged for 15 minutes at 3000 rpm. Measurement of Malondialdehyde (MDA) levels as a biomarker of oxidative stress using the Thiobarbituric Acid Reactive Substances (TBARs) method (Yosika et al., 2020).

The data analysis technique used a statistical software packet for social science (SPSS) version 20. The normality test used the Shapiro-Wilk test. The data were normally distributed and tested using the paired sample t-test and independent sample t-test with significant levels (P < 0.05).

RESULT

Based on the results of the analysis of subject characteristics, there was no significant difference in each subject characteristic data in the two groups (P > 0.05), which can be seen in Table 1.

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Table 1. Characteristics of subject

Parameters	Group		*P-Value*
	Control without Exercise (n=10)	Endurance Exercise (n=10)	
Age (yrs)	21.50±1.27	21.40±1.17	0.857
Height (m)	64.97±4.10	64.84±3.10	0.937
Weight (kg)	1.56±0.04	1.56±0.03	0.909
BMI (kg/m^2)	26.78±0.94	26.69±1.14	0.835
SBP (mmHg)	113.30±4.08	113.70±4.08	0.829
DBP (mmHg)	73.40±6.39	73.80±4.37	0.872
HR (bpm)	72.40±5.64	72.50±4.38	0.965
BT (°C)	35.94±0.42	36.05±0.41	0.561

Description: BMI: Body mass index; BT: Body temperature; DBP: Diastolic blood pressure; HR: Heart rate; SBP: Systolic blood pressure.

The results of the analysis of subject characteristics showed no differences between groups ($P > 0.05$). These results prove that subjects between groups have the same subject characteristic tendencies.

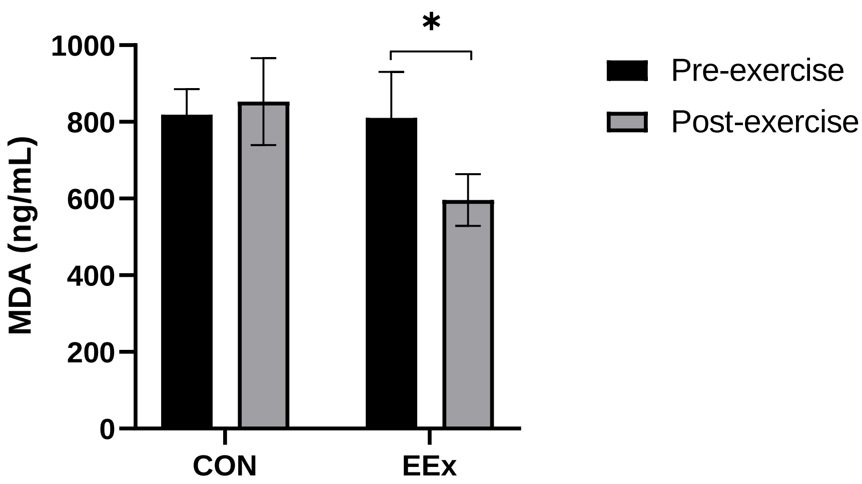

Figure 1. Differences in MDA levels (ng/mL) in the two groups
(*)Significant at pre-exercise ($P < 0.05$)
Description: CON: Control group; EEx: Endurance exercise group; (*): Significant at pre-exercise.

Results of analysis of Malondialdehyde (MDA) levels as a marker of oxidative stress between pre-exercise and post-exercise at CON (819.00±66.47 vs. 853.00±113.55 ng/mL; ($P > 0.05$)) and EEx (810.00±120.19 vs. 596.00±67.57 ng/mL; ($P < 0.05$)). These results indicate that the data pretest vs. posttest in the control group had no difference in MDA levels. Meanwhile, the resistance training group significantly decreased MDA levels in the pretest vs. posttest.

Table 2. The results of the analysis of MDA levels (ng/mL) in both groups

Parameters	MDA (ng/mL)		*P-Value*
	Control without Exercise (n=10)	Endurance Exercise (n=10)	
Pre-exercise	819.00±66.47	810.00±120.19	0.839
Post-exercise	853.00±113.55	596.00±67.57*	0.000
Delta (Δ)	34.00±113.45	-214.00±159.67*	0.001

Description: Presentation of data in the form of mean ± SD. *The P-Value* was obtained by independent sample t-test analysis. (*)Significant at pre-exercise (*P* < 0.05).

The results of the analysis using the independent sample t-test showed that the pretest data between the control vs. the resistance training group showed no difference, and the posttest data of the control vs. the endurance training group experienced a significant decrease in the endurance training group (*P* < 0.05). Furthermore, the delta data (Δ) between the control groups showed no difference, and the delta data (Δ) in the resistance training group showed a significant difference in MDA levels.

