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Correlation Between Cardiovascular Endurance and Changes in Blood Pressure in Employees of Universitas Swadaya Gunung Jati, Cirebon, Indonesia

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ABSTRACT

Background: Blood pressure is the force exerted by blood on the walls of blood vessels and depends on cardiac output and peripheral resistance. Blood pressure is influenced by various factors, one of which is cardiovascular endurance. Optimal cardiovascular endurance helps maintain blood pressure at normal levels, thereby decreasing the risk of high blood pressure and cardiovascular disease.

Aims: To determine cardiovascular endurance and blood pressure changes before and after performing the Harvard step test and to analyze the correlation between cardiovascular endurance and blood pressure changes in employees of Universitas Swadaya Gunung Jati, Cirebon, Indonesia.

Methods: This study was a quantitative analytical observational type with a cross-sectional method involving 77 employees who are not registered as teaching lecturers who met the inclusion and exclusion criteria. This study was conducted by collecting primary data in the form of blood pressure measurement, Harvard step test treatment and pulse rate measurement. The data was then analyzed statistically using a Spearman's hypothesis test.

Results: The majority of respondents were ≤40 years old (55.8%), male (64.9%), had a habit of smoking (55.8%), and abnormal HRR (83.1%). After conducting the Spearman test, *p-value = 0.727; r = -0.041* for systolic and *p-value = 0.314; r = -0.116* for diastolic. The correlation coefficient indicates a very weak negative correlation between cardiovascular endurance and blood pressure changes in employees of Universitas Swadaya Gunung Jati, Cirebon, Indonesia.

Conclusion: There is no significant correlation between cardiovascular endurance and changes in blood pressure. Cardiovascular endurance showed a significant negative correlation with blood pressure, although other factors such as age, gender, physical activity, and smoking also play a role.

Keywords: *Cardiovascular endurance; Blood pressure; Hypertension.*

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1. Introduction

Blood pressure is the force exerted by blood on the walls of blood vessels and depends on cardiac output and peripheral resistance. Blood pressure is affected by various factors, one of which is cardiovascular endurance (Sherwood, 2016; Yusup, 2023). According to data taken from the WHO, an estimated 1.28 billion people aged 30-79 years worldwide suffer from hypertension, and two-thirds of them live in lower-middle-income countries (International Society of Hypertension, 2020; World Health Organization, 2023). From the 2018 Riskesdas results, West Java is the province with the second highest incidence. According to the West Java Province health profile data in 2022, Cirebon city is the area with the 9th highest incidence with an incidence rate of 12.31% (Dewi et al., 2023; Yusup, 2023).

Cardiovascular endurance refers to the extent to which the heart is able to efficiently perform bodily activities at moderate to high levels of intensity over long periods of time. It includes the ability of the lungs, heart and blood vessels to intake, distribute and use oxygen effectively throughout the body's tissues. Optimal cardiovascular endurance plays a role in maintaining blood pressure at a normal level, thus decreasing the risk of elevated blood pressure. Cardiovascular endurance can be done using the Harvard step test, this test is an appropriate tool for determining the correlation between cardiovascular endurance and changes in blood pressure because it provides a standardized physical load that directly affects the response of the heart and blood vessels and allows for evaluation of cardiovascular recovery capacity (Yusup, 2023).

According to research conducted by Jones JR, cardiovascular disease is the most common disease experienced by workers. It is estimated that the prevalence of cardiovascular disease caused or exacerbated by work is 80 thousand during the year. This is associated with sedentary lifestyle behavior, which is an unhealthy lifestyle where employees tend to be too lazy to move or do physical activity. Office employees usually spend 6 hours per day in front of the work desk and during breaks are filled with non-physical activities such as chatting, playing gadgets, watching TV so that employees lack physical activity and tend to stay in place (Englardi et al., 2022; Prince, 2004).

