Amerta Nutrition
e-ISSN: 2580-1163 (Online)
p-ISSN: 2580-9776 (Print)
Nuradina et al. | Amerta Nutrition Vol. 7 Issue 2 (June 2023). 274-278

RESEARCH STUDY
English Version

OPEN ACCESS

Overweight and High Sodium Intake Increased Risk of Hypertension among Adolescents: A Case-control Study in Urban Setting

Status Gizi Lebih dan Asupan Natrium Tinggi Meningkatkan Risiko Hipertensi pada Remaja: Studi Kasus-Kontrol di Perkotaan

Rifka Annisa Aura Nuradina[1], Widya Asih Lestari[1]*, Imas Arumsari[1]

[1]Departemen Ilmu Gizi, Fakultas Ilmu-Ilmu Kesehatan, Universitas Muhammadiyah Prof. Dr. Hamka, Jakarta, Indonesia

ARTICLE INFO

Received: *13-12-2021*
Accepted: *10-01-2023*
Published online: *09-06-2023*

Correspondent:
Widya Asih Lestari
widya_asihlestari@uhamka.ac.id

DOI:
10.20473/amnt.v7i2.2023.274-278

Available online at:
https://e-journal.unair.ac.id/AMNT

Keywords:
Adolescent, Hypertension, Sodium, Overweight, Urban

ABSTRACT

Background: Hypertension is the leading risk factor for cardiovascular disease development. Although hypertension in adults and the elderly is more common, adolescent hypertension has increased in the past two decades. Hypertension at an early age affects cognitive performance and increases the risk of cardiovascular diseases and premature death in the future. The risk factors of hypertension are often related to urban populations' unhealthy lifestyles.
Objectives: To investigate the risk factors of hypertension among urban adolescents.
Methods: This case-control study matched by age and sex was conducted between January – July 2021 in Tangerang City, Indonesia, involving 66 adolescents. Blood pressure was measured two times using Omron® automated sphygmomanometer. The BMI defines nutritional status for age. High-sodium food sources, fruit and vegetable, and coffee consumption were assessed using an SQ-FFQ. The statistical analysis used was a Chi-square test (95% CI).
Results: The results show there is a significant relationship between nutritional status [p=0.001, OR (95%CI)= 6.133 (2.111 – 17.824)] and high-sodium food source consumption [p=0.001, OR(95%CI)= 6.824 (1.958 – 23.782)] with hypertension. There is no significant relationship between coffee [p=0.613, OR (95%CI)= 3,200 (0,315 – 32,475)], fruit [p=0.071, OR(95%CI)= 2.604(0.911– 7.445)] and vegetable [p= 0.125, OR(95%CI)= 2.222(0.795 – 6.211)] consumption with hypertension.
Conclusions: Overweight and sodium consumption increases the risk of adolescent hypertension. These factors can be modified and improved by increasing a healthy lifestyle, mainly in the urban. Future strategic interventions addressing adolescents' unhealthy lifestyles (high consumption of fat, sodium, sugar, and low physical activity) should be considered.

INTRODUCTION

Epidemiology transition has been showing a trend of mortality and disease, shifting from infectious to non-communicable diseases[1]. Hypertension is a condition considered one of the indicators that define metabolic syndrome, which could lead to the development of cardiovascular diseases. The global prevalence of hypertension among adults has increased in low and middle-income countries in the past three decades[2] and increased among adolescents in the past two decades[3]. Hypertension in adolescents should be a concern since children's hypertension is related to adult hypertension and lifelong detrimental cardiovascular events[4,5]. Hypertension is also the silent killer, rarely detected before blood pressure identification as it often comes without symptoms[6]. Identification of hypertension at an early age might provide a more strategic intervention to prevent the disabilities.

