The Effect Of Swimming Aerobic Physical Exercise On White Rats (Rattus Novergicus) Of The Wistar Strain That Are Obese

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Abstract.

Women are more likely to be obese and at risk of hypertension and coronary heart disease than men. Genetic factors influence it. Physical exercise can reduce obesity, especially on endothelial factors such as ET-1 and NO. This research explores the effect of swimming physical training on the expression of endothelin-1 and receptor-A in obese mouse models. This type of research is a true experiment carried out on 12 adult female Wistar rats (Rattus norvegicus) as research samples. The research procedures were carried out by caring for test animals, raising rats until they were obese, not giving treatment (control), physical training in the form of swimming exercises, and finally, examination of ET-1, ET-A, blood sugar levels, and total cholesterol levels. The data obtained was analyzed using SPSS. The research results of the normality test for the treatment group were more significant than 0.05 in the ET-1 examination of 0.315 and ET-A of 0.261. ET-1 levels were 92.5 pg/ml and ET-A levels were 62.5 pg/ml. Their blood sugar level was 167 mg/dL. The research concluded that in mouse tests, physical training was better for increasing ET-1 levels and reducing ET-A levels. Swimming and aerobics are better at lowering blood sugar levels.

Keywords: *Obesity, Physical Exercise, Endothelin Levels, Cholesterol Levels and Blood Sugar levels.*

I. INTRODUCTION

Obesity is a global and national health concern in Indonesia [1]. According to the Framingham Study, being overweight and having high blood pressure are two separate risk factors for cardiovascular disease [2]. A nurse's health research indicated that more women than men were in danger of hypertension and coronary heart disease as a result of obesity and that this risk was much higher among those who were already overweight 30% of the population falls into this category [3]. Being overweight appears to be a significant risk factor for the development of hypertension, according to the findings of epidemiological research, which also revealed a link between body mass index and blood pressure [4]. As the most effective nonpharmacological therapy strategy, weight reduction has been advocated for obese hypertension patients [5]. Because restoring a substantial amount of average body weight is so complex, the long-term effects of weight loss programs are highly disheartening [6]. A novel approach to treating overweight and obese patients has promoted moderate weight loss, reducing 5% to 10% of starting weight [3].Obesity has several causes, one of which is heredity [7]. There is a hereditary component to obesity, and children inherit their parents' genes [8]. Dietz found that the odds of a kid becoming overweight are 80 percent when both parents are overweight and 40 percent when only one parent is overweight [9].Research from Asia, India, and Malaysia reveals that rural residents get more carbohydrates than fat and protein. Rural residents' total calorie intake is 11.5 to 13.5 percent higher than recommended for healthy weight maintenance compared to urbanites. Sugar intake is also higher, while fiber intake is only 30 percent of what is suggested. Along with a sedentary lifestyle and heavy alcohol intake, this unhealthy diet positively affects energy balance, which in turn causes obesity [10].

In both industrialized and developing nations, the prevalence of obesity has reached epidemic proportions. Not only are adults seeing a rise in the obesity epidemic, but so are children and teenagers. From 2019 to 2022, 17.1% of American children and adolescents were overweight, while 32.2% of American adults were obese [11]. Obesity enhances the likelihood of developing cardiovascular disease (CVD), diabetes, cancer, and other chronic illnesses such as osteoarthritis, liver and kidney disease, depression, sleep apnea, and insomnia [12]. Obesity has been on the rise for the last half-century, and it may negatively affect

quality-adjusted life years [13]."Physical exercise" is a consistent, high-intensity movement program to boost strength, cardiovascular health, and overall physical performance [14]. Both aerobic and anaerobic training are forms of physical activity, but in terms of energy supply, none can be classified entirely as "aerobic" or "anaerobic" [15]. In aerobic training, you typically ride a stationary bike or run continuously at a certain intensity level for a set amount of time. Lifting weights, doing resistance exercises, or jogging at a high intensity for brief periods beyond one's anaerobic threshold constitute anaerobic training [14].