The high prevalence of hypertension globally and nationally indicates that it is a serious public health problem. One factor influencing blood pressure is cardiovascular endurance. Low cardiovascular endurance, particularly due to a sedentary lifestyle among office workers, has the potential to increase the risk of hypertension. University employees are among the low-physically active group, as they spend most of their working time sitting. Therefore, the employee population is relevant for this study because they possess risk characteristics, consistent with the problem addressed namely low cardiovascular endurance and the potential for increased blood pressure. Based on the description above, it appears that the low cardiovascular endurance possessed by workers and the incidence of hypertension, so that it needs to be studied. In addition, there are not many studies that specifically examine the relationship between cardiovascular endurance and blood pressure in the employee population, especially university. Therefore the researcher is interested in seeing the correlation between cardiovascular endurance and changes in blood pressure in employees of Universitas Swadaya Gunung Jati, Cirebon, Indonesia (Yusup, 2023).

2. Methods

Study design/ Research procedures

This study was conducted at Universitas Swadaya Gunung Jati, Cirebon, Indonesia. This study is an observational analytic research with a cross-sectional method. This study involved 77 samples that met the inclusion and exclusion criteria. Inclusion criteria are employees who are not registered as teaching lecturers at Universitas Swadaya Gunung Jati, have received an explanation of the research and are willing to become respondents, employees who are willing to do the Harvard step test, measurement of blood pressure and calculate pulse rate. Exclusion criteria include employees who are undergoing treatment for cardiovascular disease, employees who are experiencing a hypertensive crisis (hypertension emergency and hypertension urgency), and employees who are undergoing treatment for musculoskeletal disease, employees who are pregnant.

Measurements

The research subjects collected data for cardiovascular endurance using the Harvard step test method for a maximum of 5 minutes or until the respondent felt exhausted, when doing the Harvard step test, the respondent must follow the 120 bpm metronome beat. Then the pulse rate was calculated in minutes 1, 2, and 3, each of which was calculated for 30 seconds. Formulation of cardiovascular endurance = $\frac{test\ time\ (second)}{2\ x\ (HR1+HR2+HR3)} x100.$ Cardiovascular endurance is categorized as very good (≥90), good (80-89), moderate (65-79), less (55-64), very less (≤54). The blood pressure measurements procedure was performed with the respondents sitting with their back against the ground and their feet flat on the floor. The respondent rested for at least 5 minutes before the initial measurement. Blood pressure was measured before administering the Harvard step test (pre-test). After completing the test, the respondent rested for 5 minutes, and then their blood pressure was measured again (post-test). The measurements were taken twice, and the average value was taken to increase data reliability. Blood pressure measurements were taken using a digital sphygmomanometer. Blood pressure measurement results were defined as the absolute change in systolic and diastolic blood pressure that occurred after performing the Harvard step test (Hartati et al., 2020; Sari et al., 2025).

Statistical techniques

Data were analyzed for normality using the Kolmogorov-Smirnov test for blood pressure data and obtained a value of 0.200 for systolic blood pressure and 0.090 for diastolic blood pressure which shows normal distribution and continued with the Spearman test to analyze the correlation between cardiovascular endurance resistance and changes in blood pressure with p-value <0.05 considered to be statistically significant.

Ethical clearance

This study has obtained ethical clearance from the Research Ethics Committee of the Faculty of Medicine, Universitas Swadaya Gunung Jati, with reference No. 51/EC/FKUGJ/V/2024.

3. Results

This study was taken from direct measurement of the Harvard step test, blood pressure measurement and pulse calculation on employees of Universitas Swadaya Gunung Jati and collected 77 respondents who met the inclusion criteria.

