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Correlation between Physical Activity and Cardiovascular Endurance of the Employees in Universitas Swadaya Gunung Jati, Cirebon, Indonesia

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ABSTRACT

Background: Cardiovascular endurance refers to a person's ability to perform activities involving the entire body at moderate to high intensity over extended periods. Cardiovascular endurance is influenced by several factors, such as physical activity. Moderate to high-intensity physical activity trains the body to exchange oxygen more efficiently and results in enhancing cardiovascular endurance. Other factors that could contribute in cardiovascular endurance are smoking and Body Mass Index (BMI).

Aims: To find the correlation between physical activity, BMI, smoking, and cardiovascular endurance among employees of Universitas Swadaya Gunung Jati, Cirebon, Indonesia.

Methods: It was an analytic observational study with a cross-sectional approach that used the GPAQ physical activity questionnaire and cardiovascular endurance data that was obtained through the Harvard Step Test involving 77 educational staff employees at Universitas Swadaya Gunung Jati. The analytical statistics used was Spearman's correlation test with a significance value of p = <0.05.

Results: Most of the Universitas Swadaya Gunung Jati employee's had moderate level of physical activity (44.2%) and very low cardiovascular endurance (37.7%). The analytical statistic showed a significant correlation between physical activity and cardiovascular endurance with a p-value of 0.034 and a Spearman's r of 0.242. Smoking has significant correlation with cardiovascular endurance with p value of 0.003 and Spearman's r of 0.338. BMI showed negative and weak correlation with cardiovascular endurance with p value 0.008 and Spearman's r -0.302.

Conclusion: There was a significant correlation between physical activity and cardiovascular endurance among the employees of Universitas Swadaya Gunung Jati, Cirebon, Indonesia.

Keywords: *Physical activity, Cardiovascular endurance, Body Mass Index, Smoking.*
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1. Introduction

Cardiovascular endurance is the capacity to engage in full-body exercises at moderate to high intensities for prolonged periods of time. Moderate to high-intensity physical activity trains the body to exchange oxygen more efficiently and results in enhancing cardiovascular endurance (Cheng, Chiu, & Su, 2019). Good cardiovascular endurance makes the body to be able to carry out daily activities lightly without getting tired quickly. According to WHO, globally, 1 in 4 adults does not meet the recommendation level of physical activity (World Health Organization, 2022). Those who are less active have a 20% to 30% increased risk of death compared to those who are quite active. Laporan Riset Kesehatan Dasar 2018 reports that 33.5% of Indonesians aged ≥ 10 are belong to the less active group (Laporan Riset Kesehatan Dasar, 2018). This number has increased from 2013, where as many as 26.1% of Indonesians with an age range of ≥ 10 years were included in the less active group. As many as 37.5% of West Java's population within the same age range are included in the less active group. This number places West Java among the top 10 provinces with the least active population. Lack of physical activity causes a decrease in cardiovascular endurance. Low cardiovascular endurance is one of the predictors of cardiovascular disease (Franklin, Eijsvogels, Pandey, Quindry, & Toth, 2022). Cardiovascular disease has become a serious problem affecting millions of people in the world, with the death toll continuing to increase from 12.1 million deaths in 1990 to 20.1 million deaths in 2021 (World Heart Federation, 2023). High levels of cardiovascular endurance are associated with a decrease in the incidence and mortality of cardiovascular disease (Ezzatvar et al., 2021).

Physical activity refers to any movement of the body that the skeletal muscles generate and require the use of energy for. Physical activity can refer to all movement, including during leisure time, transportation to and from a place, or as part of a person's work. Sufficient intensity of physical activity can provide benefits for a person's cardiovascular health and endurance (World Health Organization, 2020). This can happen because physical activity can induce adaptation of several types of cells and tissues in the body, including mitochondrial biogenesis in skeletal muscle and heart muscle myocytes, as well as increasing aerobic respiration in these tissues. Apart from that, physical activity can also increase cardiovascular endurance by improving the process of oxygen distribution in the body through vasodilation and angiogenesis (Pinckard, Baskin, & Stanford, 2019). Physical activity is part of human life, including for adults and university employees (Tukuboya, Malonda, & Sanggelorang, 2020). Currently, with rapid development in information and technology, as well as transportation, there have been changes in human activity and mobility. The convenience obtained with this development causes a decrease in activity and the occurrence of sedentary behavior, which can cause various health consequences including a decrease in cardiovascular endurance due to lack of physical activity (Kusuma, Syafei, & Rilastiyo, 2019). A previous qualitative study by Safi in 2022 stated that university employees spend approximately 60–70% of their waking hours in the workplace, with over 75% of this time spent being sedentary (Safi, 2022). A previous study by Tukuboya et al. in 2020 revealed that 47.9% of 48 university employees enganged in low physical activity (Tukuboya et al., 2020).

