



CORRELATION OF SALT INTAKE AND PHYSICAL ACTIVITY WITH HYPERTENSION AMONG UNIVERSITY STUDENTS

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ABSTRACT

Hypertension is a major health problem in Indonesia, the city of Surakarta reporting a prevalence of 78.65% among non communicable diseases in 2023. Cases are also found in university students. They are vulnerable to unhealthy lifestyle changes, such as high salt (sodium) intake and low activity levels. This study aimed to determine the relationship between the salt intake and physical activity with hypertension among university students in Surakarta. A cross-sectional study involved 106 students selected by purposive sampling. Blood pressure was measured with a digital sphygmomanometer, salt intake were assessed with the SQFFQ, and physical activity was measured with the IPAQ. Data were analyzed using Spearman Rank and Binary Logistic Regression tests. The results showed that there was a significant association between salt intake and physical activity with hypertension ($p = 0.001$). The Nagelkerke R Square result showed 0.287, indicating that students with high salt intake and low activity levels had an increased risk of hypertension. In conclusion, high salt intake and low physical activity significantly contribute to 28.7% of hypertension cases. Students are advised to reduced salt consumption and regular physical activity to promote a healthier lifestyle.

Keywords: hypertension; physical activity; salt intake

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INTRODUCTION

Indonesia is currently undergoing an epidemiological transition marked by a rising burden of non-communicable diseases (NCDs) such as hypertension, diabetes, and cardiovascular diseases (Rusyda, 2025). According to the Global Burden of Disease data (GBD), NCDs account for more than half of disability-adjusted life years (DALYs) in Indonesia and contribute to approximately 71% of global deaths in 2021, equivalent to 41 million lives (GBD, 2021). It is estimated that in 2024, approximately 1.4 billion adults aged 30 to 79 years worldwide were affected by hypertension, accounting for about 33% of the global population within this age group (WHO, 2025). The 2023 Survey Kesehatan Indonesia revealed that hypertension occurred commonly not only in elderly persons but also in younger demographics, with rates of 10.7% in the 18–24 age group and 17.4% in the 25–34 age group (Badan Kebijakan Pembangunan Kesehatan, 2023). In Indonesia, Central Java ranks fifth among provinces with a hypertension prevalence of 32.9%, affecting around 8.5 million people. Surakarta as one of the major cities in Central Java, recorded a significantly high rate of hypertension, comprising 78.65% of all non-communicable diseases with approximately 67,355 individuals affected (Dinkes Surakarta, 2024). These findings pointed out that hypertension was no longer just a problem for the elderly, but had increasingly become a concern among young adults, particularly university students. As members of the younger generation, students were at significant risk of acquiring hypertension due to bad lifestyle choices. One of the contributing factors is the high sodium (salt) intake in daily dietary habits (Huzaipah et al., 2020). Moreover, the modern lifestyle, driven by technology improvements and its tendency

towards sedentary behavior, played a part in raising the risk of hypertension among university students (Djalil et al., 2024). Other found risk variables were drinking behaviors, smoking, excessive caffeine intake and insufficient intake of fruits and vegetables (WHO, 2025).

Research conducted by Armitha et al. (2024) demonstrated the beneficial connection between excessive salt consumption and elevated blood pressure, indicating that increased salt intake stimulates the risk of hypertension. This finding is consistent with (Dewati et al., 2023) that consuming too much salt can raise the risk of hypertension by as much as 4.77 times. Ferencia et al. (2023) mentioned that excessive salt consumption can cause increased sodium levels in the blood, disrupting the osmotic balance between cells. To balance this sodium concentration, the body retains water (fluid retention), resulting in an elevated blood volume inside of the circulatory system. As a result, the pressure on the walls of blood arteries comes up, and the heart works harder to circulate blood throughout the body. The increased cardiac activity eventually leads to a significant increase in blood pressure. Furthermore, Purwono et al. (2020) revealed a relation between salt consumption patterns and the high rate of hypertension in elderly people. Although this research provides insights into regarding the effect of salt consumption on blood pressure, the study subjects were limited to elderly people which makes the findings not necessarily generalizable to younger populations such as university students, as in the current research study.

Low levels of activity or a sedentary lifestyle could trigger dropped vascular elasticity and increased arterial stiffness. Moreover, physical inactivity reduces the generation of nitric oxide (NO), a chemical required for vasodilation, or the expansion of blood vessels. A reduction in NO levels causes greater peripheral vascular resistance, which boosts blood pressure (Arefirad et al., 2022). Studies indicate that adequate physical activity can lower blood pressure by facilitating the release of salt through perspiration (Silfiani et al., 2024). In addition, regular physical exercise can modulate blood pressure by reducing sympathetic nervous system activity and increasing arterial lumen size, leading to decreased peripheral vascular resistance (Islam et al., 2023). According to Bairapareddy et al. (2021), inadequate physical activity is associated with a higher likelihood of developing hypertension compared to other modifiable factors, including body mass index, waist circumference, and duration of sedentary duration among university students. This study investigated numerous hypertension risk variables but did not assess the impact of salt consumption habits on hypertension incidence. This determines a basis for ongoing research to investigate the correlation between elevated salt consumption habits and the frequency of hypertension throughout the same demographic group.

