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CORRELATION OF EXERCISE INTENSITY ON BLOOD FIBRINOGEN LEVELS

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Abstract
Fibrinogen is the main coagulation protein in the blood that plays a role in platelet clot formation. Increased fibrinogen levels in the blood are one of the important parameters for heart disease risk. Increased fibrinogen levels can be influenced by sports activities. The purpose of this study was to determine the correlation of exercise intensity to blood fibrinogen levels. This study used observational analytic research design with cross-sectional research type. The subjects in this study were members of the National STIKES Basketball Team who were grouped based on Maximum Heart Rate (MHR) measurements. The sampling technique of this study was purposive sampling, namely venous blood from members of the National STIKES Basketball Team. MHR measurement was carried out with a digital tensimeter and measurement of fibrinogen levels using the Stago STart Max tool at the Surakarta Prodia Clinical Laboratory. The research data obtained were analyzed using the Independent Sample T-Test test with the SPSS program for windows 11. The results of the Shapiro-Wilk normality test were obtained with a sig. $p>0.05$; homogeneity of variance test using the Levene Test with a sig value. 0.259 > p 0.05; Independent Sample T-Test test shows sig. (2-tailed) 0.000 <0.05. It can be concluded that there is a correlation between exercise intensity and blood fibrinogen levels.

INTRODUCTION

A healthy lifestyle is now increasingly popular among the public. Exercise is a type of physical activity that plays a central role in a healthy lifestyle. Exercise activities have many positive benefits for health, one of which can improve and maintain physical condition. However, exercise that is done excessively or inappropriately in accordance with physical conditions can have significant negative impacts. Excessive physical activity can lead to long-term health problems such as blood clotting disorders that contribute to heart disease. This problem is strengthened by several cases of public figures who died after exercising, including the death of Ashraf Sinclair in 2020 due to a heart attack after doing CrossFit sports. Footballer Ricky Yacobi in 2020 who fell on the Senayan Glora field Karno while playing football with

Indonesian national team players. Badminton athlete Markis Kido in 2021 who fell in a prone position and was unconscious while practicing badminton (Republika, 2018).

Based on its intensity, sports can be classified into three categories, namely light, medium, and heavy. Moderate-intensity physical activity is carried out with a total duration of at least 150 minutes per week. This type of exercise can improve heart health and is done with a moderate level of effort. Examples include brisk walking, yoga, and jogging. Strenuous physical activity is an activity that is done continuously for at least 10 minutes and causes a significant increase in pulse rate and breathing frequency compared to normal conditions. Examples of strenuous sports include weightlifting, running, cycling, and freestyle swimming (World Health Organization [WHO], 2022). Intensity in the context of physical activity is defined as a function of the strength of the nerve stimuli exerted during exercise. The strength or weakness of these stimuli is determined by several factors, including the training load, the speed of movement, the variation of the intervals, and the rest time between repetitions. One of the indicators that can be used to measure exercise intensity is heart rate, which is 60-80% of the maximum heart rate (MHR) (Milliandika, Dirgantoro, & Rakhman, 2023). One way to measure exercise intensity is to use maximum heart rate. Maximum Heart Rate (MHR) is a number that indicates the highest limit of heart rate that a person can achieve during physical activity. In determining a person's maximum heart rate, it can only be done when the person is in a state of complete rest (Ningsih & Puspitaningrum, 2018).

High-intensity exercise over a long period of time will increase the potential for blood clots. This is because blocked blood vessels will trigger several heart diseases such as unstable angina, myocardial infarction, cerebrovascular accident, and sudden cardiac death or cardiac arrest (Posthuma et al., 2015). Heart disease is associated with high blood clotting parameters. One of the blood clotting parameters affected is fibrinogen (Skouras et al., 2023). Fibrinogen is one of the most important acute phase proteins, which is synthesized by liver cells. The mechanism of fibrinogen in tissues can cause thrombosis, coagulation (Usta et al., 2021). Manzel's research states that changes in hemostatic profile are influenced by the intensity and duration of physical activity. High-intensity exercise over a long period of time will increase the potential for blood clots (Menzel & Hilberg, 2011).

