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THE EFFECT OF JUMP ROPE TRAINING ON OXIDATIVE STRESS AND PULMONARY FUNCTION AMONG MEDICAL STUDENTS

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ABSTRACT

Background. Physical inactivity has been known as a global public health problem and also becomes an important risk factor for Non-Communicable Disease (NCD). Jump rope training is an example of aerobic exercise that is easily done with simple tools. It also increases pulmonary function and reduces oxidative stress. The objective of the study assessing the effects of jump rope training on oxidative stress and pulmonary function in male medical students of Diponegoro University.
Method. This is a quasi-experimental study with 42 male medical students as subjects. The subjects were chosen purposively and divided into two groups using a matched subject design. The treatment group was given jump rope training for 6 weeks, each week consists of three-session exercises. The control group didn't perform jump rope training. The pulmonary functions measured are Vital Capacity (VC), Forced Vital Capacity (FVC) and Forced expired volume in one second (FEV1) using spirometry, while the oxidative stress level used malondialdehyde (MDA) parameters measured using the thiobarbituric reactive substances method (TBARS). Paired t-test, independent t-test, Wilcoxon, Mann-Whitney, and Spearman test were used for statistical analysis.
Results. There was a significant difference in spirometry test and MDA level in the jump rope training group compared to the control with $p < 0.001$. Spearman's correlation analysis revealed that MDA levels were not correlated with pulmonary function ($p > 0.05$).
Conclusion. Jump rope training may decline oxidative stress and improve pulmonary function in male medical students of Diponegoro University.
Keywords: jump rope training, pulmonary function, oxidative stress

INTRODUCTION

According to the *World Health Organization* (WHO), inadequate physical activity becomes a risk factor for *Non-Communicable Disease* (NCD).[1] Based on Indonesian Youth Statistics 2015, the number of people who regularly exercise hasn't reached one-third of the total population.[2] Physical activity can increase cardiorespiratory endurance and reduce the risk of cardiovascular diseases such as coronary heart disease, stroke, and hypertension. Lung volume and capacity can be used to determine whether there is an abnormal pulmonary function to assess cardiorespiratory endurance.[3] Physical exercise can also affect the level of oxidative stress. Regular physical exercise can increase the antioxidant protection mechanism that will inhibit cell damage due to oxidative stress.[4]

Jump rope training is a type of aerobic exercise. This kind of exercise can be done anywhere and anytime, even indoors without fear of air pollution, lack of sports facilities or other things that cause a lack of physical activity. As an aerobic exercise, jump rope training can increase cardiovascular endurance and respiration.

Previous research reported that by doing exercise regularly, it can improve pulmonary function.[5] Besides, based on

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research conducted by Cassano et al, the level of oxidative stress is inversely proportional to the ability of respiratory function.[6] At rest, oxidative stress levels are found to be lower in physically active individuals compared to individuals who are less physically active.[7,8] Based on the background described, also based on the previous studies, we hypothesized that increasing physical activity by doing jump rope training increased pulmonary function and decreased oxidative stress levels.

METHODS

2.1 Participants

The study was approved by the ethical committees of the Faculty of Medicine at Diponegoro University.

This research is a quasi-experimental study with pre-test and post-test design. Researchers tested 42 male undergraduate medical students of Diponegoro University, ranging from 18 to 23 years of age. Subjects were chosen purposively with inclusion and exclusion criteria. In group determination, the author used a design or pattern matched subject design, which is an experiment that uses two groups of samples that have been equated subject by the subject before the treatment is carried out.

There are two groups tested in this experiment, one is the experimental group (EP) and the other is the control group (C). The EP group was given jump rope training for 6 weeks and each week consists of three-session exercise and each session contains 3 sets. While the C group is not allowed to do exercise for 6 weeks. The parameter of the examination was pulmonary function consisting of vital capacity (VC), forced vital capacity (FVC), and Forced expired volume in one second (FEV1) measured using spirometry and serum malondialdehyde (MDA) levels measured using the Thiobarbituric Acid Reactive Substance (TBARS) method. Both EP and C groups are required to do these tests at the beginning of this research (pre-test) and after 6 weeks of training (post-test).