The risk factors of hypertension are often identified along with the unhealthy lifestyle among the urban population, such as alcohol consumption, stress level, smoking habit, nutritional status, fruit and vegetable consumption, sodium consumption, and coffee consumption. Obesogenic environments and behaviors have contributed to increasing obesity among adolescents. The contribution from marketing and promotion also defined adolescents' motivation to choose unhealthy products[7]. Overweight and obese is a risk factor for obesity as it increases the volume and blood pressure to be pumped to make the supply sufficient for the circulatory need[8]. Obesity also activates the sympathetic nervous system and impairs renal mechanisms toward diuresis[9]. A cup of coffee leads to elevated blood pressure as caffeine increases vasoconstriction and vascular resistance[10,11,12]. Fruit and vegetable consumption lowers the risk of hypertension since potassium, magnesium, vitamin C, folic acid, flavonoid, and carotenoid content improve endothelial function and vasodilation and increase antioxidant activity[13,14]. The abundant study explained the causal effect of high sodium consumption and hypertension. High sodium intake impairs systemic vascular resistance

How to cite: *Nuradina, R. A. A., Lestari, W. A., & Arumsari, I. Overweight and High Sodium Intake Increased Risk of Hypertension among Adolescents: A Case-control Study in Urban Setting: Status Gizi Lebih dan Asupan Natrium Tinggi Meningkatkan Risiko Hipertensi pada Remaja: Studi Kasus-Kontrol di Perkotaan. Amerta Nutrition, 7(2), 274–278.*

and endothelial function and increases ROS production[8,15,16].

According to Indonesia Basic Health Survey, the prevalence of hypertension in Indonesia among people aged≥18 increased by 8.3% in five years[17,18]. A study in Palembang, Indonesia, showed that the prevalence rate of hypertension among adolescents was 8%. It was demonstrated that adulthood blood pressure is related to childhood blood pressure[19]. Therefore, lifestyle intervention to control adulthood hypertension is needed for adolescents. Tangerang City is an industrialized city in Banten Province, Indonesia, one of six Jakarta (the country's capital city) buffer regions. Its geographical and social condition contributes to urban health and nutritional problems. Tangerang Health Profile shows the prevalence of hypertension in people aged ≥15 years is 63.3%[20]. Therefore, this study aims to investigate the risk factors of hypertension among urban adolescents.

METHODS

This study was an analytical observational study using a case-control design. Participants were recruited from Neroktog Urban Communities, Tangerang City, Banten Province, Indonesia. The sample size was estimated for the hypothesis test for estimating the odds ratio. The case and control group ratio was 1:1, with matching by age and sex. The total number of samples was 66, consisting of 33 for the control and 33 for the case. The study applied consecutive sampling with inclusion criteria (1) age 15 - 18 years; (2) Moderate physical activity (GPAQ); (3) Have no family history of hypertension.

Blood pressure was measured two times using Omron® automated blood pressure monitor. The second measurement was started 5-15 minutes after the first measurement. Participants were not allowed to exercise or have a meal 30 minutes before the measurement. Hypertension was defined at ≥120/≥80 mmHg[21]. Nutritional status was measured by calculating the body mass index for age. Body weight and height were measured twice using a digital scale and *microtoise*. High-sodium food sources, fruit and vegetable, and coffee consumption were assessed using Semi-Quantitative Food Frequency Questionnaire (SQ-FFQ). The chi-square test (95% CI) was used for the statistical analysis.

Ethical clearance was obtained from Ethical Committee for Health Studies with the letter 03/21.06/010565, Universitas Muhammadiyah Prof. DR. Hamka. Informed consent was provided to the participants before data collection.

RESULTS AND DISCUSSION

The results show that 32 (48.5%) participants were overweight, 4 (6.1%) participants consumed coffee ≥ 3 cups per day, 42 (53.6%) participants consumed fruit ≤ 1 portion per day, 43 (65.2%) participants consumed vegetable ≤ 1 portion per day, and 46 (69.7%) participants consumed high-sodium food source > 3 times per day.

Table 1. Analysis of hypertension with nutritional status, coffee consumption, fruit and vegetable consumption, and high-sodium food source consumption

Variable	Category	Case		Control		p-value	OR	95% CI	
		n	%	n	%			Lower	Upper
Nutritional Status	Overweight	23	69.7	9	27.3	0.001*	6.13	2.11	17.82
	Normal to underweight	10	30.3	24	72.7				
Coffee consumption (cup/day)	≥ 3	3	9.1	1	3	0.613	3.20	0.31	32.48
	< 3	30	90.9	32	97				
Vegetable consumption (portion/day)	≤ 1	24	72.7	18	54.5	0.125	2.22	0.80	6.21
	≥2	9	27.3	15	45.5				
Fruit consumption (portion/day)	<1	25	75.8	18	54.5	0.071	2.60	0.91	7.44
	≥1	8	24.2	15	45.5				
High-sodium food source Consumption (time/day)	>3	29	87.9	17	51.5	0.001*	6.82	1.96	23.78
	≤3	4	12.1	16	48.5				

*) Indicates significant differences between case and control group analyzed by Chi-square test (95% CI).