Surakarta, acknowledged as an educational center with a substantial and varied student demographic, provides as an ideal site for study on hypertension prevalence in young adult populations. Data from PDDIKTI indicated that the overall student population in Surakarta is 103,401 individuals. Nevertheless, research examining the correlation between high salt consumption and physical activity with the prevalence of hypertension among university students, especially in Surakarta, is rare. This study intends to analyze the correlation between high salt intake habits, physical activity, and the occurrence of hypertension among university students in Surakarta.

METHOD

This study adopted an analytical observational methodology with a cross-sectional design, conducted in April 2025 at three major universities in Surakarta: Universitas Sebelas Maret (UNS), Universitas Slamet Riyadi (UNISRI), and Poltekkes Kemenkes Surakarta (POLKESTA). A total of 106 students participated, comprising 81 from UNS, 15 from UNISRI, and 12 from POLKESTA. In the current study, subjects were chosen by purposive sampling. The inclusion criteria comprised being an active student staying in Surakarta for a minimum of one year, willingness to participate, absence of antihypertensive medication, non-consumption of alcohol, and freedom from chronic illnesses. During the data collection process, this study obtained official ethical approval from the Dr. Moewardi General Hospital Health Research Ethics Committee (No. 375/II/HREC/2025). In

addition, all participants in this study also provided medical consent in the form of informed consent to prospective respondents before participating in the study to provide information to respondents and give them an understanding of the research being conducted. The researchers also explained the objectives of the research procedures in full detail by providing training and socialization sessions with the respondents.

Data collection techniques were very important to consider when conducting research in order to facilitate the research process in finding the necessary data. After finding out about previous research and understanding the problems of the phenomenon that occurred, this study used questionnaires and physical measurements as data collection techniques. First, the researchers provided respondents with the opportunity to complete a demographic questionnaire, followed by the use of a digital sphygmomanometer for blood pressure measurements at 10-minute intervals. Body weight and height were also measured to assess nutritional status. A follow-up session was conducted one week later, during which respondents completed questionnaires assessing salt consumption and physical activity. The respondents' salt intake expressed in milligrams per day, was assessed using the Semi Quantitative Food Frequency Questionnaire (SQFFQ). SQFFQ is an instrument used to assess the frequency of food consumption per day, week or month (Sirajuddin et al., 2018). This questionnaire was modified by incorporating household portion size estimations in grams and supplemented with a list of food items to be completed by respondents. Subsequently, the daily food consumption data in grams were entered into the NutriSurvey application to calculate nutrient intake, including the amount of sodium consumed by respondents. Assessment of physical activity levels is conducted through the International Physical Activity Questionnaire (IPAQ) which was measured in MET-minutes per week with reference to the physical activity table. Blood pressure was remeasured twice during this session. Respondents with blood pressure $\geq 130/85$ mmHg were classified as having hypertension based on the average of their four measures (Kemenkes, 2021).

In the present research, descriptive statistics were chosen to describe participant characteristics, including the distribution of age, gender, nutritional status, salt intake, physical activity levels, and blood pressure status. This descriptive analysis aimed to provide a general overview of the respondents' profiles and the overall pattern of the collected data. Furthermore, the Spearman Rank correlation test was used to analyze the relationship between students' salt consumption and hypertension, as well as the relationship between students' physical activity and hypertension. In addition, binary logistic regression analysis was applied to evaluate the combined influence of both factors on the incidence of hypertension. This analysis allowed the researcher to assess the extent to which each factor contributed to the likelihood of developing hypertension simultaneously. The level of statistical significance for all analyses was set at $p < 0.05$, indicating that the results were considered statistically significant when the probability value was less than 0.05.

RESULT

The research findings from 106 respondents are presented in Table 1, which describes the frequency distribution of respondents' characteristics, including gender, age, nutritional status, physical activity, and salt intake.

Based on the information in Table 1, 82 participants (77.3%) were female, and 34 respondents (32.1%) were the most common age group, the majority of participants were 21 years old, and the majority of participants, 45 people (42.4%), were classified as overweight based on their nutritional status. In terms of physical activity levels, almost half of the participants (49.1%) were categorized as moderately active. In this time period, 58.5% of responders were identified as above the recommended salt intake limit of 1500 mg per day. According to blood pressure testing results, the majority of the 58 responders (54.7%) were classified as normotensive.

