Journal of Health and Nutrition Research
Vol. 5, No. 1, 2026, pg. 1-11, https://doi.org/10.56303/jhnresearch.v5i1.673
Journal homepage: https://journalmpci.com/index.php/jhnr/index

e-ISSN: **2829-9760**

Factors Associated with Blood Pressure and Cholesterol Level in Adolescents: A Survey Study in An Islamic School in Palu City, Indonesia

Nikmah Utami Dewi[1]*, Disty Rahmawaty Tahir[1], Ningsih Wulandari[1]

[1] Department of Nutrition, Tadulako University, Palu, Indonesia

Corresponding Author: nikmah@untad.ac.id

ORIGINAL ARTICLES

Submitted: 4 August 2025

Accepted: 22 October 2025

Keywords:
Adolescents, Blood pressure, Cholesterol, Natrium, Survey

ABSTRACT

The risk of degenerative diseases, including high blood pressure and high cholesterol levels, can occur at any age. This study aims to explore the relationship between several modifiable factors and blood pressure and cholesterol levels in adolescents. The survey was conducted in one of the Islamic schools in a densely populated area in Palu City using a cross-sectional study design with a simple random sampling technique on 100 respondents aged 15–18 years. Dietary and habitual intake as well as physical activity were collected through a 2x24-hour food recall questionnaire, a qualitative food frequency questionnaire, and an IPAQ questionnaire. Blood pressure and blood cholesterol levels were measured using a digital tension meter and easy touch GCU, respectively. Results indicated that 41 percent of adolescents had elevated blood pressure (>120/80 mmHg) and 42 percent had high cholesterol levels (≥200 mg/dl), with an average systolic blood pressure of 121 mmHg and cholesterol levels of 199 mg/dL. Only sodium was significantly associated with blood pressure ($p = 0.02$), and no factors were significantly associated with cholesterol levels after multivariate analysis by including other variables: fat intake, potassium intake, fried and fast-food eating habits, physical activity, and gender ($p > 0.05$). Further exploration should include additional dietary factors such as saturated fat intake and overall dietary patterns, as well as psychosocial, and environmental influences to help design appropriate nutritional behavior change interventions for adolescents.

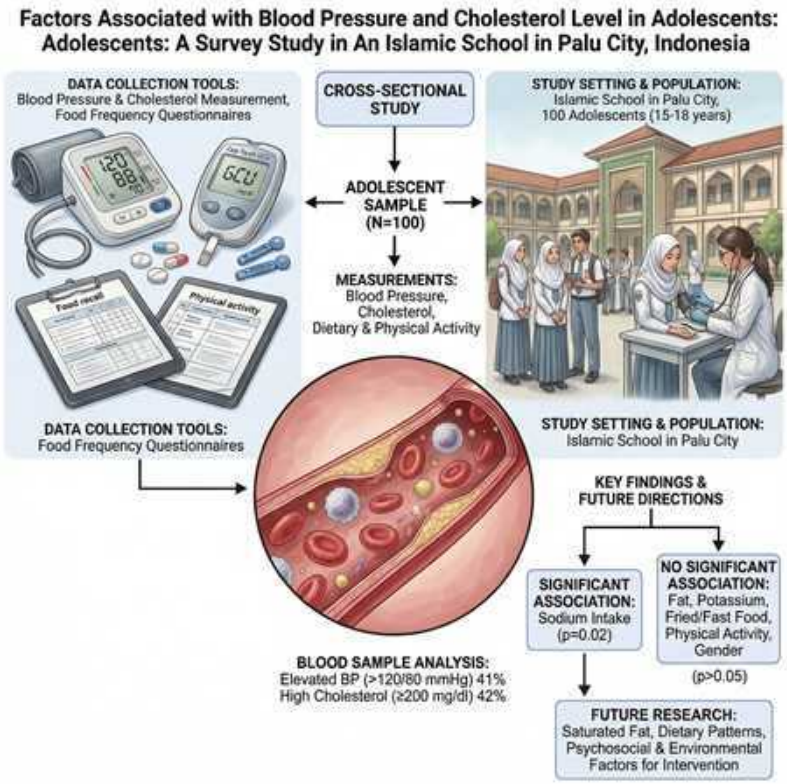
Access this article online

Quick Response Code

Key Messages:

- Degenerative diseases such as high blood pressure and high cholesterol are currently found in adolescents, including in small cities like Palu.
- Sodium intake is significantly related to high blood pressure. However, no statistically proven factors are associated with cholesterol levels after multivariate analysis.
- Further research is needed to consider other confounding variables to design more appropriate nutritional behavior change interventions for adolescents.