Smoking and BMI are other factors that consistently link to cardiovascular endurance. Smoking can cause plaque formation in the bloodstream, which can narrow blood vessels, disrupt oxygen delivery, and reduce cardiovascular endurance (Jeon, Kim, Jeong, & So, 2021). A previous study also recorded that BMI influences cardiovascular endurance (Singh et al., 2023). Increased fat mass and left ventricle dysfunction that could happen in obese people result in decreased cardiac output, affecting blood volume and blood oxygen carrying capacity, hence decreasing cardiovascular endurance (Takken et al., 2022). However, research on the correlation between physical activity, smoking, and BMI with cardiovascular endurance in university employees remains lacking. Thus, it becomes important to study the correlation between physical activity and other factors that could affect cardiovascular endurance, such as smoking and BMI, among employees at Universitas Swadaya Gunung Jati, Cirebon, Indonesia.

2. Methods

Study design

It was an observational study with cross-sectional design. The sample size for the study was calculated using Slovin formula by taking permissible error as 10% with 90% confidence interval. Meanwhile minimum sample size was calculated as n = 68. Quota sampling was used for sampling technique. The exclusion criteria were pregnant woman, employees under musculoskeletal or cardiovascular therapy at the time of study, and employees with hypertension crisis at the time of study to minimalize risk of bias and adverse event.

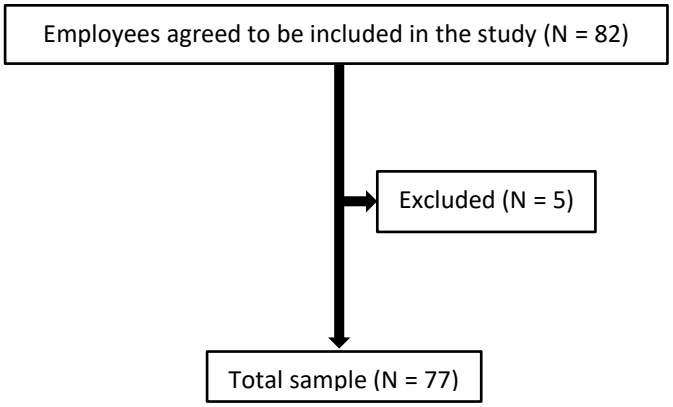

Figure 1. Subjects reqruitment

Measurements

Physical activity measured through the WHO Global Physical Activity Questionnaire which consist of 16 questions and divided into three sections: activity at work, travel to and from places, recreational activities, and one additional question about sedentary behavior asking about total sedentary time (World Health Organization, 2019). Cardiovascular endurance obtained through the Harvard Step Test (Hartati & Syafaruddin, 2020). This study also obtained some characteristics like age, BMI, and smoking habits that were asked with yes or no question.

Physical activity levels categorized as low, moderate, and high physical activity (World Health Organization, 2019). Cardiovascular endurance categorized as very poor, poor, moderate, good, very good (Hartati & Syafaruddin, 2020). This study also obtained some characteristics like age, BMI, and smoking habits. BMI categorized as underweight, normal, overweight, obese I, and obese II. Smoking habits asked with yes or no question.

Statistical Techniques

Acquired data were then analyzed using univariate statistics to summarize the data. Kolmogorov-Smirnov test determined that the data were not normally distributed ($p = 0.000$), thus the spearman correlation test was used to determine correlation between physical activity, sedentary behavior, BMI, smoking habits and cardiovascular endurance of the employee in Universitas Swadaya Gunung Jati with p-value <0.05 considered to be statistically significant.

Ethical Clearance

This study is inseparable from reciprocal correlation between the participants and researchers. All participants have received the explanation of the study and signed the informed consent to participate in this study. No data were obtained before the participant agreed to sign the informed consent. This study has been ethically approved from the Health Research Ethics Committee of Faculty of Medicine Universitas Swadaya Gunung Jati with Ethical Approval No.81/EC/FKUGJ/V/2024.

3. Results

Respondent characteristics

A total of 77 employees of Universitas Swadaya Gunung Jati participated in this study. There were 49 (63.6%) males and 28 (36.4%) females. Most of the participants age were under <40 (57.1%). BMI of the majority of 29 participants (37.7%) were in grade I obesity category and 44 participants (55.8%) were smokers. Regarding the participants physical activity, 34 participants (44.2%) reported moderate level of physical activity; 25 participants (32.5%) reported high level of physical activity; and 18 participants (23.4%) reported low level of physical activity. Data recorded that 41 (53.2%) participants reported <420 minutes of sedentary behavior in a day, while 36 (46.8%) participants reported >420 minutes of sedentary behavior in a day. In terms of cardiovascular endurance, the majority of 29 participants (37.7%) reported very poor cardiovascular endurance; 9 participants (11.7%) reported poor cardiovascular endurance; 9 participants (11.7%) reported moderate cardiovascular endurance; 5 participants (6.5%) reported good cardiovascular endurance; and 25 participants (32.5%) reported very good cardiovascular endurance. (Table 1)