Exercise can affect blood fibrinogen levels through a variety of factors, including the type and timing of exercise, as well as individual physiological conditions. Exercise with strenuous intensity and long duration tends to increase fibrinogen levels, while moderate intensity has a smaller impact on the hemostatic system (Karri et al., 2021). Exercise time also has an effect, where physical activity in the morning shows a higher increase in fibrinogen compared to night due to temperature factors that trigger cryofibrinogen precipitation (Sarda-Kolopp & Miossec, 2023). In addition, hemostatic stress due to physical injury can activate fibrinogen to stop bleeding (von Roland, 2015). Hormonal factors, such as pregnancy and post-menopausal conditions, also play a role in increasing fibrinogen levels (Ritarwan & Yenita, 2017). Old age also affects fibrinogen levels due to a decrease in the rate of fibrinolysis (Fu & Nair, 2024). The use of anticoagulant drugs such as warfarin or rivaroxaban may lower fibrinogen levels (Arble & Arnetz, 2021). Lifestyle factors such as smoking and excessive alcohol consumption are known to increase fibrinogen levels, which contribute to the risk of cardiovascular disease (Lestari, S., & Setyawan, 2014). A history of heart disease such as atherosclerosis and myocardial infarction is also associated with increased blood fibrinogen levels (Posthuma et al., 2015).

The mechanism of blood clotting due to exercise is that when a person exercises at a heavy intensity, it will trigger an increase in catecholamines which affect the formation of platelets. Increased platelet formation leads to increased platelet aggregation. Increased platelet aggregation will have a direct impact on the increase in fibrinogen in the blood (Skouras et al., 2023). Vahid's research on the effect of exercise on fibrinogen and plasma viscosity, there was a significant correlation between sample groups on fibrinogen changes. Platelet aggregation accompanied by an increase in von Willebrand factor (vWF) decreases the fibrinolysis process which causes the level of fibrinogen in the blood to increase (16, 17).

The production of catecholamines due to exercise is influenced by the intensity of exercise. Based on the level of intensity, exercise which is a type of physical activity is divided into light, moderate, and heavy physical activity. Exercise intensity can be categorized based on maximum heart rate. Maximum heart rate (MHR) is the maximum heart rate that a person can achieve while exercising. The intensity of exercise is categorized as light if the MHR range is between 50-60%. Moderate exercise intensity has a MHR range of 60-70%. Exercise is categorized as heavy intensity if the MHR range is more than 80% (Kemenkes RI, 2021). Rana's research on platelet aggregation states that high-intensity exercise can cause pathological changes in the endothelial wall due to platelet aggregation that affects fibrinogen levels in the blood (Rana et al., 2019). Therefore, the author wants to conduct research related to the correlation between exercise intensity and blood fibrinogen levels.

METHOD

A. Study design

This study is an observational analytical research with a cross-sectional approach conducted in August 2024. Sampling and measurement of Maximum Heart Rate (MHR) was carried out at the Surakarta Citizen High School. Fibrinogen levels were checked at Prodia Surakarta's Clinical Laboratory. The population of this study is members of the Basketball Team of the National College of Health Sciences (STIKES Nasional) Surakarta. A sample of 20 respondents was taken by purposive sampling and divided into three groups based on the intensity of exercise, namely light, moderate and heavy which was determined based on the measurement of maximum heart rate (MHR) according to the Regulation of the Ministry of Health of the Republic of Indonesia (Kemenkes RI) in 2021. Respondents' criteria data were collected through questionnaires, exercise intensity data was obtained from MHR measurements using digital sphygmomanometers, while blood fibrinogen levels were measured using a semi-automatic method using the Stago STart Max tool at Prodia Surakarta's clinical laboratory.

B. Ethical statement

This research has received approval from the Health Research Ethics Committee of the University of Muhammadiyah Purwokerto (KEPK-UMP), with an approval letter No: KEPK/UMP/18/X/2024. All participants involved in this study have been given an explanation of the research objectives and procedures, and signed an informed consent before sampling was carried out. This research was conducted while maintaining the confidentiality of participants' identities and personal data and following applicable research ethical principles, such as respecting participants' rights, ensuring security, and ensuring that there is no coercion in participation.

C. Materials

The tools used in this study were Stago STart Max, cuvette, ball vial¸2.5 ml combitips, connected pipettes, Stago STart Max notebook, black and gray thermal pipettes, ball extractors, triangular stirring rods, micropipettes, yellow tips, vacutainer tubes of sodium citrate 3.2%, centrifuges, holders, lancets, tourniquets, droppipettes, latex gloves, masks, tube racks, sample cooling boxes, Label paper, markers, and digital sphygmomanometers. The materials used in this study were venous blood samples, STA Liquid-Fib reagents, NaCl 0.9%, aquabides, 70% alcohol, cotton, plaster.

