JIKM. 2025; 17 (1): 52-63
DOI: https://doi.org/10.52022/jikm.v17i1.783
p-ISSN: 2085-4366, e-ISSN: 2684-950X



# Prevalence and Factors Associated with Hypertension among Adolescents in Peri-Urban Areas

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***Abstract***

***Background:*** *Hypertension in adolescents is becoming an increasingly important health issue because it can continue into adulthood and increase the risk of cardiovascular disease later in life. The purpose of this study was to determine the prevalence of hypertension and pre-hypertension and to analyze the related factors in adolescents in peri-urban areas.*

***Methods:*** *This study used a cross-sectional design conducted in October 2023 on 40 Christian Junior High School 4 Mebung students in Alor Regency. The sample selection was purposive, with inclusion criteria of 13–16 years old. Data were collected using structured questionnaires, interviews, and blood pressure measurements. Blood pressure was measured three times to ensure the accuracy of the measurement results. Data analysis included univariate analysis to describe the characteristics of the respondents and chi-square test to assess the relationship between independent variables (sodium intake, physical activity, parental history of hypertension, sleep duration, sleep quality, and stress) with hypertension status.*

***Results:*** *Pre-hypertension prevalence was 30%, and hypertension was 20%. Three factors showed a significant relationship with hypertension: a history of hypertension in the father (p-value = 0.038), high sodium intake (p-value = 0.002), and sleep duration of less than 8 hours (p-value = 0.001). Other factors, such as a history of hypertension in the mother, physical activity, sleep disorders, and stress, did not show a significant relationship.*

***Conclusion:*** *Hypertension in adolescents in peri-urban areas is related to genetic factors and lifestyle behavior. Prevention efforts need to be focused on low-sodium nutritional education, adequate sleep management, and routine blood pressure screening in schools.*

***Keywords:*** *Adolescent hypertension, Family history, Peri-urban, Sleep duration, Sodium intake*

## INTRODUCTION

Non-communicable diseases (NCDs) are currently the leading cause of death globally, including in developing countries where the burden of disease has shifted from infectious diseases to non-communicable conditions.[1] NCDs now account for 41 million deaths annually, representing nearly 7 out of 10 deaths worldwide. The majority of these deaths are caused by cardiovascular diseases, which affect all age groups, countries, and geographic regions.[2] Hypertension is a major contributor to cardiovascular disease and premature mortality worldwide. Its prevalence continues to rise, particularly in low and middle-income countries. Estimates indicate that 31.1% of adults, or approximately 1.39 billion people globally, suffer from hypertension.[3] Variations in risk factors, such as high sodium intake, unhealthy diets, obesity, alcohol consumption, and physical inactivity, contribute to regional heterogeneity in hypertension prevalence. Despite the increasing prevalence, awareness, treatment, and healthcare-seeking behavior, blood pressure control remains low, especially in developing countries.[4]

Hypertension, or high blood pressure, is a systolic blood pressure exceeding 140 mmHg and/or a diastolic pressure over 90 mmHg on two separate measurements. Prolonged elevation in blood pressure increases the risk of kidney, heart, and brain damage if not detected early.[5] Hypertension is

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Received: April 3, 2025
Accepted: May 17, 2025
Published: May 19, 2025

now increasingly identified not only in adults but also in adolescents. This is concerning, as adolescent hypertension can persist into adulthood and significantly increase morbidity and mortality risks. Although less common than in adults, substantial evidence indicates that adult hypertension often originates during childhood and adolescence.[6]

Blood pressure during childhood serves as a strong predictor of adult blood pressure. The estimated prevalence of hypertension among children is approximately 1–2% in developed countries. A study conducted in the United States found a significant rise in systolic and diastolic blood pressure among youth, due to various contributing factors.[7] In Indonesia, it is reported that one in ten adolescents and young adults suffer from hypertension, with adolescent hypertension rates of 8% and 12%, respectively.[8]

According to the 2018 Indonesia Basic Health Research survey, the number of hypertension cases in East Nusa Tenggara Province reached 76,130, representing approximately 7.2% of the total population.[9] More recent data from Oebobo indicate a hypertension prevalence of 10.1% among adolescents aged ≥15 years, with an estimated 19,474 adolescents affected.[10] This figure is projected to rise, contributing to the growing burden of adult hypertension.