Table 1 shows the results of bivariate analysis using the Chi-square test to determine the relation of each variable. Nutritional status was categorized as normal to underweight if the Z-Score (BMI for age) is ≤1 SD and overweight if the Z-Score (BMI for age) is >1 SD - >2SD[22]. The nutritional status and high-sodium food consumption were significantly related to hypertension incidence. Participants who were overweight were 6.13 times more likely to develop hypertension than those who were normal and underweight. Participants who consume high-sodium food sources more than three times a day were 6.13 times more likely to develop hypertension than those who consume less. Coffee consumption was not significantly related to hypertension incidence or vegetable and fruit consumption. The high-sodium food source was related to hypertension incidence with a p-value of 0.001.

This result aligns with previous studies, which also demonstrated the relationship between obesity and hypertension in adolescents in urban and rural[23,24]. It strengthens the point that over-nutrition induced by unhealthy lifestyles is a common problem in rural areas and a challenge in an industrialized urban area like Tangerang City. The present study found that participants also like to consume local high-dense food, such as *mie ayam, bakso, siomay,* variety kinds of fritters, and other high-fat snacks.

Being overweight could elevate blood pressure through several inflammatory, hormonal, and circulatory mechanisms. Obesity impairs essential factors in regulating vascular tones, such as nitric oxide (NO), reactive oxygen species (ROS), endothelin, and RAS. Obesity alters the amount of NO, which causes vascular stress. Adipose tissue also affects blood pressure via the

How to cite: *Nuradina, R. A. A., Lestari, W. A., & Arumsari, I. Overweight and High Sodium Intake Increased Risk of Hypertension among Adolescents: A Case-control Study in Urban Setting: Status Gizi Lebih dan Asupan Natrium Tinggi Meningkatkan Risiko Hipertensi pada Remaja: Studi Kasus-Kontrol di Perkotaan. Amerta Nutrition, 7(2), 274–278.*

regulation of leptin and adiponectin, which is related to arterial tone. Obesity appears conjointly with insulin resistance which also leads to vascular dysfunction[25]. Higher body mass also causes higher volumes of blood pumped in the circulation[26,27].

Coffee consumption might lead to elevated blood pressure because of its caffeine content, even though this condition is differed by the individual caffeine metabolism. Previous studies explained that the results regarding the relationship between caffeine intake and blood pressure are still inconclusive. The present study shows no significant relationship between coffee consumption and hypertension. Coffee consumption among participants is relatively low, and they mostly consumed instant coffee with low caffeine content. This result also aligns with the study conducted in the Paniki Bawah public health center in Manado City, which found no relationship between coffee consumption and hypertension[28].

Caffeine, the dominant compound in coffee, tea, cocoa bean, and energy drink, increase blood pressure by affecting adrenaline and epinephrine, which induce the heart to pump harder to circulate the blood. Aside from its caffeine content, consuming coffee as a sweet beverage might impair insulin sensitivity and increase oxidative stress. A very mixed result on the relation between coffee consumption and hypertension is also related to the genetic profile of cytochrome P450 1A2 (CYP1A2)[29]. Coffee consumption is also related to other unhealthy lifestyles, such as smoking and high sodium consumption. Therefore the development of hypertension might not be caused directly by caffeine consumption but other factors. Besides caffeine, coffee is also rich in potassium and polyphenol. Potassium is known to improve endothelial dysfunction, while chlorogenic acid, the main polyphenol content of coffee, has an antihypertensive effect[30]. These factors could explain why the relationship between coffee consumption and hypertension remains inconclusive.

This study found that habitual fruit and vegetable consumption is still low. The food environment can cause this finding, which is essential in shaping eating behavior. Thus, it is crucial to provide healthy food at school and home[31]. Moreover, adolescents' low fruit and vegetable consumption is related to lower preference and picky eating habits.