GRAPHICAL ABSTRACT



INTRODUCTION

Adolescence is a stage of life that represent a phase of peak growth. During this period, there are several changes happened in body composition, including significant increase in weight and bone mass, along with high level of physical activity, which lead to the changes in nutritional needs during late adolescence (1). At this period, nutritional problem often arises. The imbalance between nutrient intake and need able to trigger various nutritional problem in adolescents (2–4). High cholesterol level and increased blood pressure are nutrition-related health issues which its prevalence is rising among adolescents in Indonesia (5,6).

The global prevalence of hypercholesterolemia reached around 30-40%, indicating that nearly half of the world population experiencing high cholesterol level (7–10). In Indonesia, the prevalence of hypercholesterolemia aged more than 15 years old reached around 30 percent, with the prevalence of very high cholesterol level among adolescents aged 15-24 years old reached 10 percent (5). Several nutrition and health surveys among adolescents showed that the percentage of adolescents with high total cholesterol level reaching 50% (11,12).

The prevalence of high blood pressure also shows a high number. In 2019, the global prevalence of hypertension was 33.1 percent (13). Hypertension in Southeast Asia was 33.1 percent, where in Indonesia the prevalence is 32.4 percent (13). Although this number decreased in 2023, the prevalence of hypertension in individual aged ≥18 years still above 30 percent (14). Among adolescents aged 15-19 years, the prevalence of adolescents with elevated and classified as high blood pressure were 19.4 percent (15). This prevalence has increased from previous year where the number only 8.4% (6).

High cholesterol level and high blood pressure are among non-communicable diseases associated with modifiable and non-modifiable factors (16). Some modifiable factors have relation to high cholesterol level and high blood pressure include unhealthy diet and low physical activity (17,18). High sodium intake, low potassium, and high fat, including eating junk food and fried foods, are associated with high blood pressure and cholesterol (19–21).

Religion-based education is associated with health behaviors, including eating patterns, stress

https://doi.org/10.56303/jhnresearch.v5i1.673

management, and adolescents' psychological well-being (22,23). In Islamic school, students are instilled with Islamic values, such as halal and good food, avoiding excess, and maintaining trust regarding their body as a gift from God (24). However, various studies have found that some principles are often not implemented in good practices (25,26), This may be related to the influence of the modern environment, which includes the availability and affordability of fast food and attractive processed snacks, which have a stronger influence on adolescents' eating preferences than recommended eating guidelines (27).Studying adolescent health in Islamic schools provides important insights into how faith-based education contributes to eating behaviors and adolescent health outcomes (28)

This research aims to identify modifiable factors related to cholesterol level and blood pressure among adolescents at Islamic school in Palu, Indonesia. Exploring factors related to high cholesterol and blood pressure among adolescents studying in Islamic school is particularly important since lifestyle patterns, dietary habits, and physical activity levels in Islamic school settings may differ from general populations, providing a quicker opportunity to improve their health condition before leading to worser health outcomes.

METHODS

This research is an observational analytic descriptive study with cross-sectional design conducted at one of the Islam senior high schools in a densely populated area in Palu City from August to September 2024. The method of respondent selection in this study was a simple random sampling technique with a sample size of 100 respondents, which was determined based on the Lemeshow formula for sample size calculation (29). The respondents were student attending school at research location with inclusion criteria of being 15-17 years old, not currently consuming medication that affecting blood pressure and cholesterol level, willing and obtaining permission from their parents or guardian. Respondents were excluded if they were on a special diet prescribed by a doctor, were ill, or did not finishing the data collection. By these criteria, there were no respondents excluded in this study.

Data on fat (grams), sodium (milligrams), and potassium (milligrams) intake were collected through two non-consecutive 24-hour dietary recalls. Information on fast and fried food consumption habits was collected through a Food Frequency Questionnaire (FFQ) that was pre-tested among adolescents from a population with characteristics similar to those of the study participants to ensure cultural and contextual relevance. Physical activity was assessed using the International Physical Activity Questionnaire (IPAQ). The blood pressure measurement procedure followed the Indonesia Health Survey protocol of the Indonesian Ministry of Health, using a digital sphygmomanometer (30). Total cholesterol levels were measured from fingertip capillary blood using an Easy Touch GCU without fasting.

Fast food and fried food eating habits are categorized as never, rarely (<3 times/month), sometimes (1-2 times/week), often (1 time/day), and very often (>1 time/day) (5). Physical activity consisted of light (<600 MET-minutes/week), moderate (≥600 MET-minutes/week), and vigorous (≥1500 MET-minutes/week) (31). Respondents are categorized as having high blood pressure if their blood pressure is elevated or high (systolic blood pressure >120 mmHg) and having high cholesterol if their total cholesterol level is greater than or equal to 200 mg/dL. The relationship between variables was identified using Spearman-Rho test at 95% confidence level. Logistic regression was used to determine the simultaneous relationship between variables concerning adolescents' cholesterol level and blood pressure.

