

Determinants of Adolescent Hypertension: Dietary Pattern and Gender Differences in Urban

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Abstract: Hypertension in adolescents is a global concern because it has the potential to continue into adulthood and increase the risk of cardiovascular disease. Lifestyle changes and consumption patterns high in sugar, salt, fat, and ultra-processed foods (UPF) contribute to increased blood pressure at a young age. This study aims to analyze the relationship between gender, nutritional status, and dietary patterns with blood pressure status among secondary school adolescents in urban areas of Indonesia. An analytical observational study with a cross-sectional design was conducted on 167 students aged 15–18 years. Data were collected through a Food Frequency Questionnaire (FFQ), anthropometric measurements, and blood pressure measurements. Analysis was performed using the Chi-square test with a significance level of $p < 0.05$.

The Results of this research showed that

The prevalence of hypertension was 14.4% and overweight was 13.2%. Only gender was significantly associated with blood pressure ($p = 0.021$), with a higher proportion of hypertension in males (20.7%) than females (8.2%). No significant association was found between consumption patterns (sweet foods, salt, fat, UPF, sweetened beverages) and blood pressure ($p > 0.05$).

The Conclusion is that hypertension among adolescents is high and more prevalent in males. Although dietary patterns did not show a significant association, the high prevalence of UPF and sweetened beverage consumption indicates the need for nutritional interventions and early blood pressure screening in schools to prevent hypertension from an early age.

Keywords: Adolescents, hypertension, dietary patterns, BMI

Introduction

Hypertension is one of the leading causes of global morbidity and mortality, and although it is generally considered a disease of adults, recent evidence shows that high blood pressure is also found in children and adolescents. A global meta-analysis found that the prevalence of hypertension in those aged ≤ 19 years reached approximately 4.0% (95% CI, 3.29-4.78%) and “pre-hypertension” approximately 9.7% (95% CI, 7.26-12.38%) in the global population of children and adolescents (Song et al., 2019).

The literature shows several relationships between these variables, Gender, nutritional status. Gender that divided by and female, study show that males tend to have higher blood pressure than females during adolescence, which may be related to biological factors (e.g., sex hormones) and lifestyle behavior.

Nutritional status (overweight/obesity): Overweight in adolescents has been shown to be an important risk factor for hypertension through mechanisms such as insulin resistance, increased sympathetic activity, and vascular inflammation. Example: A recent review noted that hypertension and obesity often co-occur in adolescents (Chhabria et al., 2024).

Dietary patterns (salt, sugar, fat, UPF): High salt intake has been directly linked to increased blood pressure in adolescents and children. For example, one study measured sodium intake from snacks and found

a correlation with blood pressure values in adolescents. Meanwhile, UPF consumption in general also shows a correlation with blood pressure and poor cardiometabolic factors in young people (Zhang et al., 2022).

This condition confirms that adolescents are a relevant population group in cardiovascular disease prevention efforts long before adulthood. In addition, lifestyle factors such as high consumption of sugar, salt, fat, and ultra-processed foods (UPF) are showing an upward trend, especially in middle-income countries such as Indonesia. A systematic review shows that UPF consumption is consistently associated with blood pressure and hypertension (positive association) in children and adults (Barbosa et al., 2022)

Therefore, changes in adolescent dietary patterns—from traditional foods to fast food and processed products—are a major concern in public health. This study aims to describe the characteristics of food consumption patterns (sweet foods, salt, fat, ultra-processed foods, sweetened beverages) among school-aged adolescents and also to analyze the relationship between gender, nutritional status (overweight/BMI), and food consumption patterns with blood pressure status (hypertension) among school adolescents.

The research is important because it provides local evidence that can be used as a basis for public health interventions in secondary schools—especially in countries such as Indonesia, which are undergoing rapid nutritional and lifestyle transitions. These findings can form the basis for early blood pressure screening programs, adolescent diet education, and policies to reduce sugar, salt, and processed food consumption. Thus, this research contributes to strengthening cardiovascular disease prevention strategies from a young age and supports efforts to achieve global health targets.

Methods

This study used an analytical observational design with a cross-sectional approach. This design was chosen to describe the relationship between food consumption patterns (independent) and blood pressure status (dependent) in adolescents.

The study was conducted from May to August 2024 at a senior high school in West Aceh. The location was selected purposively, considering ease of access, the school's involvement in the School Health Program (UKS), and the availability of student nutrition data.

The target population is all high school students aged 15–18 years. The minimum sample size was calculated using the formula for two population proportions with a 95% confidence level and 80% power, resulting in a minimum of 150 respondents. After adjusting for a possible 10% non-response rate, the total sample for this study was 167 respondents.

Independent variable is hypertension and the dependent variable are Sex, Body Mass Index (BMI), Sugar consumption, Salt Consumption, Fat Consumption, Ultra Processed Food (UPF) Consumption, and sweet drink consumption. Data analysis used univariate and bivariate by SPSS for describe the characteristic respondents and the correlation between the independent and dependents variable.

Results

The results of the nutritional status assessment in the form of body mass index of 40 respondents and the results of food recal analysis in the form of carbohydrate, fat, and fiber nutrient variables can be seen in the table below.