The protective effect of fruit and vegetable against cardiovascular diseases has been widely confirmed. Bioactive nutrients in food and vegetable, such as vitamin A, vitamin C, flavonoids, and magnesium, have antioxidant and anti-inflammatory activity[32,33], which can delay hypertension[34]. A healthy fiber-rich diet promotes better health outcomes, although the study results between fiber intake and hypertension are inconclusive. It could be explained that studies that primarily identify the effect of total fiber for all kinds of food sources, not specified by the type, whether it is soluble or insoluble. For example, a study found that fiber from cereals and vegetables is significantly related to a lower risk of hypertension but not fiber from fruit[35].

High-sodium food sources observed in this study are crackers, biscuits, ultra-processed food, canned food, salted fish and seafood, sauce, ketchup, soy sauce, and instant foods. Sodium is vital in regulating fluid balance and is a Renin-Angiotensin-Aldosterone System (RAAS) component. Reducing sodium consumption is beneficial to reduce hypertension risk and the mortality and morbidity caused by cardiovascular diseases. Increased salt consumption results in high fluid retention, thus affect to the high pressure of the artery. High sodium intake is also related to inflammation[17]. Inflammatory cells, T cells, and macrophages infiltrate the kidney and contribute to hypertension[36].

CONCLUSIONS

This study found a significant relationship between nutritional status and high-sodium food consumption with hypertension incidence among adolescents in Neroktog urban communities, Tangerang City, Banten Province, Indonesia. There was no significant relationship between coffee consumption, fruit and vegetable consumption, and hypertension incidence. Fat and sodium consumption increase the risk of hypertension among adolescents. These modifiable factors could be improved by increasing healthy lifestyles, mainly in the urban setting. We recommend a future strategic intervention addressing the unhealthy lifestyle among adolescents (high consumption of fat, sodium, sugar, and low physical activity), which should be considered.

ACKNOWLEDGEMENT

Acknowledgments to the respondents, the teaching staff of the nutrition study program at the Universitas Muhammadiyah Prof. DR. HAMKA, and relatives who have also supported writing this article.

Conflict of Interest and Funding Disclosure

The authors declare there is no conflict of interest. This research was funded independently by the authors.

REFERENCES

1. Shaumi, N. R. F. & Achmad, E. K. Kajian Literatur: Faktor Risiko Hipertensi pada Remaja di Indonesia. *Media Penelit. dan Pengemb. Kesehat.* **29**, 115–122 (2019).
2. Zhou, B. *et al.* Worldwide Trends in Hypertension Prevalence and Progress in Treatment and Control from 1990 to 2019: A Pooled Analysis of 1201 Population-Representative Studies with 104 Million Participants. *Lancet* **398**, 957–980 (2021).
3. Song, P. *et al.* Global Prevalence of Hypertension in Children: A Systematic Review and Meta-analysis. *JAMA Pediatr.* **173**, 1154–1163 (2019).
4. Sommer, A. & Twig, G. The Impact of Childhood and Adolescent Obesity on Cardiovascular Risk in Adulthood: a Systematic Review. *Curr. Diab. Rep.* **18**, (2018).
5. Saing, J. H. Hipertensi pada Remaja. *Sari Pediatr.* **6**, 159 (2016).
6. Bintari Fajar, K., Suyatno & Kartasurya, M. I.

How to cite: *Nuradina, R. A. A., Lestari, W. A., & Arumsari, I. Overweight and High Sodium Intake Increased Risk of Hypertension among Adolescents: A Case-control Study in Urban Setting: Status Gizi Lebih dan Asupan Natrium Tinggi Meningkatkan Risiko Hipertensi pada Remaja: Studi Kasus-Kontrol di Perkotaan. Amerta Nutrition, 7(2), 274–278.*

Faktor Risiko Kejadian Hipertensi pada Siswa SMA di Kota Semarang Tahun 2016. *J. Kesehat. Masy.* **5**, 70–77 (2017).