CODE OF HEALTH ETHICS

This study has met ethical eligibility based on the ethical clearance certificate issued by the Health Research Ethics Committee of the Faculty of Medicine, Tadulako University, Number: 6925/UN28.10/KL/2024

RESULTS

A total of 100 respondents participated in the study. Most respondents were girls (60%), with the majority being 16 years old (52%) (Table 1).

https://doi.org/10.56303/jhnresearch.v5i1.673

Table 1. The characteristics of respondents

Variable	n	%
Gender		
Male	40	40
Female	60	60
Age (years)		
15	25	25
16	52	52
17	23	23

More than 50 percent of respondents have fat intake exceeding the Recommended Dietary Allowances (RDAs), which are 85 grams per day for men and 70 grams per day for women. Most respondents also have sodium intake exceeding 1700 mg/day (65%), while 64% have potassium intake below RDA (>5,300 mg/day) (Table 2). The average fat intake of respondents is 80 grams for both men and women. Sodium and potassium intake are 1967 mg and 1126 mg, respectively.

Table 2. The Distribution of Fat, Natrium, and Potassium Intake of Respondents

Variable	n	%
Fat Intake		
Excess Intake (male >85 g/day; female >70 g/day)	51	51
Sufficient intake (male 85 g/day; female 70 g/day)	49	49
Natrium Intake		
Excess Intake (>1700 mg/day)	65	65
Sufficient intake (≤1700 g/day)	35	35
Potassium Intake		
Excess Intake (<5.300 mg/day)	64	64
Sufficient intake (5.300 mg/day)	36	36

Regarding eating habits, 60% of respondents rarely consumed junk food (less than 3 times per month), while 41% reported eating fried foods at least once a day. Most respondents (61%) had moderate physical activity levels (Table 3).

Table 3. The Distribution of Junk Food and Fried Food Habitual Intake and Physical Activity of Respondents

Variable	n	%
Junk Food Habitual Intake		
Never	4	4
Rarely	60	60
Sometimes	34	34
Often	1	1
Very often	1	1
Fried Food Habitual Intake		
Never	1	1
Rarely	14	14
Sometimes	30	30
Often	41	41
Very often	14	14
Physical Activity		
Light	4	4
Moderate	61	61
Vigorous	35	35

This study's results indicate that most adolescents (59%) have blood pressure above normal, with an average systolic blood pressure of 121 mmHg and a maximum of 163 mmHg (Table 4). The percentage of

https://doi.org/10.56303/jhnresearch.v5i1.673

adolescents with a total cholesterol level also shows a high number. Over 40% of adolescents have total cholesterol levels above 200 mg/dL.

Table 4 Blood Pressure And Cholesterol Level of Respondents

Variable	n	%	Mean (Min -Max)
Blood Pressure			
High	59	59	121 (90-163) mmHg
Normal	41	41	
Cholesterol Level			
High	42	42	199 (115-290) mg/dL
Normal	58	58	

Analysis of several modifiable factors examined in this study shows that only habitual intake of junk food is significantly associated with blood pressure in adolescents (p=0.04) with a negative correlation (Table 5). This means the more frequently junk food is consumed, the lower the blood pressure in adolescents

Table 5 Blood pressure and cholesterol association with several modifiable factors

Blood Pressure/ Cholesterol	Variables	Spearman Correlation Coefficient	p-value
Blood Pressure	Fat Intake	-0,09	0.33
	Sodium intake	0.16	0.12
	Potassium intake	0.09	0.18
	Fried food habitual intake	-0.11	0.23
	Junk food habitual intake	-0.20	0.04*
	Physical activity	-0.17	0.09
	Cholesterol level	-0.11	0.95
	Gender	-0.08	0.41
Cholesterol	Fat Intake	-0.05	0.62
	Fried Food eating habit	0.05	0.64
	Junk Food eating habit	-0.02	0.85
	Physical Activity	0.13	0.19
	Gender	-0.09	0.38

*p-value < 0.05

The relationship between habitual junk food intake and blood pressure faded after simultaneously including all other variables (Table 6). Sodium intake became significantly associated with blood pressure in adolescents. This means the higher the sodium intake, the higher the blood pressure.

Table 6. Multivariate analysis of Blood pressure and cholesterol with several modifiable factors

Variables	B	p-value
Blood Pressure		
Fat Intake	-0.01	0.42
Sodium intake	1.28	0.02*
Potassium intake	0.57	0.44
Fried food habitual intake	-0.36	0.23
Junk food eating habit	-0.47	0.35
Physical activity	-0.59	0.25
Cholesterol level	-0.00	0.44
Gender	-0.16	0.74
Constant	0.91	0.69
Cholesterol Level		
Fat Intake	-0.01	0.55
Fried Food eating habit	0.31	0.27
Junk Food eating habit	0.30	0.50
Physical Activity	-0.65	0.18

https://doi.org/10.56303/jhnresearch.v5i1.673

Variables	B	p-value
Gender	0.20	0.65
Constant	-0.78	0.60

*p-value < 0.05.