Although adult hypertension has long been recognized as a public health concern, childhood and adolescent hypertension often receive less attention. Elevated blood pressure in children frequently goes undiagnosed. While blood pressure measurement is a routine vital sign in adult health assessments, it is rarely performed in children and adolescents. The diagnosis of hypertension in children is complex, as normal blood pressure values in children and adolescents vary. They depend on age, gender, and height percentile.[11] This complexity contributes to a significant underdiagnosis of both hypertension and prehypertension in the pediatric population.[12]

Adolescent hypertension is a multifactorial health problem influenced by environmental and genetic factors. If left untreated, early-onset hypertension can lead to serious long-term health consequences, including physiological disturbances that increase the risk of complications such as stroke.[13] Given this age group's often asymptomatic nature of high blood pressure, early detection through systematic screening is critical. Routine blood pressure screening in schools allows for proper identification of individuals at risk so that early intervention strategies can be put in place, which may include lifestyle modifications and clinical monitoring to prevent disease progression.[14]

Mebung is classified as a peri-urban area, a transitional area between rural and urban areas undergoing simultaneous spatial, social, and ecological transformation. Although Mebung is still classified as a village administratively, the community has faced challenges commonly found in peri-urban areas, such as unequal access to basic services such as clean water, sanitation, health facilities, and proper nutrition. This study aimed to determine the prevalence rate of hypertension and pre-hypertension and factors associated with the incidence of hypertension in adolescents living in peri-urban areas.

## METHOD

### Participants and Study Design

This study used a cross-sectional design conducted at Christian Junior High School 4 Mebung, Alor Regency, in October 2023. This school was selected based on the researcher's consideration of determining the incidence of hypertension and prehypertension in adolescents in suburban areas. This area was chosen because it is a peri-urban area experiencing a lifestyle transition from rural to urban. The population in this study were all students of Christian Junior High School 4 Mebung and 40 students were selected as respondents using a purposive sampling method with inclusion criteria aged 13-16 years, had no history of chronic diseases other than hypertension, and were willing to take part in all stages of the study by providing written informed consent.

### Measurements and Procedure

Data collection was carried out by interviews using questionnaires and direct measurements. The data collected using questionnaires were respondents' characteristics, sodium intake, physical activity, sleep quality and duration, stress, and history of hypertension in parents. In contrast, the school provided other quantitative data, such as height and weight. Blood pressure data were obtained by measuring

students' blood pressure using a calibrated digital tensiometer. Trained health workers took measurements three times. If there is a difference in the results of the first and second measurements, this is done to ensure accuracy.

The blood pressure readings were then classified according to established pediatric standards. Normal blood pressure was defined as an average systolic and diastolic blood pressure below the 90th percentile for age, sex, and height; prehypertension was defined as an average systolic or diastolic blood pressure between the 90th and 95th percentiles; stage 1 hypertension was defined as a reading above the 95th percentile to 5 mmHg above the 99th percentile; and severe hypertension was classified when the reading exceeded five mmHg above the 99th percentile.[15]

Sodium intake data were measured using the semi-quantitative Food Frequency Questionnaire (SQFFQ) adapted to local high-sodium foods; physical activity was collected using the Physical Activity Questionnaire for Adolescents (APAQ), classified as physically active or inactive. Sleep quality and duration were measured by questions about the number of hours of sleep at night and sleep disorders experienced in the past week. Perceived stress was measured using the Perceived Stress Scale (PSS) and categorized into "perceived stress" and "no perceived stress." PSS is one of the most widely used instruments to measure perceived stress in adolescents. Data on the history of hypertension of parents, in this case, the father and mother, were obtained through direct confirmation from the respondents.

### Statistical Analysis and Ethical Clearance

The analysis used in this study was univariate and bivariate. Data was analyzed using statistical software. Univariate analysis was conducted to obtain a description of the characteristics of the respondents. Bivariate analysis was used to determine the relationship between independent variables such as sodium intake data, physical activity, sleep quality, sleep duration, stress, and history of hypertension of parents with hypertension. This study has received ethical approval, which was obtained from the Health Research Ethics Committee of the Faculty of Public Health, Nusa Cendana University, Number: 452/KEPKFKMUNDANA/2023.

## RESULT

The sociodemographic characteristics of the respondents showed quite a significant variation in age distribution among the 40 participants. The majority of respondents were aged 14 and 15 years. Regarding gender, female students constituted the majority, with 21 individuals (52.5%), while male students accounted for 19 individuals (47.5%). As shown in Table 1, most respondents were in the 14–15 age range. Furthermore, Table 1 also indicates that most respondents were of Alor ethnicity, comprising 35 individuals (87.5%), while only five (12.5%) belonged to other ethnic groups.

In Table 1, 23 respondents (57.5%) stated that their father did not have hypertension. These findings suggest that nearly half of the adolescents surveyed had a paternal history of hypertension. Regarding maternal history, the majority of respondents (65%) stated that their mothers did not have a history of hypertension. This result implies that the prevalence of maternal hypertension among respondents is slightly lower compared to paternal hypertension.

Based on Table 1, it was found that out of 40 adolescent respondents, the majority had a low sodium intake (77.5%). In terms of physical activity, most respondents were physically active (92.5%). This study also assessed the respondents' sleep duration. The majority reported an adequate sleep duration of ≥8 hours per day (65%, or 26 individuals. Most respondents (92.5%) stated they did not experience sleep disturbances. In addition, 90% of respondents reported that they did not experience stress.

