Original Article

Althea Medical Journal
ISSN Online: 2337-4330
https://doi.org/10.15850/amj.v12n3.4189

Overnutrition Status Is Associated with Elevated Blood Pressure among Adolescents in Central Jakarta, Indonesia

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Abstract

Background: Overweight and obesity are rising among Indonesian adolescents and are known risk factors for hypertension. This study aimed to examine the relationship between overnutrition status and blood pressure among adolescents.

Methods: A cross-sectional study was conducted from May to September 2024 among overweight and obese adolescents aged 12–16 years in Central Jakarta, Indonesia. Nutritional status was determined by body mass index (BMI) Z-scores based on CDC growth charts, adjusted for sex and age. Blood pressure was measured using a digital sphygmomanometer and classified according to the 2017 American Academy of Pediatrics (AAP) guidelines. Data were analyzed using chi-square tests.

Results: A total of 98 adolescents participated (67.3% male; mean age 13 years). Overweight (49%) and obesity (51%) were almost equally distributed, with the highest BMI recorded at 46.7 kg/m^2. More than half (58.2%) had elevated blood pressure, with one case reaching grade 2 hypertension (143/84 mmHg). Overnutrition status was significantly associated with elevated blood pressure (p=0.044). Stratified analysis showed a strong association among males (p=0.005), where 42.4% of obese males exhibited elevated blood pressure, but no significant association was observed among females (p=0.58).

Conclusions: Overnutrition status is significantly associated with elevated blood pressure among adolescents, particularly in males. Early interventions promoting balanced nutrition, physical activity, and healthy lifestyle habits are critical to reducing the long-term cardiovascular risk in this age group.

Keywords: Adolescents, blood pressure, overnutrition status, overweight, obesity

Althea Medical Journal.
2025;12(3):191–196

Received: January 3, 2025
Accepted: September 4, 2025
Published: September 30, 2025

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Introduction

Elevated blood pressure in adolescents is triggered by various factors, with overnutrition, including overweight and obesity being one of the most prevalent.[1] The global prevalence of blood pressure above normal thresholds has steadily increased among adolescents.[2] In Indonesia, the 2018 Basic Health Survey (*Riset Kesehatan Dasar*, RISKESDAS) reported a combined prevalence of overweight and obesity of 34.1%.[3] Moreover, a study in 2017 showed a higher prevalence of hypertension among adolescents in Central Jakarta (9.6%) compared to 2013 (8.7%).[4] Hypertension in this age group is influenced by physical inactivity, unhealthy dietary habits, stress, genetic predisposition, and obesity.[5,6]

The prevalence of obesity to rise globally.[5] National data has shown a similar trend in Indonesia, with North Sulawesi exhibiting the highest rate (30.2%), followed by Jakarta, the

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Table 1 American Academy of Pediatrics (AAP) 2017 Blood Pressure Classification in Children and Adolescents[9]

Category	Age 1 – <13 years	Age ≥13 years
Normal	Systolic and diastolic < 90th percentile	<120 / <80 mmHg
Pre-hypertension	Systolic and diastolic ≥ 90th to <95th percentile OR 120/80 mmHg up to <95th percentile (whichever is lower)	120 / <80 – 129 / 80 mmHg
Hypertension grade I	Systolic and diastolic ≥ 95th to <95th + 12 mmHg OR blood pressure 130/80 – 139/89 mmHg (whichever is lower)	130/80 – 139/89 mmHg
Hypertension grade II	Systolic and diastolic ≥ 95th percentile + 12 mmHg OR ≥140/90 mmHg (whichever is lower)	≥140 / 90 mmHg

capital city of Indonesia and East Kalimantan. In Central Jakarta specifically, the prevalence of obesity among adolescents aged 13–15 years is 20.6%, whereas in those aged 16–18 years is 12.64%. Several behavioral and environmental factors contribute to these patterns, including frequent fast-food consumption, insufficient physical activity, inadequate intake of fruits and vegetables, and socio-economic status of the family.[7]

Overnutrition in adolescents might be related to the development of hypertension. Excessive accumulation of adipose tissue contributes to endothelial dysfunction, increase cardiac workload, and disrupt hormonal balance and kidney function.8 These mechanisms may elevate blood pressure beyond normal levels. Therefore, this study aimed to examine the relationship between overnutrition status and blood pressure among adolescents in Jakarta, Indonesia.