DISCUSSION

This study explored modifiable factors associated with blood pressure and cholesterol levels among adolescents in an Islamic school in Palu City. The findings reveal a concerning prevalence of elevated blood pressure (59%) and high cholesterol (42%) among adolescents, indicating an emerging risk of non-communicable diseases at an early age.

The prevalence of adolescents with increased and high blood pressure in this study was found to be higher compared to several other studies in Indonesia and other parts of the world (15,32,33). Adolescents' average systolic blood pressure was also exceeded the average values observed in others studies, ranging from 108 - 113 mmHg (33–35).

Similarly, the proportion of adolescents with total cholesterol levels above 200 mg/dL in this study was slightly higher than the national statistic for Indonesians aged 13–34 years, which reported a prevalence of 39.4% (14). The mean cholesterol level among respondents was 199 mg/dL, which falls within the borderline between normal and high categories. The maximum cholesterol level among adolescents reaches 290 mg/dL, which categorized as very high.

Overall, the prevalence of adolescents with high cholesterol in this study was greater than that reported in previous studies in Indonesia and several systematic studies in other countries (15,36,37). Two studies showed higher figures than this research (11,12). However, one of these studies used a lower cut-off point for defining high cholesterol (170 mg/dL) (11), while the other focused on slightly older adolescents, aged 18-24 years (12), which may explain difference.

This study found that more than half of the adolescents had fat and sodium intakes exceeding the Recommended Dietary Allowances (RDA), while most had inadequate potassium intake. The percentage of adolescents with fat intake exceeding RDA in this study is lower compared to other studies in Indonesia (38). However, fat intake in this study was higher than intake of younger adolescents (13-15 years) in Sumatra (39) or several other studies with adolescent group aged 15-17 years in Java (40,41). For average intake of fat, this study shows lower value compared to adolescent intake in Indonesia in 2010 (42) but much higher than the average fat intake among adolescent girls in rural Indonesia or other countries (43,44).

The average sodium intake of adolescents in this study was also lower than several other countries (45,46). However, this average indicates that the adolescents' intake in this study was higher than the RDA (47). On the contrary, the average potassium intake was much lower than Indonesian adolescent RDA (47). This trend is identical to several studies in other region of Indonesia, Mexico, and the United States (48–50).

In eating habits, it is known that most respondents rarely consuming junk food or consuming junk food less than 3 times per month (60%). This is in contrast to the habit of eating fried foods frequently, where almost half of respondents (41%) eat at least 1 time a day. The habit of eating fried foods frequently among adolescents was found in various regions of Indonesia (51). Cooking food by frying is Indonesia's most popular food preparation method. Fried foods provide a more savory and crispy sensation, which most Indonesians prefer (27,52).

This study mainly classified adolescents' physical activity as moderate (61%). Several studies showed lower physical activity level among urban adolescents compare to rural adolescents (53–55). Adolescents have longer screen time compare to other age group, especially after school (56,57). This research is located in a densely populated area near traditional market center in the city of Palu. Most of the residents in this area work as entrepreneur, including seller (58). This condition allows adolescents to help their parents, who are entrepreneur, in the selling process.

Analysis of several modifiable factors examined in this study shows that only habitual intake of junk food is significantly associated with blood pressure in adolescents (p=0.04) with a negative correlation. This means the more frequently junk food is consumed, the lower the blood pressure in adolescents. This counterintuitive result may be explained by several factors. First, adolescents with higher junk food

https://doi.org/10.56303/jhnresearch.v5i1.673

consumption may also have higher overall energy expenditure or physical activity levels, which could mitigate the impact of unhealthy diets on blood pressure (59). Second, there is a possibility of underreporting bias, where participants with higher blood pressure underreported their junk food consumption due to social desirability or recall limitations (60). Third, metabolic differences and short-term dietary effects in adolescents might not immediately reflect long-term consequences of unhealthy eating habits, leading to misleading associations (61). However, since this relationship disappeared in the multivariate analysis, it is likely that the initial correlation was confounded by other factors such as sodium intake or physical activity levels, rather than representing a true association . Sodium intake became significantly associated with blood pressure in adolescents. This means the higher the sodium intake, the higher the blood pressure.

High sodium level is associated with high blood pressure, the result is the same as found in various cohort studies (62). Sodium plays a role in maintaining water stability and controlling blood pressure (63). High sodium levels in bloodstream can lead to water retention, ultimately increasing blood volume and boosting blood circulation, making the heart works harder to distribute blood (64). Excessive sodium intake can also impacting the enlargement of artery size, leading to increment of blood pressure (65).