According to Table 2, blood pressure among adolescents was measured and classified into three categories: normal, prehypertensive (Pre-HT), and hypertensive (HT). Table 2 showed that 20 adolescents (50%) had normal blood pressure. Meanwhile, 12 respondents (30%) were classified as prehypertensive, with blood pressure values at the upper threshold compared to the normal group. In addition, eight adolescents (20%) were identified as hypertensive, exhibiting significantly higher blood pressure levels than the other two groups. The average systolic blood pressure among adolescents in the hypertensive category was 121 ± 10.73 mmHg, while the average diastolic pressure was 79 ± 9.1 mmHg.

**Table 1. Sociodemographic and Lifestyle among Adolescents**

| Variable | N | Percentage (%) |
|---|---|---|
| Age | | |
| 13 | 4 (10%) | 10 |
| 14 | 16 (40%) | 40 |
| 15 | 16 (40%) | 40 |
| 16 | 4 (10%) | 10 |
| Gender | | |
| Boys | 19 (47.5%) | 47.5 |
| Girls | 21 (52.5%) | 52.5 |
| Ethnic | | |
| Alor | 35 (87.5%) | 87.5 |
| Others | 5 (12.5%) | 12.5 |
| Hypertensive father | | |
| Yes | 17 (42.5%) | 42.5 |
| No | 23 (57.5%) | 57.5 |
| Hypertensive mother | | |
| Yes | 14 (35%) | 35 |
| No | 26 (65%) | 65 |
| Dietary Sodium Intake | | |
| High | 9 (22.5%) | 22.5 |
| Low | 31 (77.5%) | 77.5 |
| Physical Activity | | |
| Less Active | 3 (7.5%) | 7.5 |
| Active | 37 (92.5%) | 92.5 |
| Sleep Duration | | |
| Inadequate (< 8 hours) | 14 (35%) | 35 |
| Adequate ( ≥ 8 hours) | 26 (65%) | 65 |
| Sleep Disorders | | |
| Yes | 3 (7.5%) | 7.5 |
| No | 37 (92.5%) | 92.5 |
| Perceived Stress | | |
| Yes | 4 (10%) | 10 |
| No | 36 (90%) | 90 |

**Table 2. Blood Pressure Levels in Adolescents**

| Blood Pressure Level | N (%) | Systolic Blood Pressure | Diastolic Blood Pressure |
|---|---|---|---|
| Normal | 20 (50%) | | |
| Pre-Hypertension | 12 (30%) | 121±10.73 | 79 ± 9.1 |
| Hypertension | 8 (20%) | | |

Table 3 also shows that of the 19 male respondents, nine respondents (47.4%) had normal blood pressure, five people (26.3%) were in the prehypertension category, and five others (26.3%) had hypertension. Meanwhile, of the 21 female respondents involved in this study, 11 people (52.4%) had normal blood pressure, seven people (33.3%) were in the prehypertension category, and three people (14.3%) were in the hypertension category. Generally, the proportion of women with normal blood pressure (52.4%) is greater than that of men (47.4%). Likewise, the proportion of prehypertension is higher in women (33.3%) than in men (26.3%). Conversely, the prevalence of hypertension is higher in men (26.3%) than in women (14.3%).

**Table 3. Distribution of Blood Pressure by Gender**

| Gender | Normal | Prehypertension | Hypertension | Total |
|---|---|---|---|---|
| Male | 9 (47.4%) | 5 (26.3 %) | 5(26.3%) | 19 (100) |
| Female | 11(52.4%) | 7 (33.3%) | 3(14.3%) | 21(100%) |

Based on the analysis results presented in Table 4, several factors related to hypertension in respondents were found. The results of the chi-square test showed that three variables were significantly associated with hypertension in adolescents, namely, a history of hypertension in the father, sodium intake, and sleep duration. In the group of adolescents who had fathers with a history of hypertension, more did not experience hypertension (64.7%) compared to those who had hypertension (35.3%). Furthermore, in the group of adolescents whose fathers did not have a history of hypertension. The proportion of those who experienced hypertension was much smaller (8.7%) compared to those who did not experience hypertension (91.3%). Although the majority of adolescents with hypertensive fathers did not experience hypertension, the proportion of the group of adolescents who experienced hypertension was the highest in the group of adolescents who had fathers with a history of hypertension. This finding indicates the potential for a genetic or hereditary component related to high blood pressure (p-value = 0.038). Sodium intake also showed a significant relationship with hypertension. Adolescents with high sodium intake experienced hypertension more (55.6%) compared to those who did not experience hypertension (44.4%). In contrast, in adolescents with low sodium intake, the majority did not experience hypertension (90.3%), and only 9.7% experienced hypertension. These results indicate that the proportion of hypertension is much higher in adolescents with high sodium intake and support evidence that there is a relationship between excessive sodium consumption and high blood pressure.