7. Fauzi, R., Arumsari, I., Maruf, M. A., & Ahsan, A. Association of Tobacco Advertising, Promotion, and Sponsorship (TAPS) Exposure on Smoking Intention and Current Smoking Behavior among Youth in Indonesia. *Journal of Substance Use*, **1-7** (2022).
8. Widyartha, I. M. J., Putra, I. W. G. A. E. & Ani, L. S. Riwayat Keluarga, Stres, Aktivitas Fisik Ringan, Obesitas dan Konsumsi Makanan Asin Berlebihan Sebagai Faktor Risiko Hipertensi. *Public Heal. Prev. Med. Arch.* **4**, 148 (2016).
9. Chrysant, S. G. Pathophysiology and Treatment of Obesity-Related Hypertension. *J. Clin. Hypertens.* **21**, 555–559 (2019).
10. Zhang, Z., Hu, G., Caballero, B., Appel, L. & Chen, L. Habitual Coffee Consumption and Risk of Hypertension: A Systematic Review and Meta-Analysis of Prospective Observational Studies. *Am. J. Clin. Nutr.* **93**, 1212–1219 (2011).
11. Bistara, D. N. & Kartini, Y. Hubungan Kebiasaan Mengkonsumsi Kopi dengan Tekanan Darah Pada Dewasa Muda. *J. Kesehat. Vokasional* **3**, 23 (2018).
12. Ngueta, G. Caffeine and Caffeine Metabolites in Relation to Hypertension in US Adults. *Eur. J. Clin. Nutr.* **74**, 77–86 (2020).
13. Li, B., Li, F., Wang, L. & Zhang, D. Fruit and Vegetables Consumption and Risk of Hypertension: A Meta-Analysis. *J. Clin. Hypertens.* **18**, 468–476 (2016).
14. Suryani, N., Noviana & Libri, O. Hubungan Status Gizi, Aktivitas Fisik, Konsumsi Buah dan Sayur dengan Kejadian Hipertensi di Poliklinik Penyakit Dalam RSD Idaman Kota Banjarbaru. *J. Kesehat. Indones. (The Indones. J. Heal.* **X**, p101 (2020).
15. NST, E. R. W. Hubungan Asupan Natrium dengan Kejadian Hipertensi di UPT Pelayanan Sosial Lanjut Usia Binjai Tahun 2014. (Skripsi. Fakultas Kesehatan. Universitas Sumatera Utara Medan, 2015).
16. Grillo, A., Salvi, L., Coruzzi, P., Salvi, P. & Parati, G. Sodium Intake and Hypertension. *Nutrients* **11**, 1–16 (2019).
17. Ministry of Health of Indonesia. *Hasil Utama Riskesdas 2013*. *Kemenkes RI* (2013) doi:10.1517/13543784.7.5.803.
18. Ministry of Health of Indonesia. *Hasil Utama RISKESDAS 2018*. *Kementrian Kesehatan Republik Indonesia* (2018).
19. Bao, W., Threefoot, S. A., Srinivasan, S. R., & Berenson, G. S. Essential Hypertension Predicted by Tracking of Elevated Blood Pressure from Childhood to Adulthood: the Bogalusa Heart Study. *American journal of hypertension*, ***8*** (7), 657-665 (1995).
20. Tangerang City Health Office, Indonesia. *Profil Kesehatan Kota Tangerang Tahun 2019*. (2020).
21. JNC7. *The Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure*. *US Department Of Health and Human Services* (2004) doi:10.1097/00001573-199903000-00014.
22. Ministry of Health of Indonesia. *Pedoman Pengendalian Faktor Resiko Penyakit Jantung dan Pembuluh Darah Edisi I*. (Ditjen PP & PL, 2011).
23. Angesti, A. N., Triyanti, T. & Sartika, R. A. D. Riwayat Hipertensi Keluarga Sebagai Faktor Dominan Hipertensi pada Remaja Kelas XI SMA Sejahtera 1 Depok Tahun 2017. *Bul. Penelit. Kesehat.* **46**, 1–10 (2018).
24. Yolanda, R., DR. IR. Irianton Aritonang, M. & dr. Emy Huriyati, M. K. Asupan Zat Gizi (Energi, Protein, Lemak) dan Status Gizi Terhadap Hipertensi Pada Remaja SMA di Kota Yogyakarta. (Universitas Gadjah Mada, 2015).
25. Seravalle, G. & Grassi, G. Obesity and hypertension. *Pharmacol. Res.* **122**, 1–7 (2017).
26. Ramadhani, E. T. & Sulistyorini, Y. Hubungan Kasus Obesitas dengan Hipertensi di Provinsi Jawa Timur Tahun 2015-2016. *J. Berk. Epidemiol.* **6**, 35–42 (2018).
27. Yulyius, Bolang, A. S. L. & Kawengian, S. E. S. Hubungan Antara Status Gizi dengan Tekanan Darah Mahasiswa Program Studi Pendidikan Dokter Angkatan 2013 Fakultas Kedokteran Universitas Sam Ratulangi. *J. e-Biomedik* **2**, (2014).
28. Mullo, O. E., Langi, F. L. F. G. & Asrifuddin, A. Hubungan Antara Kebiasaan Minum Kopi dengan Kejadian Hipertensi di Wilayah Kerja Puskesmas Paniki Bawah Kota Manado. *KESMAS* **7**, 1–9 (2018).
29. Gaeini, Z., Bahadoran, Z., Mirmiran, P. & Azizi, F. Tea, Coffee, Caffeine Intake and The Risk of Cardio-Metabolic Outcomes: Findings From a Population With Low Coffee and High Tea Consumption. *Nutr. Metab.* **16**, 1–10 (2019).
30. Chei, C.-L., Loh, J. K., Soh, A., Yuan, J.-M. & Koh, W.-P. Coffee, Tea, Caffeine, and Risk of Hypertension: The Singapore Chinese Health Study. *Eur. J. Nutr.* **57**, 1333–1342 (2018).
31. Lestari, A. Faktor-faktor yang Berhubungan dengan Perilaku Konsumsi Buah dan Sayur pada Siswa SMPN 226 Jakarta Selatan Tahun 2012. *FKIK UIN* (UIN Syarif Hidayatullah, 2013).