Endothelin-1 levels will often rise in individuals who are overweight [16]. Vasoconstriction, brought about by an increase in Endothelin-1, causes smooth muscle cells in the blood vessels to increase and migrate more rapidly [17]. In humans, a rise in the number of smooth muscle cells in the blood vessels narrows their flexibility, raising the risk of atherosclerosis. This condition limits the blood vessel lumen and puts the patient at risk for hypertension [18].Cardiac myocytes or autocrine parallel pathways may express endothelial factors, including ET-1 and NO, depending on the underlying disease. The three genes make endothelins work together to create pre-endothelin, a huge mRNA protein precursor. On chromosome 6, you'll find the endothelin-1 gene in humans [19]. By controlling the binding of transcription factors such as GATA-2 and AP-1 to particular regions of the ET-1 gene promoter, hormones and vascular factors affect the production preproendothelin-1 by the ET-1 gene. A long-chain amino acid called Preproendothelin-1 is produced when messenger RNA is translated. There is a constant parallel between the endothelin receptor and the regulation of endothelin production [17].The above suggests that exercise influences ET-1 levels and its receptors; nevertheless, there is a shortage of research into this topic, particularly about the involvement of ET-1 receptors in obesity and the small sample sizes used in these investigations (humans). Therefore, more studies employing mice as a model are required to ascertain whether or not exercise lowers endothelium-1 levels and, by extension, endothelin-A receptor levels in obesity.

II. METHODS

This study used a post-test control group research design, making it a true experimental study [20]. One experimental animal model employed in this study is an overweight male rat model split into two groups: one that gets exercise and one that doesn't (control group) [21]. Twelve rats were utilized for the investigation, with six assigned to the treatment group and six to the control group.The recommended sample size for each category was five heads and a predicted 10% dropout rate; this study utilized six experimental animals per group [22]. Rattus norvegicus, an adult female Wistar strain rat, was employed in the study. The rats were healthy and had a weight range of 150-300 grams. They were also two to three months old. Physical perfection and the ability to move freely define health.

In this theoretical study, reductions in ET-1 and ET-A receptors are the dependent variable, whereas physical activity is the independent variable. A variable can potentially change as the investigation progresses [23]. The female Wistar strain rats' age (5 months), gender, and body weight were the control variables, while the rats' daily activity level was the confounding variable.The study induced obesity in mice by feeding them a diet rich in carbohydrates and fat. Twelve animals were enrolled; six were assigned to the control and six to the exercise group. The control group received no therapy, while the exercise group performed aerobic swimming exercises for four weeks.Statistical analysis was performed on the collected data using SPSS [24]. After determining that the data follows a normal distribution using the Shapiro-Wilk test, we will compare the two groups that received and did not get therapy for obesity using an independent sample t-test to see whether there was a difference in ET-1 levels and ET-A receptors.

III. RESULTS AND DISCUSSION

Research Result

The study involved 12 rats, divided into six groups, treated with a 14-day high carbohydrate and fat diet to increase obesity levels.A 14-day high-fat, high-cholesterol diet was administered to mice, with a meal of quail egg yolk increasing cholesterol levels. Weight, energy expenditure, cholesterol, and glucose levels were used to validate obesity. Weight characteristics were determined using the Lee index to decide if the

mice were overweight.Evidence suggests that rats fed a high-fat diet are more likely to become obese, as their lee index values rise over 0.3 [25].

Table 1. Characteristics of Test Animals

Component	Group K	Group P
Rat Type	Adult wistar strain rats (*Rattus norvegicus*)	
Gender	Females	
General Conditions	White coat color, healthy and active	
Average Initial Body Weight	240,8 gr	279,5 gr
Average Final Body Weight	271,6 gr	192,5 gr

After four weeks of treatment with aerobic physical exercise and swimming, the Lee index in the treatment group dropped to 0.29, indicating that the rats in that group are no longer obese; in contrast, the control group reached 0.5 at the same point without treatment, meaning that the rats in that group are obese. The study's author concludes that an extract from aerobic physical exercise, such as swimming, influences the weight of overweight rats.