Respondent characteristics

According to Table 1, it is known that the most respondents are respondents aged ≤40 years as many as 43 respondents (55.8%). Respondents in this study were mostly male with 50 respondents (64.9%). When viewed from the characteristics of smoking habits, respondents who have smoking habits are 43 respondents (55.8) and 34 who do not smoke (44.2%). HRR data obtained by the majority of respondents obtained abnormal HRR as many as 64 (83.1%) and normal HRR as many as 13 respondents (16.9%). The majority of respondents had a very poor cardiovascular endurance category with 29 respondents (37.7%). The data showed that the majority of respondents experienced an increase in systolic blood pressure and 42 respondents experienced an increase in diastolic blood pressure.

Bivariate analysis

From the Table 2 below it can be seen that changes in blood pressure after doing the Harvard step test vary greatly both systolic blood pressure and diastolic BP. Where at systolic BP, the mean value is 6.42 ± 12.919, the minimum value is -33 and the maximum value is 31. At diastolic BP, the mean value is 0.45 ± 8.094, the minimum value is -14 and the maximum value is 31. From Table 3, it is clear that the respondents with very good cardiovascular endurance experienced an increase in systolic BP as many as 18 respondents and a decrease in diastolic BP as many as 13 respondents. The good cardiovascular category experienced an increase in both blood pressure in the form of

3 respondents for systolic BP and 4 respondents for diastolic BP. The moderate category experienced an increase in systolic BP of 6 respondents and a decrease in diastolic BP of 5 respondents. The poor category experienced an increase in systolic BP of 7 respondents and a decrease in diastolic BP of 5 respondents. In the very poor category, the majority of respondents experienced an increase in both blood pressures, which were 24 respondents for systolic BP and 18 respondents for diastolic BP.

Table 1. Demographic characteristics

Demographic characteristics	Frequency	Percentage
Age		
≤40 years old	43	55.8%
>40 years old	34	44.2%
gender		
Female	27	35.1%
Male	50	64.9%
Smoking Habit		
No Smoking	34	44.2%
Smoking	43	55.8%
Heart Rate Recovery (HRR)		
Normal HRR	13	16.9%
Abnormal HRR	64	83.1%
Cardiovascular Endurance		
Very good	25	32.5%
Good	5	6.5%
Moderate	9	11.7%
Poor	9	11.7%
Very Poor	29	37.7%
Changes in systolic BP		
Decreased	19	24.7%
Increased	58	75.3%
Changes in diastolic BP		
Decreased	35	45.5%
Increased	42	54.5%

Table 2. Changes in blood pressure

Changes BP	Mean	Standard Deviation	Minimum	Maximum
Systolic BP	6.42	12.919	-33	31
Diastolic BP	0.45	8.094	-14	31

Table 3. Cross tabulation cardiovascular endurance and changes in blood pressure

Cardiovascular	Changes in systolic BP			Changes in diastolic BP		
Endurance	Decreased	Increased	**Total**	Decreased	Increased	**Total**
Very good	7	18	25	13	12	25
Good	2	3	5	1	4	5
Moderate	3	6	9	5	4	9
Poor	2	7	9	5	4	9
Very Poor	5	24	29	11	18	29
Total	19	58	77	35	42	77

According to Table 4, it is known that the results of the bivariate test are p-value = 0.727 (p <0.05) with a correlation coefficient of r = -0.041 for the correlation between cardiovascular endurance and changes in systolic blood pressure and p-value = 0.314 (p <0.05) with a correlation coefficient of r = -0.116 for the correlation between cardiovascular endurance and changes in diastolic blood pressure. From these results it can be seen that there is no significant correlation and shown a negative correlation direction with a very weak strength. This means that an increase in cardiovascular endurance tends to be followed by a decrease in blood pressure but the correlation is weak. Thus it can be concluded that no significant correlation was found between cardiovascular endurance and changes in blood pressure in employees of Universitas Swadaya Gunung Jati, Cirebon, Indonesia.