How to cite: *Nuradina, R. A. A., Lestari, W. A., & Arumsari, I. Overweight and High Sodium Intake Increased Risk of Hypertension among Adolescents: A Case-control Study in Urban Setting: Status Gizi Lebih dan Asupan Natrium Tinggi Meningkatkan Risiko Hipertensi pada Remaja: Studi Kasus-Kontrol di Perkotaan. Amerta Nutrition, 7(2), 274–278.*

32. Arumsari, I., Mäkynen, K., Adisakwattana, S. & Ngamukote, S. Effects of Different Cooking Methods and Palm Oil Addition on the Bioaccessibility of Beta-Carotene of Sweet Leaf (Sauropus androgynous). *J. Nutr. Sci. Vitaminol. (Tokyo).* **66**, S202–S205 (2020).
33. Sarker, U. & Oba, S. Response of Nutrients, Minerals, Antioxidant Leaf Pigments, Vitamins, Polyphenol, Flavonoid and Antioxidant Activity in Selected Vegetable Amaranth Under Four Soil Water Content. *Food Chem.* **252**, 72–83 (2018).
34. Yuan, S. *et al.* Fat Intake and Hypertension Among Adults in China: The Modifying Effects of Fruit and Vegetable Intake. **2**, 294–301 (2019).
35. Sun, B., Shi, X., Wang, T. & Zhang, D. Exploration of the Association Between Dietary Fiber Intake and Hypertension among US Adults Using 2017 American College of Cardiology/American Heart Association Blood Pressure Guidelines: Nhanes 2007–2014. *Nutrients* **10**, 1–11 (2018).
36. Kirabo, A. A New Paradigm of Sodium Regulation in Inflammation and Hypertension. *Am. J. Physiol. - Regul. Integr. Comp. Physiol.* **313**, R706–R710 (2017).

How to cite: *Nuradina, R. A. A., Lestari, W. A., & Arumsari, I. Overweight and High Sodium Intake Increased Risk of Hypertension among Adolescents: A Case-control Study in Urban Setting: Status Gizi Lebih dan Asupan Natrium Tinggi Meningkatkan Risiko Hipertensi pada Remaja: Studi Kasus-Kontrol di Perkotaan. Amerta Nutrition, 7(2), 274–278.*