2.2 Treatment

The EP group, which consisted of 21 subjects, did exercise three days a week. Participants exercised three times per week, with training progressing gradually in length and intensity. The EP group exercised jump rope training progressed from 15 min in the first 2 weeks, 20 min in the next 2 weeks, and 25 min in the last 2 weeks. Control participants were asked to revert to their prestudy activity levels. The control group continued with their normal daily activities during the six weeks of research without additional guided physical activities.

2.3 Laboratory Test

All subjects did not carry out strenuous activities within 24 hours before blood sampling. Measurements were taken on recruitment and repeated after six weeks. The 3cc blood sample was centrifuged, transferred, and immediately frozen for MDA analysis. Plasma MDA levels were determined by using Thiobarbituric Acid Reactive Substance (TBARS) method. In this method, first, 1 mL of 15% trichloroacetic acid, 1 mL of 0.675% TBA solution in 0.25 N HCl and 0.1 mL plasma are added to the tube and mixed. After incubating for 15 minutes at 80° C and the coolant with cold mixed water was centrifuged at 3000 rpm for 15 minutes. After that, take the supernatant and put it in the cuvette. Optical density was measured at 545 nm by a spectrophotometer. MDA is stated as nmol/L.

2.4 Statistical Analysis

Data analysis includes descriptive analysis and hypothesis. Dependent variables data (VC, FVC, FEV1, and MDA) from each group were analyzed using paired t-test for normal distribution, and Wilcoxon for abnormal distribution. Intergroup

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dependent variables data were analyzed using the unpaired t-test for normal distribution and Mann – Whitney for abnormal distribution. The relationship between MDA levels with VC, FVC, and FEV1 was assessed using the Spearman correlation test. The value of the degree of significance is $p < 0.05$.

RESULT

A total of 42 male undergraduate medical students of Diponegoro University were included in the analysis. Subjects characteristics of this research are shown below.

Table 1. Characteristics of Research Subjects

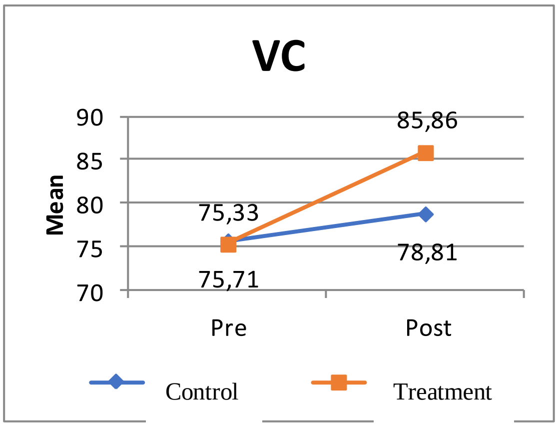
Parameter	N	Minimum	Maximum	Mean ± Standard Deviation
Age (year)	42	18	23	19,50 ± 1,194
Height (cm)	42	155	180	170,24 ± 5,050
Weight (kg)	42	48	78	64,21 ± 8,274
Body Mass Index (kg/m^2)	42	18,5	24,9	22,07 ± 2,2987

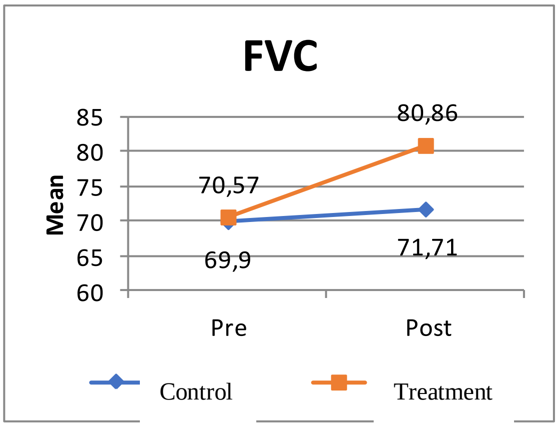
These following data were obtained from the measurement of pulmonary function (VC, FVC, FEV1) using spirometry.