**Table 4. Factors Associated with Hypertension**

| Variable | Hypertension | | p-value |
|---|---|---|---|
| | Yes | No | |
| Hypertensive father | | | |
| Yes | 6 (35.3%) | 11 (64.7%) | 0.038* |
| No | 2 (8.7%) | 21 (91.3%) | |
| Hypertensive mother | | | |
| Yes | 3 (21.4%) | 11 (78.6%) | 0.868 |
| No | 5 (19.2%) | 21 (80.8%) | |
| Dietary Sodium Intake | | | |
| High | 5 (55.6%) | 4 (44.4%) | 0.002* |
| Low | 3 (9.7%) | 28 (90.3%) | |
| Physical Activity | | | |
| Less Active | 1 (33.3%) | 2 (66.7%) | 0.548 |
| Active | 7 (18.9%) | 30(81.1%) | |
| Sleep Duration | | | |
| Inadequate (< 8 hours) | 7 (50%) | 7 (50%) | 0.001* |
| Adequate ( ≥ 8 hours) | 1 (3.8%) | 25 (96.2%) | |
| Sleep Disorders | | | |
| Yes | 0 | 3 (100%) | 0.368 |
| No | 8 (21.6%) | 29 (78.4%) | |
| Perceived Stress | | | |
| Yes | 1 (25%) | 3 (75%) | 0.792 |
| No | 7 (19.4%) | 29 (80.6%) | |

*p-value < 0,05

In addition, inadequate sleep duration is also significantly associated with hypertension (p = 0.001). Among adolescents with a sleep duration of less than 8 hours per night, the proportion of those who experience hypertension and those who do not experience hypertension is the same. Meanwhile, in adolescents with a sleep duration of ≥ 8 hours, only 3.8% experienced hypertension, while 96.2% did not experience hypertension. The proportion of hypertension was higher in the group of adolescents

who had a sleep duration of less than 8 hours. These findings also indicate that a lack of sleep is an important factor contributing to hypertension in adolescents. Other variables examined in this study, including maternal hypertension history, physical activity, sleep disturbances, and perceived stress, did not show a statistically significant relationship with high blood pressure, because the p-value exceeded 0.05. Nevertheless, these factors remain relevant in preventing adolescent hypertension and should be considered in broader health promotion strategies (Table 4).

## DISCUSSION

### Prevalence Hypertension

This study found that the prevalence of high blood pressure among adolescents in the peri-urban area of Mebung was high, with 30% classified as pre-hypertensive and 20% hypertensive. This suggests that half of the adolescent population studied had blood pressure levels above the standard threshold, a proportion that cannot be ignored from a public health perspective. This figure is also higher than the prevalence of hypertension reported in national surveys. Data from the Indonesian Health Survey in 2023 showed that the prevalence of hypertension in adolescents was 8%.[16]

The high proportion of hypertension and pre-hypertension in peri-urban areas reflects that environmental and socio-economic characteristics in peri-urban areas have undergone a shift where traditional lifestyles are rapidly shifting towards more urbanized behaviors, including dietary changes and increased exposure to stress, reduced physical activity in the absence of improved infrastructure and adequate health services. This study is in line with Twinamasiko et al. findings that peri-urban areas are experiencing significant changes in lifestyle, including increased consumption of processed and fast foods and decreased physical activity.[17]

In addition, the lack of routine blood pressure checks in adolescents contributes to the underdiagnosis of hypertension, as many cases are asymptomatic until complications arise. The fact that 50% of the respondents in this study were already categorized as hypertensive and pre-hypertensive indicates the urgent need for early detection and preventive interventions in school settings, especially in transitional areas such as peri-urban areas.

### Hypertensive Father and Hypertension

Parental history of hypertension, particularly paternal history, is recognized as a genetic predisposition for elevated blood pressure. Hypertension is influenced not only by sociodemographic and lifestyle factors, but also by hereditary components. A study conducted by Metoki and Kuriyama found that children with one hypertensive parent have about two times the risk of developing hypertension. In contrast, children with two hypertensive parents have more than four times the risk compared to children of normotensive parents.[14]

This study found a significant association between paternal hypertension and a higher prevalence of hypertension among adolescents, compared to those whose fathers did not have a history of hypertension. These findings provide evidence that paternal genetic factors contribute to an increased risk of hypertension in offspring. A study conducted by Wang et al. demonstrated that individuals with a hypertensive father had a 1.5 to 2 times higher risk of developing hypertension. This condition was also linked to elevated blood pressure levels in the children. This assertion is supported by Kanchan et al., who concluded that a hypertensive family history is both a predictor and a risk factor for hypertension. The study emphasized that multiple genes determine hypertension and that the heritability of hypertension varies from 30% to 60%.[15] Similarly, a study conducted in Indonesia reported that adolescents with hypertensive parents tended to have higher blood pressure, with a stronger association observed when the father was the affected parent.[8]