Methods

This study employed a descriptive observational design with a cross-sectional approach, using consecutive sampling. Data were collected between May and September 2024 from. junior high and high school students aged 12–16 years in Central Jakarta, Indonesia. Participants were included if they were overweight or obese as defined by the CDC weight classification adjusted for age and sex. Written informed consent was obtained from parents prior to participation. The exclusion criteria were those who were currently taking certain medications, such as antihypertensive drugs, corticosteroids, insulin, or antihistamines, had kidney disease, adrenocortical tumor disease, or adrenomedullary tumors.

Ethical approval for this study was granted by the Research Ethics Commission of School of Medicine and Health Sciences Atma Jaya

Table 2 Distribution of Body Mass index and Blood Pressure among Participants (n=98)

Variable	Frequency	Percentage (%)
Gender		
Male	66	67.3
Female	32	32.7
Body mass index (average, kg/m^2)	26.8	
Male		
Overweight	28	42.4
Obesity	38	57.6
Female		
Overweight	20	62.5
Obesity	12	37.5
Blood Pressure (average, mmHg)	123.79 / 76.46	
Normal	41	41.8
Above normal limits*	57	58.2

Note. * Above normal limits = systolic and/or diastolic ≥ 90th percentile (AAP 2017)

Table 3 Relationship Between Overnutrition Status and Blood Pressure in Adolescents (n=98)

Blood Pressure	Body Mass Index						p-value
	Overweight		Obesity		Total		
	n	%	n	%	n	%	
Normal	25	25.5	16	16.3	41	41.8	0.044
Above normal limits*	23	23.5	34	34.7	57	58.2	
Total	48	49	50	51	98	100	

Note. * Above normal limits= systolic and/or diastolic ≥ 90th percentile (AAP 2017).

Catholic University of Indonesia (clearance number 07/04/KEP-FKIKUAJ/2024). Furthermore, research permits were also obtained from the Dean of the School of Medicine and Health Sciences Atma Jaya Catholic University of Indonesia and formally addressed to the participating school. Additionally, informed consent forms signed by parents confirmed the voluntary participation of each adolescent.

Nutritional status was assessed using body mass index (BMI), calculated from weight and height, and interpreted according to the CDC growth charts adjusted for age and gender. Blood pressure was measured using a digital sphygmomanometer and classified based on the 2017 American Academy of Pediatrics (AAP) guidelines for individuals aged 12–16 years (Table 1).[9]

Data analysis included univariate methods to describe variable distributions and chi-square test for bivariate analysis to assess the relationship between overnutrition status and blood pressure. A significance level of $p<0.05$ was applied.

Results

In total, 98 overweight and obese students were included in this study, with the majority being male (n=66; 67.3%). The mean age of the respondents was 13 years. Based on BMI classification, 48 students (49%) were overweight, and 50 students (51%) were obese, with the highest recorded BMI being 46.7 kg/m^2.

More than half of the students (n=57; 58.2%) had blood pressure values above the normal range according to the 2017 AAP classification, with the highest recorded blood pressure being 143/84 mmHg (grade II hypertension). A significant association

Table 4 Relationship between Overnutrition Status and Blood Pressure in Male Students (n=66)

Blood Pressure	Body Mass Index						P-Value
	Overweight		Obesity		Total		
	n	%	n	%	n	%	
Normal	17	25.8	10	15.2	27	40.9	0.005
Above normal limits*	11	16.7	28	42.4	39	59.1	
Total	28	42.4	38	57.6	66	100	

Note. * Above normal limits = systolic and/or diastolic ≥ 90th percentile (AAP 2017).