D. Procedures

The research begins with the process of selecting subjects according to the inclusion and exclusion criteria that have been determined. Respondents were asked to fill out a questionnaire to find out the suitability of the respondents' inclusion criteria. Respondents who met the criteria were asked to fill out informed consent as a sign of consent to be a sample in the study. After obtaining the respondent's consent through informed consent, a maximum heart rate measurement (MHR) was carried out using a digital sphygmomanometer that has an automatic pulse measurement feature. Measurements are taken at rest and after physical activity to get an estimate of maximum heart rate. The results of the maximum heart rate measurement (MHR) are categorized into three groups: light, moderate, and heavy intensity. Blood samples were taken from the cubitic vein using a vacutainer tube containing 3.2% anticoagulant sodium citrate. A blood sample of 3 mL was centricled at a speed of 3000 rpm for 15 minutes to obtain plasma. The separated plasma samples are then stored in a cooler box and immediately taken to Prodia Clinical Laboratory to be checked for fibrinogen levels by the Clauss method using the Stago STart Max device and STA Liquid-Fib reagent in accordance with applicable laboratory standard procedures.

E. Statistical Analysis

The data from this study was statistically analyzed using the SPSS program. Before the hypothesis test is carried out, a normality and homogeneity test is first carried out to determine the appropriate type of statistical test. The normality test was carried out using the Shapiro-Wilk test, because the number of samples in this study was less than 50. This test aims to find out whether the numerical data obtained is normally distributed. The data is said to be normally distributed if the significance value (sig.) is > 0.05, and abnormal if sig. < 0.05 (Hardisman, 2021). Next, a variance homogeneity test was carried out using the Levene test to ensure that the data came from populations that had the same variance. The Levene test can be used for data that does not have to be normally distributed. The data is said to be homogeneous if the value of sig. ≥ 0.05, and is not homogeneous if the value of sig. < 0.05 (Ghozali, 2016) .

After the two initial tests were carried out, it was followed by a hypothesis test to determine the difference in fibrinogen levels based on the intensity of exercise. If the data is distributed normally and homogeneously, the parametric test Independent Sample T-Test is used, with the criterion Ha accepted if the value of sig. < 0.05 and Ho are accepted if the value of sig. > 0.05. However, if the data is not normally distributed, then a non-parametric Mann-Whitney test is used, provided that Ha is accepted if the value is Asymp. Sig. < 0.05 and Ho are accepted if the value of Asymp. Sig. > 0.05 (Ghozali, 2016).

RESULTS AND DISCUSSION

A. Questionnaire Result Data

Gender

All subjects in this study were male. The total number of subjects was 20 people (100%). Thus, the gender aspect is uniform and in accordance with the criteria that have been determined.

Age

Based on the results of the analysis of age data, it is known that the average age of the respondents in this study is 21.55 years with a standard deviation of 1.73 years. The youngest age of the respondents was 19 years old, while the oldest age was 24 years old.

Table 1. Average Age of Respondents

Age	Sum	Average	Standard Deviation	Minimum	Maximum
19	4	21,55	1,73	19	24
20	2				
21	3				
22	3				
23	6				
24	2				

Summary: The average age of respondents in this study was 21 years old

This shows that the age range of the subjects is relatively narrow and is in the category of young adulthood. The age distribution of respondents was quite even, with the age of 23 years being the largest group, namely 6 people. The standard value of the deviation that is not too large indicates that the respondents' age data does not vary too much and tends to be around the average value.

Medical History

Based on the results of a questionnaire related to health history, all subjects in this study did not have a history of hypertension or heart disease. Of the total 20 respondents (100%), none were found to have a medical history related to the two conditions. This shows that all subjects have met the study inclusion criteria that require participants to be in good health, especially free from diseases that can affect fibrinogen levels in the blood.

Consumption of Blood Thinning Drugs

Based on the results of a questionnaire related to the consumption of blood-thinning drugs, none of the study subjects took blood-thinning drugs, such as warfarin, apixaban, dabigatran, or rivaroxaban. Of the total 20 subjects (100%), none were or had taken the drugs.

Thus, all respondents met the study's inclusion criteria, which required subjects to be free from the consumption of drugs that could affect fibrinogen levels in the blood.