In many traditional societies, fathers often serve as central figures in the family, influencing their children's dietary patterns and lifestyle behavior. Male adolescents, in particular, tend to emulate their fathers' habits, such as consuming salty fish, chili sauces, or adding salt to meals, which may contribute to similar health risks. Whelton et al. found that adolescents will likely imitate their parents' dietary patterns, physical activities, and overall lifestyle behaviors. Moreover, he emphasized that while family history remains a significant risk factor, environmental and behavioral influences may exert a more substantial effect than genetic predisposition.[20]

### Hypertensive Mother and Hypertension

Hypertension is a multifactorial condition influenced by genetic and environmental factors. Parental hypertension has been identified as one of the key determinants in its development. The inheritance mechanism involves complex interactions between genetic variants and familial lifestyle behaviors. Moreover, specific genetic variants may be more strongly expressed through the paternal line, particularly those related to the renin-angiotensin system and blood pressure regulation. This supports the current study's finding, showing a stronger association between paternal hypertension and adolescent blood pressure than maternal history.

This study found no significant association between maternal hypertension and adolescent hypertension. Although some mothers may have a history of hypertension, if the children do not imitate their lifestyle behaviors, the statistical association becomes weaker. In addition, maternal hypertension may be underreported, either due to the mother's reluctance to disclose her condition or due to limited family awareness regarding health status. In traditional communities, greater attention is often given to the father's health as the primary breadwinner, who is also more likely to receive medical treatment when ill. The lack of routine blood pressure screening for mothers and limited access to healthcare services may also contribute to the underdiagnosis of maternal hypertension. A study by Bonsang et al. found that women were more likely than men to report false-negative hypertension, meaning they had hypertension but did not report it.[17]

### Dietary Sodium Intake and Hypertension

Sodium intake refers to the amount of sodium consumed through food, primarily from table salt and processed foods. A study by Yuan et al. found that higher sodium intake was associated with increased systolic and diastolic blood pressure, as well as a higher risk of heart failure and hypertension.[18] In this study, sodium intake was categorized into high and low. The results demonstrated that adolescents with high sodium intake had a greater proportion of elevated blood pressure than those with lower intake. A statistically significant association was found between sodium intake and hypertension. These findings indicate that the higher the sodium intake, the greater the risk of elevated blood pressure.

The results of this study are consistent with the findings of Afsin et al., who reported that high sodium intake is a significant risk factor for cardiovascular disease, including hypertension.[19] Similarly, He et al. observed a direct correlation between increased sodium intake and the prevalence of hypertension.[20] Excessive sodium intake can lead to fluid retention, increased plasma volume, and elevated blood pressure. Globally, high sodium intake is estimated to contribute to 1.6 million deaths annually due to cardiovascular diseases, particularly hypertension.[21]

High sodium intake among respondents in this study may be linked to traditional cooking practices and dietary patterns in their community. The respondents were part of a coastal population where high-salt consumption is typical. This is mainly due to conventional fish preservation methods that involve salting, which increases the sodium content of daily meals. Similar findings have been reported in other studies conducted in coastal regions, where a high-salt diet, such as salted fish, was correlated with increased blood pressure among local populations.[22]

### Physical Activity and Hypertension

Physical activity is one of the key determinants in controlling blood pressure and preventing hypertension. Physiologically, physical activity helps improve heart performance, repair endothelial dysfunction, reduce peripheral vascular resistance, and stress.[23] Physical activity (PA) may promote long-term weight loss, minimize muscle sympathetic nerve activity, and improve cardiovascular health.[24, 25]

The findings of this study showed no significant association between physical activity and hypertension. This result suggests that, within the studied population, physical activity has not consistently emerged as a variable influencing blood pressure levels despite its continued clinical relevance. Whether they were hypertensive or normotensive, most respondents were physically active. Nearly all students in this study reported walking to school daily, covering distances ranging from 500 meters to 2 kilometers. This indicates that the majority of respondents maintained an active lifestyle. These findings align with a study by Adeke et al. in rural Nigeria, which demonstrated that even though the population was generally physically active due to daily labor, such as farming, the prevalence of

hypertension remained high due to other factors such as high salt intake, stress, and family history.[25]

These findings differ from most previous studies, which reported a strong association between low levels of physical activity and increased risk of hypertension. A study by Zhou et al. found that individuals with a sedentary lifestyle were at higher risk of developing hypertension compared to those who were physically active.[26] Although physical activity was not significantly associated with hypertension in the present study, physical activity-based interventions remain beneficial for blood pressure control and weight management, metabolic regulation, and mental health.