In contrast, other dietary factors such as fat and potassium intake, as well as fried and fast-food consumption, were not significantly associated with blood pressure. This may be due to the relatively narrow variation of intake within the study population, measurement limitations from short-term dietary recall, or the buffering effects of other unmeasured factors such as total energy expenditure, genetic predisposition, and psychosocial stress (66,67). Moreover, the cross-sectional design limits the ability to detect long-term cumulative effects of these factors. Therefore, while sodium emerged as a key determinant in this population, future longitudinal studies are needed to explore the combined effects of multiple dietary and lifestyle factors on adolescent blood pressure.

Several modifiable factors identified in this study were not associated with adolescent cholesterol level. Various other factors that were not studied, such as intake of saturated fats and trans fats, especially those derived from packaged foods, are variables that might explain the relationship between modifiable factors and cholesterol level (68,69). Although attempts were made to include several non-modifiable factors in this study, other aspects such as genetics, race, and ethnicity were not explored, potentially obscuring the relationship between variables (70,71).

This research presents important information related to non-communicable diseases among adolescents, which is crucial for the prevention efforts against larger health issues that may arise. This research also fills the information gap, especially in Islamic schools that are rarely targeted, thus providing specific recommendations for religious-based schools (72). Several other factors related to blood pressure and cholesterol among adolescents were not identified in this study, which could obscure the relationships between variables examined in this research. Cross-sectional research design also does not allow researchers to explain the relationship found as cause and effect.

CONCLUSION

About two-fifths of adolescents experienced blood pressure and cholesterol level above normal. The modifiable factor related to blood pressure is sodium intake. High sodium intake is associated with high blood pressure. Other factors, including mediator of behavioral changes related to blood pressure and cholesterol level, must be explored to develop an appropriate intervention model to prevent increasing blood pressure and cholesterol level among adolescents, especially those who attending Islamic or other religious schools.

ACKNOWLEDGMENTS

The authors thank the Head and teachers of Palu State Islamic High School for permission and facilitating the data collection process.

CONFLICTS OF INTEREST

The authors declare no conflict of interest.

https://doi.org/10.56303/jhnresearch.v5i1.673

REFERENCES

1. Norris SA, Frongillo EA, Black MM, Dong Y, Fall C, Lampl M, et al. Nutrition in adolescent growth and development. The Lancet. 2022 Jan 8;399(10320):172–84.
2. Moore Heslin A, McNulty B. Adolescent nutrition and health: characteristics, risk factors and opportunities of an overlooked life stage. Proceedings of the Nutrition Society. 2023/03/16 ed. 2023;82(2):142–56.
3. Dewi NU, Krisnasari S, Sanjaya K, Aida N. Dietary Quality and Nutritional Status of Adolescents in Rural Areas of Sigi Regency, Indonesia. Media Gizi Indonesia. 2025;20(2):178–84.
4. Dewi NU, Khomsan A, Dwiriani CM, Riyadi H, Ekayanti I, Hartini DA, et al. Factors Associated with Diet Quality among Adolescents in a Post-Disaster Area: A Cross-Sectional Study in Indonesia. Nutrients. 2023;15(5):1–22.
5. Health Research and Development Unit. Indonesia Basic Health Research. Jakarta; 2018.
6. Health Research and Development Unit. Indonesia Basic Health Research. Jakarta; 2013.
7. Pengpid S, Peltzer K. National high prevalence, and low awareness, treatment and control of dyslipidaemia among people aged 15–69 years in Mongolia in 2019. Scientific Reports. 2022;12(1):10478.
8. Abujbara M, Batieha A, Khader Y, Jaddou H, El-Khateeb M, Ajlouni K. The Prevalence of Dyslipidemia among Jordanians. Journal of Lipids. 2018 Jan 1;2018(1):6298739.
9. Gebreegziabiher G, Belachew T, Mehari K, Tamiru D. Prevalence of dyslipidemia and associated risk factors among adult residents of Mekelle City, Northern Ethiopia. PLOS ONE. 2021 Feb 9;16(2):e0243103.
10. Pan L, Yang Z, Wu Y, Yin RX, Liao Y, Wang J, et al. The prevalence, awareness, treatment and control of dyslipidemia among adults in China. Atherosclerosis. 2016 May 1;248:2–9.
11. Suciawati A, Silawati V, Mulyati D. Factors Associated with Cholesterol Levels among Adolescent Girls. Jurnal Ilmiah Kebidanan Indonesia. 2019;15:30–6.
12. Sari HP, Fadlilah SH, Febriani AR, Yasmin A, Fadilah FN, Azizah NF. The Influence of Physical Activity, Fast Food, and Body Composition on Hypercholesterolemia in Young Adults: A Step Toward SDGs - Good Health and Well-being. E3S Web of Conferences. 2025;609.
13. World Health Organization. Global report on hypertension: the race against a silent killer. Vol. 01. Geneva; 2023. 1–7 p.
14. Ministry of Health of The Republic of Indonesia. Indonesian Health Survey 2023. Jakarta; 2023.
15. Sudikno S, Mubasyiroh R, Rachmalina R, Arfines PP, Puspita T. Prevalence and associated factors for prehypertension and hypertension among Indonesian adolescents: a cross-sectional community survey. BMJ Open. 2023 Mar 1;13(3):e065056.
16. Budreviciute A, Damiati S, Sabir DK, Onder K, Schuller-Goetzburg P, Plakys G, et al. Management and Prevention Strategies for Non-communicable Diseases (NCDs) and Their Risk Factors. Frontiers in public health. 2020;8:574111.
17. Zhu Y, Wang Z. Association between joint physical activity and healthy dietary patterns and hypertension in US adults: cross-sectional NHANES study. BMC Public Health. 2024;24(1):855.
18. Ghodeshwar GK, Dube A, Khobragade D. Impact of Lifestyle Modifications on Cardiovascular Health: A Narrative Review. Cureus. 2023 July;15(7):e42616.
19. Te Morenga L, Montez JM. Health effects of saturated and trans-fatty acid intake in children and adolescents: Systematic review and meta-analysis. PLOS ONE. 2017 Nov 17;12(11):e0186672.
20. Gadiraju T V, Patel Y, Gaziano JM, Djoussé L. Fried Food Consumption and Cardiovascular Health: A Review of Current Evidence. Nutrients. 2015 Oct;7(10):8424–30.
21. Kim BS, Yu MY, Shin J. Effect of low sodium and high potassium diet on lowering blood pressure and cardiovascular events. Clinical hypertension. 2024 Jan;30(1):2.
22. Estrada CAM, Lomboy MFTC, Gregorio ER, Amalia E, Leynes CR, Quizon RR, et al. Religious education can contribute to adolescent mental health in school settings. International Journal of Mental Health Systems. 2019;13(1):28.