Table 2. Rat Body Weight

Parameters	Group	Average	
		Day 14 (After high-fat diet)	Week 4 (day 28) After 14 days of aerobic swimming and physical exercise treatment)
Body Weight	Control	240,8 gr	279,5 gr*
	Treatment	271,6 gr	192,5 gr
Naso-anal length	Control	203 mm	203 mm
	Treatment	205 mm	205 mm
Index Lee	Control	0.4	0.5
	Treatment	0.5	0.29

*(without treatment)

Next, we assessed the ET-1 and ET-A levels in the blood of all the rats after 14 days of a high-fat, high-cholesterol diet. Then, we compared the groups after four weeks (28 days) of no exercise (control group) and exercise (treatment group), as shown in the following table:

Table 3. Endothelin-1 Level (pg/ml)

Body Weight	Before	After	ET-1	Before	D14	D28
Control	220	245	Average	62,4	72	86,7
	210	250		60,3	73	86,2
	285	310		60,7	72	86,1
	290	315		62,3	73	86,1
	240	292		62,6	77	86,0
	200	265		62,5	72	86,2
Average	240,83	279,5	Average	61,8	73,17	86,22
Treatment	280	190	Treatment	62,1	71	89
	300	205		62	72	90
	260	190		60	71	92
	260	195		61,5	73	88
	250	170		62	77	95
	280	205		63	72	95
Average	271,67	192,5	Average	61,77	72,67	91,5

Considering the ET-1 test findings, specifically on 14 days after introducing a high-fat diet and cholesterol, the control group showed an increase in ET-1 of 73.16 pg/ml; on 28 days without exercise, the same group demonstrated a rise of 86.21 pg/ml. On day 14, following the introduction of a high-fat, cholesterol-laden meal, the treatment group showed an ET-1 examination result of 72.6 pg/ml; on day 28, this group's ET-1 resulted in a 92.5 pg/ml rise after aerobic swimming. In this approach, groups of exercised rats have higher ET-1 levels than groups of inactive rats.

Table 4. Endothelin-A Level (pg/ml)

ET-A	Before	D14	D28
Control	93	80	70
	98	80	70
	94	76	66

	97	70	65
	98	80	70
	96	80	70
Average	96	77,67	68,5
Treatment	93	70	62
	98	70	66
	99	79	63
	89	70	62
	96	75	60
	99	75	62
Average	95,67	73,17	62,5

According to the ET-A data, the control group had a drop of ET-A of 77.6 pg/ml on day 14 after the high-fat diet and cholesterol induction, and on day 28, this group did not exercise to reduce ET-A, which resulted in a loss of 68.5 pg/ml. Alternatively, the treatment group showed a drop in ET-A with a result of 73.1 pg/ml on day 14 after starting a high-fat and cholesterol diet. On day 28, the group continued to show a decline of 62.5 pg/ml after swimming aerobically. Thus, compared to the control group that did not get any exercise, the exercise group's ET-A decrease levels are much higher. Following the measurement of obesity levels in the test animals, blood tests were administered to all rats to determine their cholesterol and sugar levels after 14 days of a high-fat, high-cholesterol diet. The rats in the control group were not exercised for four weeks, while those in the treatment group were given physical activity for 28 days.

Table 5. Cholesterol Level (mg/dL)

Group	**D0**	**D14**	**D28**
Control-1	51	58	55
2	52	59	58
3	51	59	55
4	50	60	57
5	52	61	58
6	51	59	57
Average	51,16	59,3	56,6
Treatment-1	50	60	47
2	50	59	44
3	52	58	48
4	51	59	43
5	52	60	44
6	50	60	46
Average	50,8	59,3	45,3

The control group achieved a cholesterol level of 56.6 mg/dL on day 28 without receiving any physical activity therapy when comparing the outcomes of the treatment group with the control group. Aerobic swimming activity began on day 14 following the introduction of a high-fat diet. It continued until day 28 in the therapy group, leading to cholesterol examination findings of 45.3 mg/dL (week 4). This means that compared to the control group that did not receive exercise, the exercise group saw a more significant reduction in cholesterol levels.On day 28, the control group achieved a blood sugar level of 194.6 mg/dL without physical activity treatment, according to the comparison between the treatment and control groups.