Smoking

Table 2. Respondents Smoking Habits

No	Smoking Habits	Sum	Percentage (%)
1	No Smoking	17	85
2	≤10 cigarettes / day	3	15
3	11-20 cigarettes / day	0	0
4	> 20 cigarettes / day	0	0
5	E-Cigarette Smoking	0	0
	Total	20	100

Summary: A total of 17 people (85%) of respondents stated that they did not smoke, while 3 people (15%) stated that they smoked with an intensity of ≤10 cigarettes per day.

Based on the results of the questionnaire shown in Table 2, it is known that the majority of the study subjects do not have a smoking habit. A total of 17 people (85%) of respondents stated that they did not smoke, while 3 people (15%) stated that they smoked with an intensity of ≤10 cigarettes per day. No subjects smoked 11-20 cigarettes per day, more than 20 cigarettes per day, or who used e-cigarettes. These findings indicate that most of the study subjects have a habit of living without cigarette consumption, thus minimizing the potential influence of smoking habits on blood fibrinogen levels.

Alcohol Consumption

The criteria for research subjects based on alcohol consumption habits were categorized into two, namely consuming alcohol and not consuming alcohol. Based on the results of the questionnaire, all subjects in this study, namely as many as 20 people (100%) stated that they did not have the habit of consuming alcohol. These findings show that all respondents have met the inclusion criteria set in the study, namely being free from alcohol consumption that has the potential to affect physiological conditions, including blood fibrinogen levels.

Table 3. Maximum Heart Rate Measurement (MHR) Data

No	Exercise intensity	Sum	Percentage (%)
1	Light	0	0
2	Medium	10	50
3	Heavy	10	50
	Total	20	100

Summary: All research subjects were divided into two categories of exercise intensity, namely moderate and severe.

Based on the results of the maximum heart rate measurement shown in Table 3, it is known that all study subjects are evenly divided into two categories of exercise intensity, namely moderate and severe, as many as 10 people (50%) each. None of the subjects fell into the light exercise intensity category (0%). Thus, the total number of subjects involved in the study was 20 people, all of whom carried out moderate to heavy intensity sports activities.

B. Results of Fibrinogen Levels and Smoking Habits

In this study, although most of the subjects did not smoke (85%), there were 15% of respondents who had a smoking habit with an intensity of ≤10 cigarettes per day. Although it is included in the category of light smokers, the existence of this group still needs to be considered because exposure to cigarettes, even in small amounts, can still have a physiological impact on the cardiovascular and hemorrhagic systems, including fibrinogen levels (Sarda-Kolopp & Miossec, 2023). Therefore, it is important to conduct a statistical analysis to find out if there is a difference in blood fibrinogen levels between subjects who smoke and those who do not smoke.

Table 4. Correlation between Blood Fibrinogen Levels and Smoking Habits

	Sig. (2-tailed)	Mean Difference	% Confidence Interval Of The Difference	
			Lower	Upper
Assumption of Equal Data Variation	0,259	32,647	26,235	91,529

Summary: There was no significant correlation between smoking habits and blood fibrinogen levels.

Based on the results of data analysis using statistical tests (Independent Samples t-Test), a significance value (Sig. 2-tailed) was obtained of 0.259, with a mean difference of fibrinogen levels of 32.647 mg/dL between the group of smokers (≤10 sticks/day) and those who did not smoke. A 95% confidence interval indicates a lower limit of 26,235 and an upper limit of 91,529. Although there was a difference in the average value of fibrinogen levels between the two groups, the results of the statistical test showed that the correlation was not statistically significant ($p>0.05$). Thus, it can be concluded that in this study there was no significant correlation between smoking habits and blood fibrinogen levels. This may be due to the relatively small number of smoking subjects (only 3 people), so it does not provide a strong enough variation of the data to show a statistically significant correlation.

C. Characteristics of Numerical Data

Table 5. Characteristics of Numerical Data

	Sum	Average	Standard Deviation	Minimum	Maximum
Medium	10	260,000	21,307	223	288
Heavy	10	333,555	29,201	291	371

Summary: Subjects with strenuous exercise intensity had higher blood fibrinogen levels compared to moderate-intensity exercisers.