Table 1.
Distribution of Respondent Characteristics (n=106)

Respondent Characteristics	Frequency (n)	Percentage (%)
Gender		
Male	24	22,7
Female	82	77,3
Age (Year)		
19	12	11,3
20	11	10,4
21	34	32,1
22	24	22,6
23	25	23,6
Nutritional status		
Underweight (< 18,5 kg/m ²)	12	11,3
Normal (18,5 - 22,9 kg/m ²)	43	40,6
Overweight (23- 24,9 kg/m ²)	45	42,4
Obesity (≥ 25 kg/m ²)	6	5,7
Physical Activity		
Heavy (> 3000 Mets-minutes/week)	8	7,5
Moderate (600 - 3000 Mets-minutes/week)	52	49,1
Light (< 600 Mets-minutes/week)	46	43,4
Salt Intake		
Baik (≤ 1500 mg/day)	44	41,5
Lebih (> 1500 mg/day)	62	58,5
Hypertensive Event		
Not hypertension (< 130/85 mmHg)	58	54,7
Hypertension (≥ 130/85 mmHg)	48	45,3

Table 1.
The Correlation between Salt Intake and Physical Activity with the Hypertension

	Hypertension
Salt Intake	r = 0,413 p = 0,001 n = 106
Physical Activity	r = - 0,447 p = 0,001 n = 106

Table 2, there was a correlation between the salt intake and the hypertension in students in the city of Surakarta, with a significance value of $p = 0,001$. Additionally, results from the statistical tests revealed a correlation coefficient (r) of 0,413. The results of the bivariate analysis in this study also showed that there was a correlation between the level of physical activity and the hypertension in students in the city of Surakarta, with $p = 0,001$. The statistical test results showed a correlation coefficient of $r = -0,447$, indicating a moderate negative relationship.

Table 3.
The Correlation between Salt Intake and Physical Activity with the Hypertension

Variable	<i>P value</i>	OR	IC 95%		<i>Nagelkerke R Square</i>
			<i>Lower</i>	<i>Upper</i>	
Salt Intake	0,009	6,857	1,000	1,001	0,287
Physical Activity	0,001	10,980	0,998	1,000	

Table 3, the variable of salt intake had a p -value of 0,009 and the variable of physical activity had a p -value of 0,001. Furthermore, the odds ratio (OR) value for the salt intake habit variable was 6,857 and the physical activity variable, the OR value was 10,980. In addition, based on the Nagelkerke R Square value from this logistic regression test was 0,287.

DISCUSSION

Based on the information in Table 1, This study ascribed salt intake among students to a diet predominantly consisting of processed foods, rapid meals, and fast food. Students residing in dorms sometimes lack adequate time to prepare their own meals due to the demands of their academic schedules, assignments, and extracurricular activities. As a result, people prefer options that are

practical, quick, conveniently available, and inexpensive. These foods are usually high in sodium because they are treated with preservatives, flavor enhancers such as monosodium glutamate, and added salt to improve palatability and lengthen shelf life (Rochmah & Utami, 2022). The repeated consumption of sodium-rich foods indirectly increases the risk of hypertension and other health issues.

According to blood pressure testing results, the majority of the 58 responders (54.7%) were classified as normotensive. This suggests that most college students have normal blood pressure despite being exposed to a variety of risk factors. These findings reinforce the notion that a healthy lifestyle, particularly adequate exercise, is crucial in maintaining normal blood pressure even in conditions of high salt consumption (Islam et al., 2023) even though respondents consumed a lot of salt. This is in agreement with earlier studies, the interaction of lifestyle habits, dietary habits, and physical activity levels considerably influences the chance of getting hypertension. To help reduce cases of hypertension among students, campuses can implement campus-based interventions that begin with simple steps such as regularly measuring blood pressure, educating students about salt consumption, and encouraging students to engage in regular physical activity.

There was information regarding the results of the Spearman's rank correlation test, which was used to determine the potential relationship between salt intake and physical activity with hypertension among university students. The analysis findings conducted in this study indicate a strong association between the habit of consuming large amounts of salt and the occurrence of hypertension in students in the city of Surakarta, with a significance value of $p = 0,001$. Findings from this research also indicated that students who regularly consume excessive amounts of salt are more prone to high blood pressure compared to students who consume salt in accordance with proper recommendations. Additionally, results from the statistical tests revealed a correlation coefficient (r) of 0,413 indicating a positive relationship of moderate strength between the variable of salt consumption habits and the occurrence of hypertension. In conclusion, Students who consume more salt exhibit a greater probability of developing hypertension. This finding has proven that the increase in hypertension among young adults, such as university students, can occur due to dietary habits that are high in sodium.