Table 4. Hypothesis test

	Cardiovascular Endurance	
	p-value	r
Changes in systolic BP	0.727	-0.041
Changes in diastolic BP	0.314	-0.116

4. Discussion

From the results of data collection with a total of 77 respondents, it was found that in this study most of respondents were ≤40 years old with 43 respondents (55.8%). Meanwhile, the respondents with the highest gender were men, totaling 50 respondents (64.9%). Smoking habits in respondents amounted to 43 respondents (55.8%). Respondents in this study had an abnormal HRR of 64 (83.1%). The data showed that most of the respondents had a very poor cardiovascular endurance category, namely 29 respondents (37.7%). These results are in accordance with research conducted by Yusup (2023) which stated that the majority of cardiovascular endurance in respondents is poor with a total of 75 respondents (96.2) out of 78 respondents. This research is also in line with a study conducted by Saputra et al (2022) which stated that the most respondents are respondents with poor cardiovascular endurance categories with a total of 18 respondents (35.3%) (Saputra et al, 2022; Yusup, 2023).

Cardiovascular endurance describes the extent to which the heart is able to carry out body activities efficiently at moderate to high intensity levels over a long period of time. This includes the ability of the lungs, heart and blood vessels to take up, distribute and use oxygen effectively to all body tissues. From the results of the study on UGJ employees, it was found that most respondents were in the category of very poor cardiovascular endurance. This is often associated with the theory of sedentary behavior where lazy behavior moves or does physical activity. Office employees usually spend 6 hours per day working at a desk and during breaks are filled with non-physical activities such as chatting, playing gadgets, watching TV so that employees lack physical activity and tend to stay in place (Englardi et al., 2022; Pate et al., 2012; Sylviana et al., 2021). Based on the data of this study, it was found that changes in blood pressure varied from an increase or decrease in systolic and diastolic blood pressure. From the research data, the mean value was obtained as 6.42 ± 12.919, the minimum value was obtained as -33 and the maximum value was 31.

Blood pressure changes increased in this study are in line with the results of research conducted by Handayani et al (2016) showing that there were 24 people who experienced an increase in blood pressure measurements after running. A very significant increase in blood pressure occurs when sports activities, but there are also other factors such as smoking where nicotine in cigarettes causes the release of adrenal hormones which result in increased blood pressure. The slowed HRR (abnormal) causes blood pressure to increase. In addition, carbon monoxide in cigarette smoke replaces oxygen in the blood, forcing the heart to work harder to pump oxygen to organs and tissues, which also contributes to increased blood pressure. An abnormally slow HRR makes it difficult for blood pressure to decrease at rest because the heart rate does not recover quickly. Gender can also cause an increase in blood pressure where men have a 2-3 times greater risk of having an increase in systolic blood pressure compared to women. As age increases, especially at risk age of >40 years, the risk of increasing blood pressure also increases due to increased peripheral resistance and sympathetic activity as well as due to thickening of atherosclerosis (Handayani et al., 2016; Siswanto et al., 2020; Sydó et al., 2018; Yu et al., 2017).

The decrease in blood pressure in the results of this research is in accordance with the results of research conducted by Fagard et al (2007) which found a decrease in systolic blood pressure by 3.2 mmHg with p-value= 0.1 and diastolic by 3.5 mmHg with p < 0.01. The decrease in blood pressure occurred significantly not only based on the initial blood pressure level of the participants, but also other factors such as gender, physical activity level, individual condition, use of antihypertensive drugs, blood pressure measurement method, measurement time, the type of exercise chosen, and sports training program. Exercise training has been shown to decrease blood pressure. Studies reporting continuous exercise-induced blood pressure lowering may overlook the acute effects after exercise sessions, i.e. post-exercise hypotension. Individuals who experience no change in blood pressure after physical activity may have a good HRR. It could be due to parasympathetic nerve activation that restores heart rate to resting levels. HRR can be an indicator to assess the blood pressure control status of an individual (Carpio-Rivera et al., 2016; Fagard et al., 2007; Umbas et al., 2019; Yu et al., 2017).