DISCUSSION

Based on the results, the study showed that one exercise session reduced oxidative stress in overweight young adults (Figure 1). A similar study found that serum MDA was decreased after 40 min following spaced, continuous interventions on the treadmill compared to controls in obese women (Yosika et al., 2020). Pranoto et al. (2023) reported that 30 min of treadmill exercise reduced oxidative stress in obese women. The results obtained from the exercises may be due to the fact that exercise can reduce the damage caused by ROS, thus increasing the process of scavenging free radicals, which affects the reduction of systemic circulating free radicals in young adults with overweight. Exercise as a recommendation for weight loss in overweight individuals in units of endurance sports of 40 minutes or longer to reduce MDA. This suggests that exercise can reduce oxidative stress in young adults overweight, which is characterized by lowered levels of MDA in blood serum.

The exercise intervention program is given as much as one practice session. Before being given the program, all subjects were taken pretest blood samples and then given an exercise program. After the

https://doi.org/10.29407/js_unpgri.v9i1.19923
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subject ran the program, a posttest blood sample was taken. Furthermore, blood samples were subjected to laboratory tests to measure MDA levels. Heart rate is checked periodically every minute during the walking exercise program to control exercise intensity. All subjects ascertained beforehand their health condition before carrying out the program by carrying out a health check. All subjects were divided into two groups using the matching technique. The matching technique is based on the results of screening subjects after all subjects who are willing to participate in the study agree to informed consent. The subject screening was carried out to assess the characteristics of the subject. Screening variables include female gender, age, BMI, blood pressure, resting heart rate, oxygen saturation, and body temperature. These variables already include health conditions and subject homogeneity. As evidenced by the results of the analysis of the characteristics of the subjects in this study, there were no differences between the control group and the resistance training intervention group.

Previous research by Samjoo et al. (2013) stated that resistance training reduced skeletal and systemic muscle-specific oxidative damage while improving IR and cytokine profiles associated with obesity, regardless of weight loss. The results of this study are in line with the results of previous studies. The results of previous studies were applied to obese subjects with an obese adult age range. This broadens the insight that doing resistance training in the young adult age group can also reduce MDA levels. The benefits of reducing MDA levels have been described in previous studies, decreasing MDA levels has been associated with a reduced risk of muscle cell damage due to oxidative stress during exercise in obese individuals. Previous studies agree that obesity is a complex disease associated with an increase in several markers of inflammation, which causes chronic low-grade inflammation, one of which is caused by oxidative stress (Khanna et al., 2022).

Previous research on weight loss in young adults has been discussed. Bellicha et al. (2021) found that exercise training has a beneficial effect on weight loss and changes in body composition in adults

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who are overweight or obese. Previous research has explained the contribution of exercise to weight loss in adult subjects. Clinically significant weight loss is at least 5% from baseline (Swift et al., 2016; Donnelly et al., 2009). Results by Liu et al. (2023) showed that exercise performed for six weeks significantly improved body shape in overweight and obese young adult males, while exercise coupled with fasting significantly reduced fasting insulin levels and increased insulin sensitivity in cells and tissues.

Overweight people have an imbalance of pro-oxidants and antioxidants in their bodies. Furthermore, the link between overweight and oxidative stress is that cyclic adenosine monophosphate (cAMP) regulates energy balance. In addition to functioning as an energy reservoir, adipose tissue also functions as an endocrine organ involved in the pathophysiology of oxidative stress. Being overweight leads to increased inflammatory processes, excessive lipogenesis, inhibition of lipolysis, and lipid apoptosis (Susantiningsih, 2015). Cells routinely generate free radicals and ROS that are part of their metabolic processes. Oxidative damage to tissues from stress has been shown to cause cell membrane damage, induce cell swelling, decrease cell membrane flux, maintain ionic gradients, tissue inflammation, DNA damage, and protein alterations (Algul et al., 2018). Obesity is associated with increased lipid peroxidation. Malondialdehyde (MDA), one of several by-products of the lipid peroxidation process, is a biomarker of the level of lipid peroxidation (Vasantrao Bhale et al., 2014).

The limitation of this study is that the first intervention was given only a single session of endurance exercise (acute exercise) so future research is suggested to do chronic exercise. This is because exercises carried out on an account basis can only provide temporary changes, while exercises carried out chronically can provide permanent changes. The two subjects used were only female, so the conclusions of this study cannot be generalized to both sexes. Therefore, future research can differentiate the effects of endurance exercise on reducing oxidative stress

https://doi.org/10.29407/js_unpgri.v9i1.19923
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in both sexes. These three studies only focus on overweight BMI so that future studies can differentiate reductions in oxidative stress in different BMIs such as underweight, normal, overweight, and obese.

CONCLUSION

Based on the results of the study, it was concluded that one session of endurance exercise with an intensity of 60-70% HRmax for 40 minutes reduced oxidative stress in overweight female adolescents. Endurance exercise performed for 40 minutes can be used as a recommendation for overweight individuals to reduce MDA as an indicator of oxidative stress.

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