### Sleep Duration and Hypertension

Sleep duration is a vital component of physiological balance. Adequate and high-quality sleep is essential for maintaining the autonomic nervous system, regulating blood pressure and stress hormones, and preserving normal vascular function. Lack of sleep can trigger increased activity of the sympathetic nervous system, which ultimately causes blood pressure to rise and can accumulate into hypertension later in life. This condition can also cause a stress response, so blood pressure remains high, even when resting.[27]

This study found a significant association between sleep duration of less than 8 hours per night and the incidence of hypertension. Adolescents who slept less than the recommended amount were more likely to have elevated blood pressure than those with sufficient sleep. The respondents in this study were from coastal communities, where irregular daily rhythms due to flexible work patterns such as farming, gardening, or fishing are common. Most coastal households belonged to lower-middle-income groups, requiring all family members to contribute to domestic and productive work. Male adolescents in particular often participated in economic activities to support their families. These responsibilities reduced their nighttime rest, resulting in fragmented or shorter sleep durations. This finding aligns with research conducted by the Laboratory of Anthropology for Research and Action at Gadjah Mada University in Umapura Village. It reported that children actively participated in household labor alongside their parents, especially during planting or harvesting seasons. These conditions demonstrate how a family's economic situation can limit children's opportunities to fulfill their formal education roles and may implicitly affect their sleep patterns.[28]

Another finding in this study was the substantial access adolescents had to gadgets. Despite limited electricity in some peri-urban areas, technological development has enabled adolescents to access mobile phones and other electronic devices. Gadgets at night for entertainment, social media, or online gaming often occur before bedtime, reducing sleep time. Moreover, blue light exposure from screens can suppress melatonin production, a hormone that plays a key role in regulating the sleep cycle. This disruption may delay sleep onset and shorten total nighttime sleep duration.

This study aligns with findings by Jiang et al., who reported a correlation between sleep duration and elevated blood pressure, particularly systolic pressure.[29] Individuals who consistently sleep less at night are at greater risk of developing hypertension. However, excessively long sleep durations are also not ideal. Sleeping more than 9 hours per night may contribute to metabolic dysregulation and increased blood pressure.

### Sleep Disorder and Hypertension

Sleep disorders, including insomnia, circadian rhythm disorders, and poor sleep quality, are recognized as significant risk factors in the development of hypertension. Such disorders are associated with an increased risk of cardiovascular disorders. The primary mechanism believed to mediate the relationship between sleep disorders and elevated blood pressure is excessive activation of the sympathetic nervous system, along with elevated cortisol levels and impaired vascular recovery processes.[30] A study conducted by Isayeva et al. found that individuals with insomnia had a 21% higher risk of developing hypertension compared to those without sleep disorders.[31]

This study found no significant association between sleep disorders and hypertension among adolescents. Although some respondents reported experiencing sleep disorders, the statistical analysis revealed no meaningful correlation. These results differ from previous studies examining the link between sleep quality and hypertension. In this study, sleep disorders were reported by respondents who were not hypertensive, suggesting that the disorders may have been periodic or situational, such as those caused by stress or fatigue. The frequency or duration of the sleep disorders may not have been sufficient for their physiological effects to accumulate and manifest as elevated blood pressure at the

time of the study.

Furthermore, waking up early to assist with household chores was considered part of the daily routine rather than a sleep problem. The absence of complaints was thus interpreted as the absence of disorders, which may have contributed to reporting bias. These findings align with those of Hosokawa et al., who observed that poor sleep habits among adolescents are often not recognized as problems because they are perceived as part of everyday routines.[32]

Sleep disorders have been associated with increased hypertension risk. Individuals experiencing such disorders have been shown to exhibit significantly higher systolic blood pressure. However, several studies have also indicated that this association may become statistically insignificant when other factors such as psychosocial stress or sleep duration are controlled.[33] Although sleep disorders may not show a direct statistical effect in this population, they may still hold clinical relevance due to their role in activating the sympathetic nervous system and increasing cortisol levels, both of which contribute to hypertension.

## Stress and Hypertension

Stress is a physiological and emotional response to environmental stimuli, which, when persistent, can contribute to systemic disorders, including hypertension. The primary physiological mechanisms linking stress and blood pressure involve activating the sympathetic nervous system and the hypothalamic–pituitary–adrenal (HPA) axis. Stress primarily contributes to increased blood pressure by activating the sympathetic nervous system and the HPA axis. This system releases stress hormones, including cortisol and adrenaline, which increase heart rate, constrict blood vessels, and ultimately increase the risk of hypertension.[34] Stress can also reduce sleep quality and raise blood pressure through hormonal responses that accelerate heart rate and constrict blood vessels. Furthermore, maladaptive stress responses have been associated with increased risk of hypertension.[35]

The findings of this study indicated no significant association between stress and hypertension among the respondents. Nevertheless, a small proportion of respondents reported experiencing mild stress and exhibited slightly higher blood pressure than those who did not experience stress. This study did not distinguish between acute and chronic stress, making it difficult to characterize the stress conditions experienced by respondents fully. Hypertension is more closely associated with prolonged, chronic stress. However, the stress experienced by respondents in this study appeared to be situational, such as during exam periods, specific academic challenges, or household responsibilities, thus not exerting a significant physiological impact on blood pressure.