Table 5 shows the characteristics of blood fibrinogen level data by exercise intensity category, namely moderate and severe. In the moderate-exercise intensity group, 10 subjects (50%) had blood fibrinogen levels with an average of 260,000 mg/dL, a standard deviation of 21,307, a minimum value of 223 mg/dL, and a maximum value of 288 mg/dL. Meanwhile, in the group with strenuous exercise intensity, which also consisted of 10 subjects (50%), the average fibrinogen level was 333.555 mg/dL, with a standard deviation of 29.201, a minimum value of 291 mg/dL, and a maximum value of 371 mg/dL.

The considerable difference in mean values between the two groups showed a tendency that subjects with strenuous exercise intensity had higher blood fibrinogen levels compared to those who exercised at moderate intensity. This indicates a possible correlation between increased physical activity intensity and increased blood fibrinogen levels. However, to determine whether the difference is statistically significant, further analysis is needed through an inferential test, such as the Independent Samples t-Test.

D. Data Analysis

Normality Test

Table 6. Normality Test

Normality Test			
	Exercise intensity	**df**	**Shapiro-Wilk Sig.**
Blood Fibrinogen Level Results	Medium	10	0,616
	Heavy	10	0,087

Summary: Fibrinogen levels in both groups were distributed normally.

Normality tests were performed to find out whether blood fibrinogen levels in each exercise intensity group were distributed normally. Based on the results of the Shapiro-Wilk test shown in Table 6, a significance value of 0.087 was obtained for the heavy exercise intensity group, and 0.616 for the moderate exercise intensity group. Since the two significance values are greater than the value of $\alpha = 0.05$, it can be concluded that the fibrinogen level data in both groups is normally distributed.

Homogeneity Test

Table 7. Homogeneity Test

Homogeneity Test		
	Levene Statistic	**Sig**
Blood Fibrinogen Level Results	1,357	0,259

Summary: Data has homogeneous variance between groups

The homogeneity test aims to find out whether the variance in blood fibrinogen levels in each exercise intensity group has a uniform or homogeneous distribution. Based on Table 7, the results of the Levene test show a Levene Statistic value of 1.357 with a significance value (Sig.) of 0.259. Since the significance value is greater than $\alpha = 0.05$, it can be concluded that the data have homogeneous variance between groups.

Test Hypotheses

Table 8. Test Hypotheses

	Sig. (2-tailed)	**Mean Difference**	**95% Confidence Interval Of The Difference**	
			Lower	Upper
Assumption of Equal Data Variation	0,000	73,500	49,484	97,516

Summary: The intensity of exercise has a noticeable influence on blood fibrinogen levels.

The Independent Samples t-Test was performed to find out if there was a significant difference between blood fibrinogen levels in the moderate- and strenuous exercise intensity groups. Based on the results of the test, a significance value (Sig. 2-tailed) of 0.000 was obtained which was smaller than the value of $\alpha = 0.05$. These results showed that there was a statistically significant difference between blood fibrinogen levels in the two groups. Thus, it can be concluded that exercise intensity has a significant influence on blood fibrinogen levels, where the group with strenuous exercise intensity tends to have higher fibrinogen levels compared to the group with moderate exercise intensity, where the higher the exercise intensity, the blood fibrinogen levels tend to increase. These findings are important as a scientific basis that strenuous physical activity can affect the body's physiological response, particularly when it comes to increased blood fibrinogen levels.

This study aims to determine the correlation between exercise intensity and blood fibrinogen levels, with the intensity classification determined through the measurement of Maximum Heart Rate (MHR) which is measured after subjects undergo regular exercise. Based on the results of blood fibrinogen levels measurements conducted at Prodia Surakarta Clinical Laboratory, it was found that the group with strenuous exercise intensity had higher fibrinogen levels compared to the group with moderate exercise intensity.

All of the study respondents were male, which according to Hajar had a higher risk of experiencing an increase in fibrinogen levels in the blood, which was 60%, as one of the risk factors for heart disease (Hajar, 2016). Respondents are also in the age range of 19-24 years, which is the productive age according to the Ministry of Health. Productive age is considered important to study because higher physical activity can affect physiological conditions, including fibrinogen levels (Kemenkes RI, 2022). Aizhong's research also reinforces this urgency by stating that increased fibrinogen levels are more common in older age due to decreased fibrinolysis rates (Fu & Nair, 2024). Thus, understanding the factors that affect fibrinogen levels at productive age is an important step in efforts to prevent the risk of cardiovascular disease from an early age.