Table 2. Comparisons of VC, FVC, and FEV1 before and after 6-week period in treatment and control group.

Pulmonary Function	Group		p
	Control (Mean±SD)	Treatment (Mean±SD)	
VC			
Pre test	75,71 ± 10,68	75,33 ± 10,18	0,906[§]
Post test	78,81 ± 12,04	85,86 ± 7,01	0,026[§]*
p	0,177[¶]	<0,001[¶]*	
FVC			
Pre test	69,90 ± 10,72	70,57 ± 10,50	0,840[§]
Post test	71,71 ± 15,59	80,86 ± 9,27	0,029[‡]*
p	0,644[¶]	<0,001[†]*	
FEV1			
Pre test	75,38 ± 13,04	74,00 ± 14,76	0,458[‡]
Post test	76,67 ± 14,73	87,71 ± 9,05	0,006[§]*
p	0,481[†]	<0,001[¶]*	

Description: * Significance ($p < 0,05$); [§] Independent t; [‡] Mann Whitney; [¶] Paired t; [†] Wilcoxon





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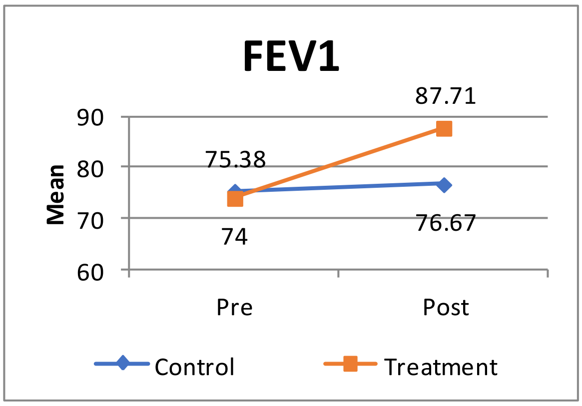


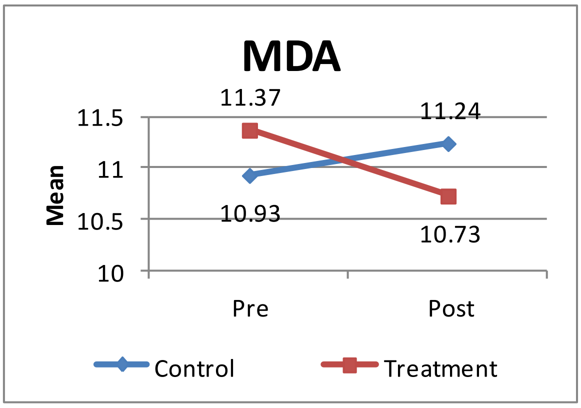
The results in the three tables above show a significant increase in the three values of the VC, FVC, and FEV1 pre-post treatment groups (p < 0.001), while the VC, FVC, and FEV1 pre-post values of the control group were not significant (VC p = 0.177; FVC p = 0.644; FEV1 p = 0.481). In the intergroup test to compare the post-test values of the control group with the treatment, a significant result was obtained (VC p = 0.026; FVC p = 0.029; FEV1 p = 0.006), meaning that the VC, FVC, and FEV1 values in the treatment group had a significant increase compared to the control group.

These following data were obtained from the measurement of MDA levels using TBARS method.

Table 3. Comparisons of MDA levels before and after 6-week period in treatment and control group.

MDA	Group		p
	Control (Mean±SD)	**Treatment** (Mean±SD)	
Pre	10,93 ± 0,83	11,37 ± 0,93	0,002‡*
Post	11,24 ± 0,92	10,73 ± 0,34	0,062‡
p	0,061†	<0,001†*	
Difference	0,31 ± 0,65	-0,65 ± 1,02	<0,001‡*

Description: * Significance (p < 0,05); ‡ Mann Whitney; † Wilcoxon



The results in the table above show a significant decrease in the pre-post MDA levels of the treatment group (p < 0.001), whereas the pre-post MDA levels in the

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control group were not significant (p = 0.061). In the intergroup test to compare the post-test values of the control group with the treatment, it was found that the results were not significant (p = 0.062). Therefore, the researcher continued testing the data by comparing the difference (delta) then obtained significant results (p < 0.001), which means a decrease in MDA levels pre-post in the treatment group is better than the control group. Spearman's cc Control analysis revealed that MDA levels correlated with all three pulmonary function variables (p > 0.05).