The results of the bivariate analysis in this study also showed that there was a correlation between the incidence of hypertension among students in Surakarta City and their level of physical activity, with $p = 0,001$. This finding indicated that the level of physical activity can also pose a risk of hypertension among students. The statistical test results showed a correlation coefficient of $r = -0,447$, indicating a moderate negative relationship. This present study also indicated that university students with low physical activity are at higher risk of developing hypertension, while those who are more active tend to have some protection against the condition.

Based on Table 3, the variable of salt intake had a p -value of 0,009, and the variable of physical activity had a p -value of 0,001. Therefore, these two values indicate that each variable does indeed have an influence in the model because their regression coefficients are not equal to zero. Therefore, it can be concluded that the findings of this study indicate that both variables significantly contribute to the occurrence of hypertension among the university student respondents. Furthermore, the odds ratio (OR) value for the salt intake habit variable was 6,857. This indicated that university students identified as having the habit of consuming high amounts of salt in their diet were exhibited 6,857 times greater odds of developing hypertension compared to students who do not have this habit.

Meanwhile, for the physical activity variable, the OR value was 10,980, meaning that students who are less active in physical activities and lead a sedentary lifestyle are 10,980 times greater likelihood of hypertension relative to students who engage in more active or intense physical activities. In addition, based on the Nagelkerke R Square value from this logistic regression test was 0,287, it can be concluded that the combination of salt consumption and physical activity affected approximately

28,7% of the variation in hypertension cases among university students.

It was shown that ingesting too much salt increased the risk of hypertension by raising peripheral resistance and blood volume. A recent meta-analysis found that limiting salt consumption could dramatically improve both systolic and diastolic blood pressure in the general population (Filippini et al., 2021). These data demonstrated that strategies to limit salt intake among college students were critical for preventing with the earliest hypertension. The pathophysiological processes relating salt intake and hypertension were predominantly connected with higher extracellular fluid volume and osmotic pressure (Sulyok et al., 2022). Sodium (Na^+) as is the major component of salt, Excessive intake can cause an increase in plasma volume, cardiac output, and blood pressure. Sodium causes the body to retain water beyond the normal threshold, which can increase blood volume and lead to high blood pressure. In addition, high salt intake was also known to damage endothelial function and increase arterial stiffness, as well as correlated to raised blood pressure (Halmaya et al., 2024).

This research highlighted that excessive salt consumption significantly increased the risk of hypertension. Although hypertension was often considered a disease of the elderly, its prevalence increased among young adults, mainly due to unhealthy lifestyles, including high-salt and low-fiber diets, as well as low levels of physical activity (Halim & Sutriyawan, 2022). WHO guidelines suggest limiting sodium intake to a maximum of 2000 mg per day equivalent to approximately 5 grams of table salt (WHO, 2025), but in this study the average salt intake of students was 2,406 mg/day which exceeded the daily salt intake limit. A study by Graudal et al. (2020) found that a low-sodium diet can lower systolic blood pressure by 5,5 mmHg. These findings confirmed that reducing salt intake has a significant impact on lowering blood pressure.

In this study, most respondents were found to have moderate levels of physical activity. Moderate-intensity physical activity reduces blood pressure by enhancing endothelial function, increasing insulin sensitivity, and decreasing oxidative stress and inflammation (Tinduh et al., 2022). (WHO, 2020) suggested reasonable physical exercise to avoid numerous chronic illnesses such as hypertension. Physical activity was found to improve endothelial function by a higher production of nitric oxide (NO) which took part in vasodilation and lowered the resistance of the peripheral vascular system, physical activity can lower arterial stiffness, boost insulin responsiveness, and ameliorate chronic inflammation, thereby assisting in blood pressure control (Yang et al., 2025). Sedentary lifestyles among students, especially those who study or sit in class, are linked to decreased physical activity, decreased cardiorespiratory capacity, and increased arterial stiffness, negatively impacting cardiovascular health.

These findings supported prior research emphasizing the impact of physical activity in hypertension prevention and control. A research by (Zhou et al., 2022), discovered that higher levels of physical activity were substantially related with a lower risk of hypertension, through an opposite dose-response relationship, implying that as physical activity increased, the risk of contracting hypertension decreased and vice versa. In agreement with this, the study by Bairapareddy et al. (2021) also showed that low levels of physical activity were correlated with an increased risk of hypertension, especially in young adults. Therefore, it is important to emphasize that being young does not guarantee freedom from the risk of hypertension. In fact, college was considered an important period for forming healthy lifestyle habits, including regular physical activity of moderate to high intensity.

CONCLUSION

The findings of this research indicate a significant correlation between excessive salt intake and inadequate physical activity with the prevalence of hypertension among university students. In order to resolve this issue, it is recommended that students improve their comprehension of nutrition, reduce their salt intake to be consistent with the World Health Organization's guidelines

(no more than 5 grammes or 2000 mg of sodium per day), and participate in moderate to active physical activities for a minimum of 150 minutes each week.

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