The absence of a significant correlation between blood fibrinogen levels and smoking habits in this study may be due to the very small number of smoking subjects, i.e. only 3 people, compared to 17 non-smokers. In addition, all smoker subjects in this study were included in the category of light smokers (≤10 cigarettes/day), so the possibility of the effect of smoking on fibrinogen levels was not too prominent. However, in terms of average values, fibrinogen levels in the smoking group were seen to be higher than in the non-smoking group. These results are in line with Levesque's research which states that although light smokers experience a slight increase in fibrinogen levels, this increase is more related to smoking rates and duration of smoking. Light smokers did show slightly higher levels of fibrinogen than non-smokers, but the increase was not very significant when compared to heavy smokers (Levesque, Dufresne, Rinfret, & Bédard, 2009).

The correlation between exercise intensity and blood fibrinogen levels in this study was reviewed through physiological mechanisms that occur due to physical activity with a certain intensity. Exercise activities, especially those with high intensity, are known to trigger increased levels of catecholamines that play a role in stimulating platelet production. This increased platelet production will cause intravascular interaction or friction between platelets and blood vessel walls. Friction that occurs continuously during exercise will trigger hemostatic stress and potentially damage the endothelium of blood vessels. This endothelial damage then triggers the process of adhesion and platelet aggregation as the body's response to blood vessel injury (Skouras et al., 2023). Platelet activation in this process contributes to increased fibrinogen levels, as fibrinogen plays an important role in the process of coagulation and blood clot formation. These findings are in line with the results of Rana's research which states that high-intensity exercise can cause pathological changes in the endothelial walls of blood vessels, thus supporting the correlation between increased exercise intensity and blood fibrinogen levels (Rana et al., 2019). Therefore, high exercise intensity can be one of the triggering factors for an increase in fibrinogen levels physiologically.

The findings in this study showed that there was an increase in blood fibrinogen levels in subjects who exercised with strenuous intensity. These results reinforce previous findings made by Vahid, who stated that high-intensity physical exercise can significantly increase fibrinogen levels and plasma viscosity (Vahid et al., 2019). This research is also in line with Rahajuningsih's opinion which explains that an increase in platelet aggregation accompanied by an increase in vWF (von Willebrand Factor) can decrease fibrinolysis activity, thereby triggering the accumulation of fibrinogen in the blood circulation (Rahajuningsih, 2018). In addition, research by Rana also supports these findings, stating that high-intensity exercise can cause hemostatic stress due to endothelial damage to blood vessels, which then triggers the activation of the coagulation system and increased fibrinogen levels (Rana et al., 2019). Thus, the findings in this study are consistent with previous studies that show that high-intensity exercise has the potential to increase fibrinogen levels through platelet aggregation mechanisms and disrupt the balance between coagulation and fibrinolysis.

One of the limitations of this study is the exclusion of subjects who have a smoking habit. Smoking is known to affect blood fibrinogen levels through chronic inflammation and activation of the coagulation system triggered by exposure to harmful substances in cigarettes, such as nicotine and carbon monoxide (Hajar, 2016). Although the proportion of smokers in this study is small and classified as light smokers, the existence of this factor can still be a confusing variable that has the potential to affect the results of the study. However, to address this potential bias, we conducted statistical tests and the results showed that smoking did not have a significant association with fibrinogen levels in the context of this study. However, it is suggested that in future studies, more attention should be paid to smoking habit factors, either by excluding smoker subjects or categorizing them in more detail.

CONCLUSION

This study aims to determine the correlation between exercise intensity and blood fibrinogen levels, with the intensity classification determined through Maximum Heart Rate (MHR) measurements measured after subjects undergo regular exercise. Based on the results of blood fibrinogen levels measurements conducted at Prodia Surakarta Clinical Laboratory, it was found that the group with strenuous exercise intensity had higher fibrinogen levels compared to the group with moderate exercise intensity. These findings show a correlation between increased exercise intensity and increased levels of fibrinogen in the blood. Physiologically, it can be explained that high-intensity exercise can trigger the occurrence of physiological stress and mild inflammation that stimulates the liver to increase fibrinogen production as part of the cardiovascular system's response to strenuous physical activity. Thus, the results of this study support the hypothesis that exercise intensity affects blood fibrinogen levels, and the importance of paying attention to the amount of physical activity in the context of hemostasis and circulatory system health.

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