Table 6. Blood Sugar Level (Mg/Dl)

Group	D0	D14	D28
Control-1	89	220	190
2	80	205	198
3	90	205	197
4	87	215	198
5	88	220	190
6	89	215	195
Average	87,1	213,3	194,6
Treatment-1	80	240	163
2	89	220	157
3	90	210	155
4	80	205	166

5	88	205	169
6	80	205	192
Average	84,5	214,1	167

On the other hand, the treatment group achieved a cholesterol level of 167 mg/dL with aerobic swimming activity beginning on day 14 following the introduction of a high-fat meal and continuing until day 28 (week 4). In this manner, compared to the control group that does not receive exercise, the exercise group achieves a more significant reduction in blood sugar levels in rats.Finding out if the data follows a normal distribution is the goal of the normalcy test. This research employed the Shapiro-Wilk test to ensure normalcy. The data normality test is crucial because data that tracks a normal distribution represents the population. The data is said to be regularly distributed if the p-value is more significant than 0.05 and not normally distributed if the p-value is less than 0.05 [24].

Table 7. Normality Test

Group		Shapiro-Wilk		
		Statistic	df	Sig.
ET1	Control	.769	6	.060
	Treatment	.889	6	.315
ETA	Control	.684	6	.054
	Treatment	.878	6	.261

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

The normalcy test data presentation showed that both the control and treatment groups' ET-1 and ET-A data follow a normal distribution. The control group had a significant value of 0.06 > 0.05, while the treatment group had an essential value of 0.315 > 0.05. The independent sample t-test for obesity will be used to compare the ET-1 levels and ET-A receptors in the two groups.

Table 8. Homogeneity Test Results

Group	Levene's Test for Equality of Variances	
	F	Sig.
ET1	20.130	.006
ETA	1.081	.323

A significance level higher than 0.05 indicates homogeneity in the Levene test. There is no difference between the control and test groups, suggesting that they follow the same distribution and have similar variances. An independent sample t-test is employed to compare the test groups.

Table 9. Independent Sample T-Test Results

Group		t	df	Sig. (2-tailed)	95% Confidence Interval of the Difference	
					Lower	Upper
ET1	Control	-4.276	10	.002	-8.03664	-2.53003
	Treatment	-4.276	5.068	.003	-8.44706	-2.11961
ETA	Control	4.794	10	.001	3.21112	8.78888
	Treatment	4.794	9.718	.001	3.20012	8.79988

It is evident from the test findings that the control group had a significant result of 0.002 in the ET-1 test, whereas the treatment group had a result of 0.003. Therefore, it can be inferred that there is a substantial difference between the control and treatment groups in testing ET-1 and ET-A, as the test results for ET-A obtained 0.001 in the control group and 0.001 in the treatment group, where all significance values> 0.05 [26].

Research Discussion

In this experiment, overweight white rats (*Rattus Novergicus* wistar) were subjected to aerobic swimming as a form of exercise. Twelve rats were utilized for this investigation, with six animals in each group. First, the rats undergo a preconditioning therapy in which they are fed a high-carbohydrate and high-fat diet to make them obese. After 14 days, the rats are evaluated for obesity using the Lee index, a score greater than 0.3. At week 4, the rats in the control group were considered obese due to a Lee index of 0.5

[25], which indicates that they were not receiving any therapy. In contrast, the rats in the treatment group achieved a Lee index of 0.29 after aerobic swimming activity, suggesting that they were no longer obese.Diseases related to energy imbalance and weight increase are among the health consequences of obesity, characterized by an abnormal or excessive buildup of fat in adipose tissue [27]. On the other hand, people react differently regarding the total quantity of fat they store and tend to store fat in various parts of their bodies. One way to identify people who are at high risk of developing obesity-related disorders is to look at how their body fat distribution changes as a result of gaining weight [28].Body weight as determined by the Lee index >30, ET-1 and ET-A, cholesterol levels, and blood sugar levels were the measures utilized in the study to confirm that the mice were obese.There was an increase in ET-1 for the control group with a result of 73.16 pg/ml on day 14 following the induction of a high-fat and cholesterol diet, and for this group without physical exercise, the result was 86.21 pg/ml on day 28.