DISCUSSION

We found that the 6-weeks jump rope training improved pulmonary function. Based on statistical tests in the group were given treatment in the form of skipping exercises for 6 weeks showed a significant increase in the value of pulmonary function (VC, FVC, and FEV1), whereas in the control group who did not exercise skipping and just doing activities as usual showed an increase in the value of lung function (VC, FVC, and FEV1) were not significant. The intergroup test shows that the increase in the treatment group is greater than the control group. Significant results in the treatment group from this study are supported by previous research conducted by Imtiyazi (2018), which states that physical activity or regular physical exercise can help improve lung function.[5]

Aerobic exercise that is carried out routinely with the right intensity, duration, and frequency will have good long-term effects on some organ systems of the body. This happens because of the adaptation of the organ system including musculoskeletal, cardiovascular, and respiration.

In the respiratory system, intercostal muscles and diaphragms become stronger so that the expansion and recoil power of the lungs will increase. This will cause the amount of air that can enter the lungs will be more so that it will increase one's vital capacity (VC). In musculoskeletal adaptation, there is an increase in contractile protein volume so that muscle and tendon strength will increase. Therefore, expiratory muscles will also experience increased strength. Also, an increase in the number of mitochondria in muscle cells and myoglobin influences oxygen supply so that muscle endu Treatment increase.[9] This is following prev rch conducted by Pomatahu (2015), which produced data in the form of aerobic exercise causes an increase in Forced Vital Capacity (FVC) and Forced Expired Volume in One Second (FEV1).[10]

Jump rope training is an aerobic exercise that focuses on limb muscles to swing the rope and jump. Exercises in the upper limb muscles will cause changes in the respiratory load which help reduce the mechanical load of the diaphragm during the breathing process.[11] Also, when doing activities that require arm movement, the arm must be elevated so that it will involve inspiring muscles such as trapezius muscle.[12] This will increase lung functional capacity and the ability to move a person.[11]

The pulmonary function in the control group were slightly increased, although the increase was not significant. This can be due to the accuracy of spirometry measurements depending on how correctly the respondent maneuvered on each measurement. In subsequent measurements with the same tools and maneuvers, respondents will tend to better understand how to maneuver correctly.[13]

Oxidative stress is commonly considered to have occurred if there is a decrease in concentration or activity of nonenzymatic or enzymatic antioxidants or an increase in the oxidation of nonenzymatic antioxidants. Oxidative stress has been implicated in accelerated atherosclerosis and microvascular complications of DM. In previous reports, TBARS and lipid peroxides (as reflect oxidative stress) were found to be elevated in diabetic patients with microvascular complications compared to diabetic patients without microvascular complications.[14,15] Furthermore, physical exercise may acutely induce oxidative damage, although regular training appears to enhance antioxidant defenses and, in some animal studies has decreased lipid peroxidation. Aerobic exercise training can reduce oxidative stress by enhancing antioxidant defense mechanisms that include antioxidant enzymes such as superoxide dismutase, catalase, and glutathione peroxidase.[16] Based on the results of our study, we propose that endurance exercise training over twelve weeks is important for reducing parameters of oxidative stress.

CONCLUSION

Jump rope training are proven to be effective in improving pulmonary function and reducing oxidative stress. The improvement of pulmonary function and reducing oxidative stress levels is evidenced by the results of statistical analysis in groups who practice jump rope with significant results compared to those who were not trained. This can be achieved with only 6 weeks of practice.

Further research needs to be done to study the effect of jump rope exercises on oxidative stress and pulmonary function with a larger number of samples, also measurements MDA levels needs to be done at the same time or close together so that research subjects are in the same physical condition when measuring MDA levels. The treatment of each research subject needs to be done at the same time so that each subject is in the same condition while being tested.

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