https://doi.org/10.56303/jhnresearch.v5i1.673

23. Rimbawan R, Nurdiani R, Rachman PH, Kawamata Y, Nozawa Y. School Lunch Programs and Nutritional Education Improve Knowledge, Attitudes, and Practices and Reduce the Prevalence of Anemia: A Pre-Post Intervention Study in an Indonesian Islamic Boarding School. Nutrients. 2023 Feb;15(4).
24. Solihin I, Hasanah A, Fajrussalam H. Core Ethical Values of Character Education Based on Islamic Values in Islamic Boarding Schools. International Journal on Advanced Science, Education, and Religion. 2020;3(2):21–33.
25. Keleher A, Neggaz M, Cliff CM, Muhammad YI, Mathews A, Quadri H, et al. Incorporating Halal Into Healthy and Equitable Dietary Patterns to Address Food and Nutrition Security Among K-12 and University Students: A Perspective. Journal of Nutrition Education and Behavior. 2024;56(9):663–71.
26. Elgharbawy A, Azmi NAN. Food as medicine: How Eating Halal and Tayyib Contributes to a Balanced Lifestyle. Halalsphere. 2022;2(1):86–97.
27. Briawan D, Khomsan A, Alfiah E, Nasution Z, Putri PA. Preference for and consumption of traditional and fast foods among adolescents in Indonesia. Food Research. 2023;7(4):211–26.
28. Pakpahan C, Amanda B, Sumino R, Azlansyah A, Simatupang CM, Handini LP, et al. Navigating adolescence matters in Indonesia: insights and needs of students in Islamic schools. The Pan African medical journal. 2025;50:100.
29. Lemeshow S, Hosmer DW, Klar J, Lwanga SK. Adequacy of Sample Size in Health Studies. Vol. 47, World Health Organization. Geneve; 1990. 347 p.
30. Ministry of Health of the Republic of Indonesia. Guidelines for Filling Out the Indonesia Health Survey Questionnaire 2023 (Version 11). Jakarta; 2023.
31. IPAQ Research Committee. Guidelines for Data Processing and Analysis of the International Physical Activity Questionnaire (IPAQ) – Short and Long Forms. 2005.
32. Almahmoud OH, Arabiat DH, Saleh MY. Systematic review and meta-analysis: Prevalence of hypertension among adolescents in the Arab countries. Journal of pediatric nursing. 2022;65:e72–9.
33. Liu K, Li C, Gong H, Guo Y, Hou B, Chen L, et al. Prevalence and Risk Factors for Hypertension in Adolescents Aged 12 to 17 Years: A School-Based Study in China. Hypertension. 2021 Nov 1;78(5):1577–85.
34. Hardy ST, Sakhuja S, Jaeger BC, Urbina EM, Suglia SF, Feig DI, et al. Trends in Blood Pressure and Hypertension Among US Children and Adolescents, 1999-2018. JAMA Network Open. 2021 Apr 1;4(4):e213917–e213917.
35. Kwok MK, Wong IOL, Schooling CM. Age-period-cohort projection of trends in blood pressure and body mass index in children and adolescents in Hong Kong. BMC Pediatrics. 2020;20(1):1–11.
36. Gomes ÉIL, Zago VH de S, Faria EC de. Evaluation of Lipid Profiles of Children and Youth from Basic Health Units in Campinas, SP, Brazil: A Cross-Sectional Laboratory Study. Arquivos brasileiros de cardiologia. 2020 Jan;114(1):47–56.
37. Guirguis-Blake JM, Evans C V, Coppola EL, Redmond N, Perdue LA. Screening for Lipid Disorders in Children and Adolescents: Updated Evidence Report and Systematic Review for the US Preventive Services Task Force. JAMA. 2023 July;330(3):261–74.
38. Sulistyadewi NPE, Masitah R. Asupan karbohidrat dan lemak dari konsumsi makanan jajanan terhadap status gizi pada remaja. Jurnal Kesehatan Terpadu. 2020;4(2):52–6.
39. Irwanda M, Suryani D, Krisnasary A. Gambaran Asupan Energi , Zat Gizi Makro Dan Status Gizi Remaja Di SMP N 14 Kota Bengkulu Tahun 2022. AKSARA. 2023;09(January):199–208.
40. Afifah NN, Hardiansyah A, Darmuin D. Asupan lemak, asupan serat, persepsi body image dan status gizi siswa SMA Kesatrian 1 Semarang. Nutrition Scientific Journal. 2024;3(1):8–18.
41. Faridi A, Vidyarini A, Prasetya AY. Hubungan Pengetahuan, Kebiasaan Sarapan Dan Asupan Zat Gizi Makro Sarapan Dengan Status Gizi Pada Remaja. Jurnal Riset Gizi. 2023;11(2):106–13.
42. Sutriani A, Ngadiarti I. ubungan antara asupan energi, protein, lemak, karbohidrat, serat dengan kejadian gizi lebih pada anak remaja usia 1H3-18 tahun di pulau jawa (analisis data sekunder riskesdas 2010). Nutrire Diaita. 2013;5(2):68–80.