Table 1. Characteristics of the subject

Characteristics	N	%
Gender		
Male	49	63.6
Female	28	36.4
Age		
<40	44	57.1
≥40	33	42.9
Body Mass Index		
Underweight	2	2.6
Normal	20	26
Overweight	11	14.3
Obese I	29	37.7
Obese II	15	19.5
Smoking		
No	34	44.2
Yes	43	55.8
Physical Activity		
Low	18	23.4
Moderate	34	44.2
High	25	32.5
Sedentary Behavior		
<420 Minutes	41	53.2
≥420 Minutes	36	46.8
Cardiovascular Endurance		
Very Poor	29	37.7
Poor	9	11.7
Moderate	9	11.7
Good	5	6.5
Very good	25	32.5

Table 2. Characteristics of physical activity, sedentary behavior, and cardiovascular endurance

	Median	Standard Deviation	Min	Max
Physical Activity	1680	2520.3	0	10320
Sedentary Behavior	420	201.1	60	960
Cardiovascular Endurance	66	42.54	21	208

Bivariate analysis

The bivariate test findings in this study are displayed in Table 3 and indicate that there's a significant correlation between physical activity and cardiovascular endurance with p-value 0.034 ($p < 0.05$), which suggests a substantial association between cardiovascular endurance and physical activity. The correlation coefficient (r) is 0.242, which means that the strength of the correlation between the two variables is positive and weak. In this study, the positive correlation indicates that as physical activity increases, cardiovascular endurance also tends to increase. There's also significant correlation between smoking and cardiovascular endurance with a p-value 0.003 and a r-value 0.338, which means that the strength of the correlation is positive and weak. BMI exhibited a negative and weak correlation with cardiovascular endurance, with a p-value of 0.008 and a r-value of -0.302, indicating that a higher value for one variable corresponds to a lower value for the other variable.

Table 3. Correlation between physical activity and cardiovascular endurance

		Cardiovascular Endurance	
		p-value	*r*
Spearmann's rho	Physical Activity	0.034	0.242
	Sedentary Behavior	0.146	0.167
	Smoking	0.003	0.338
	BMI	0.008	-0.302

4. Discussion

All respondents who participated in the study completed the GPAQ physical activity questionnaire and underwent the Harvard Step Test procedure. In this study, the majority of respondents were male, 49 (63.6%), while the remaining 28 (36.4%) were female. The majority of 44 participants (57.1%) were under 40 years old, while the other 33 (42.9%) were 40 years or older.

According to Table 2, out of 77 respondents, the minimum value for physical activity was 0 MET-Minutes/Week (Metabolic Equivalent Task-Minutes/Week) and the maximum value was 10.320 MET-Minutes/Week, with a median value of 1.680 MET-Minutes/Week. The minimum physical activity value of 0 MET-Minutes/Week indicates that there are still employees at UGJ who are considered inactive. Based on the GPAQ questionnaire assessment, a physical activity value below 600 MET-Minutes/Week can be considered low, while the median value of 1.680 MET-Minutes/Week falls into the moderate physical activity range. According to WHO physical activity recommendations, adults aged 18-64 are advised to participate in moderate-intensity aerobic activity for at least 150-300 minutes per week or high-intensity aerobic activity for at least 75-150 minutes per week in order to obtain health benefits, in addition with strength training that is recommended to be performed at least twice a week (World Health Organization, 2020).

The data on sedentary behavior showed a minimum value of 60 minutes and a maximum value of 960 minutes, with a median of 420 minutes. Ekelund's (2019) research indicates that sedentary behavior lasting longer than 8 hours per day is a risk factor for cardiovascular disease, particularly among individuals with low physical activity. Conversely, individuals with adequate physical activity may mitigate the cardiovascular consequences of sedentary behavior. Therefore, it is important to increase physical activity to mitigate the risk of cardiovascular disease associated with sedentary behavior (Ekelund et al., 2019).

The cardiovascular endurance data ranged from a minimum of 21 to a maximum of 208, with a median value of 66. The median cardiovascular endurance value of 66 falls into the moderate category of cardiovascular endurance. The findings of the Harvard Step Test are predictive of VO2max, a measure of cardiovascular endurance that expresses the maximum amount of oxygen (in milliliters) that may be used per kilogram of body weight per minute (Kim, Oh, & Kim, 2024). Cardiovascular endurance reflects the ability of the heart, lungs, and circulatory system to work effectively and efficiently during continuous physical activity involving muscle groups at a certain intensity (Zeiher et al., 2019). Good cardiovascular endurance allows a person to engage in high-intensity activities for longer periods without becoming easily fatigued. This is due to the well-trained heart, lungs, and blood vessels, which efficiently deliver oxygen to meet the body's energy demands during activity (Bjelica, Milanović, Aksović, Zelenović, & Božić, 2020).