This aligns with the view expressed by Laffin, who stated that while stress and anxiety may cause temporary increases in blood pressure, they do not necessarily lead to sustained hypertension. This suggests that acute stress may not significantly contribute to the development of chronic hypertension.[36] Furthermore, the impact of stress on hypertension in this study may have been overshadowed by other dominant factors, such as family history of hypertension, high sodium intake, and insufficient sleep duration.

Although the association between stress and hypertension was not statistically significant in this study, stress may still act as a triggering factor, particularly when it is prolonged. Chronic stress can disrupt sleep regulation. Individuals experiencing stress often have difficulty achieving restful sleep and may awaken frequently at night. Persistent sleep disorders impair autonomic nervous system recovery during rest and hinder the body’s natural process of blood pressure reduction.

This study has several limitations that need to be considered. First, the small sample size and purposive selection of respondents limit the generalizability of the results. Second, the cross-sectional design does not allow for causal conclusions to be drawn between risk factors and the incidence of hypertension. In addition, this study did not distinguish between acute and chronic stress, even though these differences can affect blood pressure differently. Furthermore, the limitations of the study area in one school mean that these results do not necessarily reflect the conditions of all adolescents in the peri-urban area. Although this study found a significant association between hypertension and paternal history of hypertension, high sodium intake, and insufficient sleep duration, the analysis did not take into account the possibility of confounding variables that could affect the association. Variables such as age and gender influence blood pressure regulation and may also be associated with lifestyle behaviors, but were not controlled for in the analysis. In addition, the respondents' socioeconomic status, although not directly measured in this study, could affect diet, sleep habits, and access to healthcare, all

of which are relevant to hypertension risk.

Furthermore, this study did not measure the duration of device use before bedtime, which could also be a confounding factor in the relationship between sleep duration and high blood pressure. As only bivariate analysis was conducted, the potential influence of these variables could not be thoroughly analyzed. Therefore, further research with a multivariate analysis approach is strongly recommended to control for these confounding factors and generate stronger evidence regarding the determinants of hypertension in adolescents in peri-urban areas.

## CONCLUSION

This study shows that hypertension in peri-urban adolescents is a real health problem. The prevalence of high blood pressure is 20%, and for blood pressure above normal (pre-hypertension and hypertension) is 50%, so this cannot be ignored. This study found significant associations between paternal hypertension (p=0.038), sodium intake (p=0.002), and poor sleep duration (p=0.001) with elevated blood pressure in adolescents. Paternal history of hypertension emerged as a genetic risk factor that strongly influences the predisposition to hypertension in adolescents. In contrast, other factors such as maternal history of hypertension, physical activity, sleep disturbance, and stress in adolescents did not show a significant association with the incidence of hypertension in this group of adolescents. Overall, these findings underscore the critical role of a combination of hereditary and behavioral factors in increasing the risk of hypertension in adolescents. Based on the findings of this study, concrete interventions include several school- and community-based approaches. The first thing that can be done is school blood pressure screenings. In addition, this activity needs to be integrated as part of the adolescent health program. This screening is essential for early detection and continuous monitoring of blood pressure. Furthermore, nutrition and healthy lifestyle education programs must be integrated into the school curriculum, focusing on healthy lifestyles from an early age. Educational materials can be adapted to the local context to remain relevant. Finally, there is a need for cross-sectoral cooperation between health centers, schools, and local governments to strengthen preventive health services for adolescents, including nutrition consultation.

## REFERENCE

1. Gakidou E, Afshin A, Abajobir AA, Abate KH, Abbafati C, Abbas KM, et al. Global, regional, and national comparative risk assessment of 84 behavioural, environmental and occupational, and metabolic risks or clusters of risks, 1990–2016: a systematic analysis for the Global Burden of Disease Study 2016. Lancet [Internet]. 2017 Sep;390(10100):1345–422. Available from: https://linkinghub.elsevier.com/retrieve/pii/S0140673617323668
2. Uthman OA, Ayorinde A, Oyebode O, Sartori J, Gill P, Lilford RJ. Global prevalence and trends in hypertension and type 2 diabetes mellitus among slum residents: a systematic review and meta-analysis. BMJ Open. 2022;12(2):e052393.
3. Mills KT, Bundy JD, Kelly TN, Reed JE, Kearney PM, Reynolds K, et al. Global disparities of hypertension prevalence and control: a systematic analysis of population-based studies from 90 countries. Circulation. 2016;134(6):441–50.
4. Mills KT, Stefanescu A, He J. The global epidemiology of hypertension. Nat Rev Nephrol. 2020;16(4):223–37.
5. Kementerian Kesehatan RI. Panduan Praktik Klinis Bagi Dokter di Fasilitas Pelayanan Kesehatan Primer. Jakarta; 2016.
6. Litwin M aw. Why should we screen for arterial hypertension in children and adolescents? Pediatr Nephrol. 2018;33(1):83–92.
7. Vidal-Petiot E, Ford I, Greenlaw N, Ferrari R, Fox KM, Tardif J-C, et al. Cardiovascular event rates and mortality according to achieved systolic and diastolic blood pressure in patients with stable coronary artery disease: an international cohort study. Lancet. 2016;388(10056):2142–52.
8. Kurnianto A, Kurniadi Sunjaya D, Ruluwedrata Rinawan F, Hilmanto D. Prevalence of Hypertension and Its Associated Factors among Indonesian Adolescents. Int J Hypertens [Internet]. 2020 Sep 16;2020:1–7. Available from: https://www.hindawi.com/journals/ijhy/2020/4262034/
9. Badan Kebijakan Pembangunan Kesehatan. Riset Kesehatan Dasar 2018. Jakarta; 2019.