Table 5 Relationship between Overnutrition Status and Blood Pressure in Female Students (n=32)

Blood Pressure	Body Mass Index						P-Value
	Overweight		Obesity		Total		
	n	%	n	%	n	%	
Normal	8	25	6	18.8	14	43.8	0.58
Above normal limits*	12	37.5	6	18.8	18	56.3	
Total	20	62.5	12	37.5	32	100	

Note. * Above normal limits = systolic and/or diastolic ≥ 90th percentile (AAP 2017).

was observed between overnutrition status and elevated blood pressure (p=0.044). Among obese students (51%), a substantial proportion (34.7%) exhibited blood pressure values above normal limit (systolic and/or diastolic ≥90th percentile) (Table 2).

Further subgroup analysis showed a significant association between overnutrition status and elevated blood pressure among male respondents (p=0.005). Specifically, of the 38 (57.6%) obese male respondents, 28 (42.4%) had elevated blood pressure (Table 3).

Conversely, the association between overnutrition status and blood pressure among female adolescents was not statistically significant (p=0.58). Although 56.3% of female respondents had blood pressure values above the normal range, no significant differences were observed between overweight and obese groups (Table 5).

Discussion

This study has identified a significant relationship between overnutrition status and elevated blood pressure among adolescents in Central Jakarta, consistent with findings from other regions in Indonesia.[8] Similar associations between overweight or obesity and the prevalence of hypertension in adolescents have also been reported globally.[10,11] Factors contributing to overweight at this age include excessive caloric intake from fast foods, inadequate consumption of fruits and vegetables, and low levels of physical activity.[12,13] Collectively, these lifestyle patterns contribute to increased systolic and diastolic blood pressure.[14]

The findings support existing evidence that excess adiposity elevates hypertension risk.[15] Excessive fat accumulation promotes vascular deposition of LDL and VLDL cholesterol, secretion of adipokines that increase fluid retention and vasoconstriction, and development of insulin resistance, which enhances sympathetic nervous system activity.[5] These mechanisms synergistically elevate blood pressure.

Variations in school environment, dietary patterns, socioeconomic background, and lifestyle factors may also explain disparities in nutritional status. For example, some studies report higher overweight and obesity prevalence in public schools compared with private schools, partly due to lower access to balanced diets and greater exposure to high-calorie foods. Conversely, other research found no such differences, highlighting the potential influence of regional and cultural factors.[16,17]

This study further demonstrated a sex-specific difference. A significant relationship between overnutrition status and blood pressure has been observed among male students, whereas no such association has been found in females. This may reflect physiological differences during puberty. In females, rising estrogen levels during puberty not only support reproductive development but also provide vascular protection, preserving endothelial function and vascular tone, thereby mitigating blood pressure increases. In males, testosterone stimulates epinephrine, norepinephrine, and renin activity, enhancing angiotensin II production.[18,19] These neurohormonal changes promote vasoconstriction, increase peripheral vascular resistance, and elevate blood pressure.

Nevertheless, obesity remains a major determinant of elevated blood pressure across both sexes. Excessive adipose tissue increases leptin secretion, which activates the hypothalamic–sympathetic pathway, contributing to vasoconstriction and greater peripheral resistance. This mechanism explains why overweight and obese adolescents are more likely to present with elevated systolic and diastolic blood pressure compared to peers with normal weight, regardless of pubertal stage.[20,21]

A limitation of this study is that this study did not evaluate additional variables influencing both overnutrition and blood pressure, such as detailed dietary patterns, physical activity, or psychosocial stressors. These factors may confound or mediate the observed associations. Future research should integrate these elements to provide a more comprehensive understanding of blood pressure regulation in adolescents.

In conclusion, this study demonstrates that higher nutritional status is significantly associated with elevated blood pressure in adolescents, particularly among males. These findings emphasize the importance of adopting healthy lifestyles from an early age, including regular physical activity, balanced nutrition, and avoidance of unhealthy dietary habits. Promoting such behaviors is essential to prevent overnutrition and its cardiovascular consequences in adolescence and beyond.

Acknowledgment
The researcher extends gratitude to Atma Jaya Catholic University of Indonesia and the schools in Central Jakarta for providing

the facilities and opportunities necessary to conduct the research.

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