Table 1. characteristic of responden

Variabel	Kategori	n	%
Sex	Female	85	50,9
	Male	82	49,1
BMI Status	Overweight	22	13,2
	Not overweight	145	86,8
Blood Pressure	High	24	14,4
	Not High	143	85,6
Sugar consumption	High	55	32,9
	Not High	112	67,1
Salt consumption	High	43	25,7
	Not High	124	74,3
Fat consumption	High	85	50,9
	Not High	82	49,1
UPF (ultra-processed food) consumption	High	84	50,3
	Not High	83	49,7
Sweetened beverage consumption	High	84	50,3
	Not High	83	49,7

(data primer, 2024)

Table 1 above shows that the rate of overweight in the study sample was 25%, and the risk of excessive carbohydrate and fat consumption was 50% each. This study shows that the rate of overweight is already quite high even in small community groups and needs to be a concern. Likewise, for the macronutrient consumption patterns surveyed, the majority of respondents tended to exceed daily requirements.

Table 2. Correlation Hypertension and characteritic respondents

Variabel	Kategori	Tekanan Darah Tinggi n (%)	Tekanan Darah Tidak Tinggi n (%)	p-value (Chi-square)
Sex	Female	7 (8,2)	78 (91,8)	0.021*
	Male	17 (20,7)	65 (79,3)	
BMI Status	Overweight	6 (27,3)	16 (72,7)	0.064
	Not overweight	18 (12,4)	127 (87,6)	
Sugar consumption	High	8 (14,5)	47 (85,5)	0.964
	Not High	16 (14,3)	96 (85,7)	
Salt consumption	High	6 (14,0)	37 (86,0)	0.928
	Not High	18 (14,5)	106 (85,5)	
Fat consumption	High	13 (15,3)	72 (84,7)	0.729
	Not High	11 (13,4)	71 (86,6)	
UPF (ultra-processed food) consumption	High	13 (15,5)	71 (84,5)	0.682
	Not High	11 (13,3)	72 (86,7)	
Sweetened beverage consumption	High	13 (15,5)	71 (84,5)	0.682

Not High	11 (13,3)	72 (86,7)
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Discussion

This study found that 14.4% of adolescent respondents had high blood pressure, while 13.2% were classified as overweight. The relatively high proportion of hypertension in this young age group confirms the trend of increasing cardiovascular risk burden from adolescence reported in international and national literature. Globally, surveys and meta-analyses show that the prevalence of hypertension in children and adolescents is not trivial—estimates of the prevalence of “occasional” hypertension reach around 12% in some syntheses of evidence (Ruan et al., 2025).

The finding that gender (male) is significantly associated with hypertension is consistent with evidence reporting biological and behavioral differences between men and women related to blood pressure regulation (e.g., the role of androgens, RAAS response, differences in physical activity patterns, and dietary habits). These biological and behavioral mechanisms have been discussed in recent reviews (Drury et al., 2024).

The results showed that male adolescents had a higher prevalence of hypertension than females ($p = 0.021$). This finding is consistent with the literature, which states that boys have higher blood pressure values and a higher prevalence of hypertension than girls at a young age. For example, a study in Korea found that “boys tend to have higher BP (Blood Pressure) values and more prevalent hypertension than girls (Kim et al., 2022).

The variables of consumption of sweet foods, salt, fat, UPF, and sweetened beverages did not show a significant relationship with hypertension in the bivariate analysis

Evidence shows that sodium intake is positively associated with blood pressure in children and adolescents: a meta-analysis found that each additional 1 g of sodium/day was associated with an increase of ~0.8 mmHg for SBP and ~0.7 mmHg for Diastolic Blood Pressure in children/adolescents (Leyvraz et al., 2018). Review studies also show that in obese children, sodium sensitivity to blood pressure is higher (Wójcik & Koziol-Kozakowska, 2021). Methodological factors: the use of FFQs to assess consumption may not be sensitive enough to capture real variations between individuals. Studies also show that sodium measurements using FFQs or recall are less reliable than 24-hour urine excretion.

Long-term cumulative effects: the relationship between unhealthy diets and hypertension often requires years of exposure, so it may not be apparent in cross-sectional studies of adolescents. Although not significant, the average scores for UPF consumption (134.2) and sweetened beverages (116.1) in this study indicate that heavy consumption patterns already exist—which justifies nutritional intervention, even though this analysis did not find a statistically significant association.

Recent meta-analyses and reviews indicate that consumption of ultra-processed foods (UPF) is associated with an increased risk of cardiometabolic diseases, including hypertension, in adult populations, and there is growing evidence in children/adolescents that exposure to UPF is associated with adverse cardiometabolic parameters. However, many of these studies are cohort/prospective or ecological in nature; implications for cross-sectional data in adolescents should be interpreted with caution (Lane et al., 2024).

In Indonesia, adolescent population studies have also reported an increase in the prevalence of high blood pressure and related risk factors (BMI, physical activity, family history). The findings of this study (prevalence of ~14.4% of adolescent hypertension) are slightly higher than some national adolescent surveys—however, comparisons must take into account differences in definitions, age ranges, and measurement methods (Kurnianto et al., 2020).

Although the relationship between overweight and hypertension in this study was not significant ($p = 0.064$), the direction of the relationship was consistent: there was more hypertension in the overweight group (27.3%) than in the non-overweight group (12.4%). This is consistent with a literature review showing that obesity/overweight is an important risk factor for hypertension in children and adolescent particularly through the mechanisms of insulin resistance, sympathetic activation, and vascular inflammation (Wójcik & Koziol-Kozakowska, 2021)

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