Correlation between Physical Activity and Cardiovascular Endurance

In this study, the Spearman correlation test between physical activity and cardiovascular endurance showed a statistically significant result with p = 0.034 (<0.05) and r = 0.242, which means there is a weak positive correlation. This finding is consistent with (Setiawan, 2021) study on 35 back office employees at RS Omni Alam Sutera, which found a correlation between physical activity and cardiovascular endurance with a p-value of 0.024. However, this study's results differ from (Wardani, 2021) study on 32 residents of Puri Bolon Indah aged 28-35, which reported a p-value <0.001 and a higher correlation coefficient of r = 0.762, indicating a strong correlation between physical activity and cardiovascular endurance.

Adequate intensity and frequency of physical activity can impact an individual's cardiovascular endurance. Intensity refers to the amount of weight or force required for the work or load performed, while frequency refers to how often a person engages in specific activities or work that requires muscle use. High frequency of physical activity ultimately leads to muscle strengthening, including the heart muscle, allowing the heart to work more efficiently with each contraction and pump blood more effectively, delivering necessary oxygen to cells during activity. This results in better energy fulfilment and reduced fatigue (Bjelica et al., 2020).

Result of this study indicate a positive correlation between physical activity and cardiovascular endurance, meaning that higher physical activity is associated with higher cardiovascular endurance. The weak strength of the correlation between the two variables in this study suggests that other factors may influence the cardiovascular endurance of employees at Universitas Swadaya Gunung Jati. One such factor could be the high duration of sedentary behavior among these employees. Data shows that the maximum sedentary time among UGJ employees is 960 minutes (16 hours). Sedentary behavior is negatively related to VO2max, which determines cardiovascular endurance (Prince et al., 2024). Excessive sedentary behavior is also known as a risk factor for cardiovascular disease, particularly in populations with low or moderate physical activity (Lavie, Ozemek, Carbone, Katzmarzyk, & Blair, 2019). This study analyzed the correlation between sedentary behavior and cardiovascular endurance. The analytical statistics revealed that there’s no significant correlation between sedentary behavior and cardiovascular endurance among the employees of Universitas Swadaya Gunung Jati.

Other factors that may contribute to cardiovascular endurance include smoking habits and BMI. Smoking negatively affects health as it increases blood pressure, heart rate, and the risk of coronary thrombosis, ultimately reducing the heart's ability to pump blood and supply oxygen and energy to body cells, leading to increased fatigue and decreased cardiovascular endurance (Arifin et al., 2024). This study showed that smoking has a significant correlation with cardiovascular endurance among employees of Universitas Swadaya Gunung Jati with p = 0.003 and r = 0.338. Another factor influencing cardiovascular endurance is body mass index (BMI), which includes body fat levels. Previous study by (Damayanti, 2021) discovered a significant correlation between body fat levels and cardiovascular endurance (p = 0.001). High body fat levels are known to negatively affect cardiovascular endurance because they can increase the workload on the heart and reduce diastolic filling, resulting in decreased VO2max capacity. This study also found a significant negative correlation between BMI and cardiovascular endurance among the employees of Swadaya Gunung Jati, with p = 0.008 and r = -0.302, indicating a negative correlation between cardiovascular endurance.

Study Limitations

This study has several limitations, including the use of a study design that prevents establishing the causality of the variables. Another limitation is that physical activity data were only obtained through questionnaire making it very possible to have self-reported bias, and this study only had a specific focus on employees at a single institution, which may limit generalizability.

5. Conclusion

This study found a significant correlation between physical activity, BMI, and smoking, with cardiovascular endurance of the employees in Universitas Swadaya Gunung Jati, Cirebon, Indonesia. However, due to the cross sectional design of the study, the causality of the variables could not be addressed clearly. In addition, although there may be potential biases associated with self-reported data from the questionnaire, it is still important to consider the results of this study by conducting health promotion or practical interventions, such as implementing daily exercise practices at work. Maintaining a healthy lifestyle, including doing more physical activity as recommended, weight management, and avoiding smoking habits could help improve cardiovascular health in workplace settings. Universitas Swadaya Gunung Jati could establish regular physical activity breaks and an-anti smoking program to enhance employee wellness and cardiovascular endurance

Suggestions for Further Researchers

As a follow-up to this study, we recommend conducting a statistical analysis to identify potential factors influencing cardiovascular endurance that this study did not identify. Different methods, such as experimental methods to compare cardiovascular endurance among different populations, longitudinal studies for a better understanding for the causal relationships, or taking a larger population sample can be carried out for further research.

Conflict of Interest

Authors declared no conflict of interest on the findings and the publication.

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