The results of the correlation test of cardiovascular endurance with changes in blood pressure in this study obtained a p-value = 0.727 (p < 0.05) for changes in systolic BP and p-value = 0.314 (p < 0.05) for changes in diastolic BP. Indicating that there is no significant correlation between cardiovascular endurance and changes in blood pressure in employees of Universitas Swadaya Gunung Jati. These results are inversely proportional to research conducted by Yusup (2023) which states that there is a correlation of cardiovascular endurance and physical activity on blood pressure with a p-value = 0.038. In study conducted by Buana (2012) which states that there is a negative correlation between VO2Max with systolic and diastolic blood pressure with a p-value = 0.000 for systolic BP and p-value = 0.001 for diastolic BP (Buana, 2012; Yusup, 2023). Cardiovascular endurance obtained from the Harvard step test results in an increase in oxygen (O2) demand which stimulates the sympathetic nervous system to increase the heart rate and volume of the bladder accompanied by arteriolar and venous vasoconstriction which will ultimately increase in blood pressure. Good cardiovascular endurance indicates that the heart is able to pump blood efficiently. Regular aerobic exercise increases the size and strength of the heart muscle which allows the heart to pump more blood per beat (stroke volume). Increased stroke volume contributes to increased cardiac output which can help keep blood pressure within normal ranges (Yusup, 2023).

Physical exercise, particularly regular aerobic exercise, can increase the elasticity and flexibility of blood vessels, thereby reducing peripheral resistance, a major determinant of blood pressure. A well-trained heart becomes more efficient at pumping blood, reducing its workload and lowering resting blood pressure. Furthermore, aerobic exercise improves endothelial function, which plays a role in vasodilatation, and modulates hormones such as catecholamine and angiotensin II, which are involved in blood pressure regulation, thus contributing to overall blood pressure reduction (Lin et al., 2023; Yusup, 2023).

Cardiovascular resistance does not directly affect blood pressure, but there are other factors that can influence blood pressure such as age, where there is an increase in vasoconstriction of blood vessels and stiffness of blood vessel walls. Gender, especially men, has a 2-3 times greater risk of increasing blood pressure. Adipose tissue increases in obese people, which leads to increased vascular resistance and increases the work of the heart (Kementerian Kesehatan Republik Indonesia, 2013; Setiani & Wulandari, 2023).

Furthermore, the blood pressure changes measured in this study represent acute response to physical activity, which is strongly influenced by immediate physiological conditions and does not necessarily reflect long-term cardiovascular adaptations. Post-activity blood pressure responses also exhibit considerable interindividual variation, resulting in statistically inconsistent patterns of changes. Furthermore, the uneven distribution of respondents' cardiovascular endurance, with the majority in the low endurance category, limited the range of data variation and reduced the power of statistical analysis to detect meaningful relationships (Agestri et al., 2024; Rachmawan et al., 2025; Sari et al., 2025).

Limitations In this study, there are still limitations and obstacles encountered in the implementation of study, including: Other factors that affect blood pressure, such as BMI, physical activity, coffee consumption and staying up late habits were not examined in this study, history of hypertension, consumption of antihypertensive medications. Suggestions for Further Researchers Suggestions as a follow-up to this study for further research are that this research can be carried out with different methods such as experimental methods to compare blood pressure. Future researchers can also do with other procedures such as ergo cycle and blood pressure checks can be done with a manual sphygmomanometer with the use of palpatory systolic. Researchers can also conduct further research on other factors that can affect blood pressure.

5. Conclusion

This study shows that cardiovascular endurance, as measured using the Harvard step test, is not significantly associated with changes in systolic or diastolic blood pressure after physical activity. Although there were changes in blood pressure before and after the test as a physiological response to the activity, this finding suggests that post-activity blood pressure changes more closely reflect the body's acute response and are influenced by various factors beyond cardiovascular endurance such as age, gender, physical activity, and smoking.

Conflict of Interest

There is no conflict of interest. Nothing to disclose.

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