https://doi.org/10.56303/jhnresearch.v5i1.673

43. Musfira M, Hadju V. Nutrition and Dietary Intake of Adolescent Girls in Indonesia: A Systematic Review. Scripta Medica (Banja Luka). 2024;55(4):473–87.
44. Song S, Shim JE. Trends in Dietary Intake of Total Fat and Fatty Acids Among Korean Adolescents from 2007 to 2017. Nutrients. 2019 Dec;11(12).
45. Emamian MH, Ebrahimi H, Hashemi H, Fotouhi A. Salt intake and blood pressure in Iranian children and adolescents: a population-based study. BMC Cardiovascular Disorders. 2021;21(1):1–10.
46. Brouillard AM, Deych E, Canter C, Rich MW. Trends in Sodium Intake in Children and Adolescents in the US and the Impact of US Department of Agriculture Guidelines: NHANES 2003-2016. The Journal of pediatrics. 2020 Oct;225:117–23.
47. Ministry of Health of the Republic of Indonesia. Regulation of the Minister of Health of the Republic of Indonesia Number 28 of 2019 concerning Recommended Dietary Allowance (RDA) for the Indonesian People. Jakarta, Indonesia; 2019.
48. Reddin C, Ferguson J, Murphy R, Clarke A, Judge C, Griffith V, et al. Global mean potassium intake: a systematic review and Bayesian meta-analysis. European journal of nutrition. 2023 Aug;62(5):2027–37.
49. Farapti F, Maulia PH, Fadilla C, Yogiswara N, Rejeki PS, Miftahussurur M, et al. Community-level dietary intake of sodium, potassium, and sodium-to-potassium ratio as a global public health problem: a systematic review and meta-analysis. F1000Research. 2022;11:953.
50. Vargas-Meza J, Cervantes-Armenta MA, Campos-Nonato I, Nieto C, Marrón-Ponce JA, Barquera S, et al. Dietary Sodium and Potassium Intake: Data from the Mexican National Health and Nutrition Survey 2016. Nutrients. 2022 Jan;14(2).
51. Rachmi CN, Jusril H, Ariawan I, Beal T, Sutrisna A. Eating behaviour of Indonesian adolescents: A systematic review of the literature. Public Health Nutrition. 2020;24(Lmic).
52. Negara BF, Tirtawijaya G, Cho WH, Harwanto D, Sohn JH, Kim JS, et al. Effects of Frying Processes on the Nutritional and Sensory Characteristics of Different Mackerel Products. Vol. 9, Processes. 2021.
53. Vrevic E, Malovic P, Bacovic D, Bojanic D, Nokic A. Differences in nutritional status and level of physical activity among adolescents living in urban and rural areas of Montenegro - national study. BMC Public Health. 2024;24(1):896.
54. Nurwanti E, Hadi H, Chang JS, Chao JCJ, Paramashanti BA, Gittelsohn J, et al. Rural–urban differences in dietary behavior and obesity: Results of the riskesdas study in 10–18-year-old Indonesian children and adolescents. Nutrients. 2019;11(11):1–14.
55. Malik AS, Chatterjee K. A cross-sectional study to compare levels of physical activity among adolescents in rural and urban areas of Western Maharashtra. Medical journal, Armed Forces India. 2023 Dec;79(Suppl 1):S237–43.
56. Andriyani FD, Biddle SJH, Priambadha AA, Thomas G, De Cocker K. Physical activity and sedentary behaviour of female adolescents in Indonesia: A multi-method study on duration, pattern and context. Journal of Exercise Science & Fitness. 2022;20(2):128–39.
57. Rifqi MA, Puspikawati SI, Salisa W, Zaman MNU. Sweet Sweetened Beverages Intake and Sedentary Behavior Drive Overweight Trends: A Study of Urban and Rural Adolescents in East Java, Indonesia. Amerta Nutrition. 2025;9(1):34–44.
58. BPS-Statistics of Palu Municipality. Palu Municipality in Figure 2025. Vol. 25. Palu; 2025.
59. Ahmad S, Ansari MA, Abedi AJ, Khalil S, Eram U, Khan MNA. Physical Activity Levels and Junk Food Intake among School going Adolescents in a North Indian City. 2023;35(2):182–6.
60. Popoola AA, Frediani JK, Hartman TJ, Paynabar K. Mitigating underreported error in food frequency questionnaire data using a supervised machine learning method and error adjustment algorithm. BMC Medical Informatics and Decision Making. 2023;23(1):178.
61. Winpenny EM, van Sluijs EMF, Forouhi NG. How do short-term associations between diet quality and metabolic risk vary with age? European journal of nutrition. 2021 Feb;60(1):517–27.
62. Filippini T, Malavolti M, Whelton PK, Vinceti M. Sodium Intake and Risk of Hypertension: A Systematic Review and Dose-Response Meta-analysis of Observational Cohort Studies. Current hypertension reports. 2022 May;24(5):133–44.