However, the treatment group showed an increase in ET-1 of 72.6 pg/ml on day 14 after starting a high-fat, cholesterol-laden diet and an even more significant rise of 92.5 pg/ml on day 28 after engaging in aerobic swimming as a type of physical activity. In this approach, groups of exercised rats have higher ET-1 levels than groups of inactive rats [29], [30].In this approach, groups of exercised rats have higher ET-1 levels than groups of inactive rats. This agrees with the view in [16] that endothelin-1 levels in the bloodstream can be reduced via consistent physical activity.Compared to the ventricular vessels, the renal medulla is the first site of vascular dysregulation caused by obesity. Kidney tissue can be damaged by an increase in ET-A expression, which indicates decreased blood flow. Regarding ET-A measurements, the control group showed a drop of 73.1 pg/ml on day 14 following the introduction of a high-fat, cholesterol-rich meal. In contrast, the treatment group demonstrated a 62.5 pg/ml decrease on day 28 after aerobic swimming activity. The result is that the exercise-treated rats reduced ET-A levels more effectively than the control group.Cholesterol levels were measured in both treated and untreated groups of overweight rats. Results without exercise therapy in the control group reached 56.6 mg/dL on day 28. Aerobic swimming activity began on day 14 following the introduction of a high-fat diet. It continued until day 28 in the therapy group, leading to cholesterol examination findings of 45.3 mg/dL (week 4). This means that compared to the control group that did not receive exercise, the exercise group saw a more significant reduction in cholesterol levels.Blood sugar levels in treated and untreated obese rats were also measured in these experiments.

Comparing the two groups' blood sugar levels, we find that the control group, which did not get any physical activity treatment, had a level of 194.6 mg/dL on day 28. In contrast, the treatment group achieved a cholesterol level of 167 mg/dL with aerobic swimming activity beginning on day 14 following the introduction of a high-fat meal and continuing until day 28 (week 4). In this manner, compared to the control group that does not receive exercise, the exercise group achieves a more significant reduction in blood sugar levels in rats.Obesity regulates ET-1 and ET-A levels, as well as cholesterol and blood sugar, according to the data acquired from the complete study. The role of mechanical stimulation of the endothelium by shear stress and its relationship to obesity-related endothelial dysfunction has been previously shown (physical exercise). But how exactly all three are related is still a mystery.Endothelin-1 is a vasoconstrictor peptide generated by vascular endothelial cells. [19] found that 21 obese people whose plasma concentration of endothelin-1 was considerably lower before exercise and significantly higher after exercise enhanced nitric oxide. Thus, it may be inferred that the administration of aerobic swimming exercise impacts the Wistar strain of obese white rats (*Rattus Novergicus*).

IV. CONCLUSION

The study found that aerobic swimming and physical exercise improved the ET-1 levels of obese white rats, with the treatment group showing a significant increase in ET-1 levels. In contrast, the control group demonstrated no notable increase. The results suggest that physical exercise can potentially improve ET-1 levels.Physical exercise significantly reduced ET-A levels in rats, with a 62.5 pg/ml reduction compared to 68.5 pg/ml in the non-exercise group on day 28. The study found that physical exercise, including aerobic swimming, significantly reduced cholesterol levels in rats compared to the control group, which had a cholesterol level of 56.6 mg/dL on day 28. The study found that physical exercise, including

aerobic swimming, significantly reduced blood sugar levels in rats compared to the control group, which had a blood sugar level of 194.6 mg/dL without exercise.This notion that aerobic swimming exercise can help reduce obesity has to be further investigated in human trials before any firm conclusions can be drawn. Measurements of HDL and LDL are necessary for a complete picture of cholesterol levels.

V. ACKNOWLEDGMENTS

Prima Indonesia University's Faculty of Medicine, Dentistry, and Health Sciences has the author's most profound appreciation for their help in making this study a reality. We are grateful to our research partners for the priceless advice they have given us.

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