https://doi.org/10.56303/jhnresearch.v5i1.673

63. Polychronopoulou E, Braconnier P, Burnier M. New Insights on the Role of Sodium in the Physiological Regulation of Blood Pressure and Development of Hypertension. Frontiers in cardiovascular medicine. 2019;6:136.
64. Kazi RN. Silent Effects of High Salt: Risks Beyond Hypertension and Body's Adaptation to High Salt. Vol. 13, Biomedicines. 2025.
65. Brady TM, Horst G, Appel LJ, Khoury PR, Urbina EM. Dietary sodium intake and sodium load is associated with arterial stiffness in children and young adults. Journal of hypertension. 2022 Feb;40(2):292–9.
66. Robinson CH, Chanchlani R. High Blood Pressure in Children and Adolescents: Current Perspectives and Strategies to Improve Future Kidney and Cardiovascular Health. Kidney international reports. 2022 May;7(5):954–70.
67. Zuin C. Psychosocial factors and hypertension: Exploring the mind-heart connection. J Hypertens Heart Care. 2023;6(3):147.
68. Johnson SA, Kirkpatrick CF, Miller NH, Carson JAS, Handu D, Moloney L. Saturated Fat Intake and the Prevention and Management of Cardiovascular Disease in Adults: An Academy of Nutrition and Dietetics Evidence-Based Nutrition Practice Guideline. Journal of the Academy of Nutrition and Dietetics. 2023 Dec 1;123(12):1808–30.
69. de Souza RJ, Mente A, Maroleanu A, Cozma AI, Ha V, Kishibe T, et al. Intake of saturated and trans unsaturated fatty acids and risk of all cause mortality, cardiovascular disease, and type 2 diabetes: systematic review and meta-analysis of observational studies. BMJ (Clinical research ed). 2015 Aug;351:h3978.
70. Kalwick M, Roth M. A Comprehensive Review of the Genetics of Dyslipidemias and Risk of Atherosclerotic Cardiovascular Disease. Nutrients. 2025 Feb;17(4).
71. Curtis D. Genetic Variants Associated with Hypertension Risk: Progress and Implications. Pulse (Basel, Switzerland). 2024;12(1):19–26.
72. Rahfiludin MZ, Asna AF, Suroto, Hidayanti L. Contribution of Snacks and Physical Activities to Elevated Blood Pressure of Adolescent Girls in West Java, Indonesia. Malaysian Journal of Medicine and Health Sciences. 2023;19(4):53–60.

https://doi.org/10.56303/jhnresearch.v5i1.673