10. Pidor AA, Manongga SP, Oematan GTS. Pengaruh Konsumsi Pangan Terhadap Tekanan Darah Pada Siswa SMA di Kecematan Oebobo Kota Kupang. J Pangan Gizi dan Kesehat. 2023;12(1):1–9.
11. Hansen ML, Gunn PW, Kaelber DC. Underdiagnosis of Hypertension in Children and Adolescents. JAMA [Internet]. 2007 Aug 22;298(8):874. Available from: http://jama.jamanetwork.com/article.aspx?doi=10.1001/jama.298.8.874
12. Moin A, Mohanty N, Tedla YG, Carroll AJ, Padilla R, Langman CB, et al. Under-recognition of pediatric hypertension diagnosis: Examination of 1 year of visits to community health centers. J Clin Hypertens [Internet]. 2021 Feb;23(2):257–64. Available from: https://onlinelibrary.wiley.com/doi/10.1111/jch.14148
13. Metoki H, Kuriyama S. Combination of genetic and environmental factors for childhood hypertension: a simple indicator of family history remains useful. Hypertens Res [Internet]. 2023 Apr 25;46(4):1061–3. Available from: https://www.nature.com/articles/s41440-022-01165-y
14. Glenning J, Sheeran F, Quach J, Cheung M, Best S, Quinlan C, et al. Feasibility of School-Based Screening for High Blood Pressure in Children: The Healthy Hearts at School Study. J Hypertens [Internet]. 2024 May;42(Suppl 1):e102. Available from: https://journals.lww.com/10.1097/01.hjh.0001020320.07735.af
15. Saing JH. Hipertensi pada Remaja. Sari Pediatr [Internet]. 2016 Dec 5;6(4):159. Available from: https://saripediatri.org/index.php/sari-pediatri/article/view/873
16. Badan Kebijakan Pembangunan Kesehatan. Hasil Survei Kesehatan Indonesia. Jakarta; 2024.
17. Twinamasiko B, Lukenge E, Nabawanga S, Nansalire W, Kobusingye L, Ruzaaza G, et al. Sedentary Lifestyle and Hypertension in a Periurban Area of Mbarara, South Western Uganda: A Population Based Cross Sectional Survey. Int J Hypertens [Internet]. 2018;2018:1–8. Available from: https://www.hindawi.com/journals/ijhy/2018/8253948/
18. Metoki H, Kuriyama S. Combination of genetic and environmental factors for childhood hypertension: a simple indicator of family history remains useful. Hypertens Res. 2023;46(4):1061–3.
19. KC K, Katwal S, Yadav GK, Adhikari A, Thapa RK, Jha SK, et al. Family history of hypertension and its relation to other variables in hypertensive patients: a cross-sectional study from a tertiary care hospital. Int J Surg Glob Heal [Internet]. 2023 Sep;6(5):1391–2. Available from: https://journals.lww.com/10.1097/GH9.0000000000000235
20. Whelton PK, Carey RM, Aronow WS, Casey DE, Collins KJ, Dennison Himmelfarb C, et al. 2017 ACC/AHA/AAPA/ABC/ACPM/AGS/APhA/ASH/ASPC/NMA/PCNA guideline for the prevention, detection, evaluation, and management of high blood pressure in adults: a report of the American College of Cardiology/American Heart Association Task Force on Clinical Pr. J Am Coll Cardiol. 2018;71(19):e127–248.
21. Bonsang E, Caroli E, Garrouste C. Gender heterogeneity in self-reported hypertension. Econ Hum Biol [Internet]. 2021 Dec;43:101071. Available from: https://linkinghub.elsevier.com/retrieve/pii/S1570677X21000964
22. Yuan M, Yan D, Wang Y, Qi M, Li K, Lv Z, et al. Sodium intake and the risk of heart failure and hypertension: epidemiological and Mendelian randomization analysis. Front Nutr [Internet]. 2024 Jan 26;10(5):e1428–34. Available from: https://www.frontiersin.org/articles/10.3389/fnut.2023.1263554/full
23. Afshin A, Sur PJ, Fay KA, Cornaby L, Ferrara G, Salama JS, et al. Health effects of dietary risks in 195 countries, 1990 2017: a systematic analysis for the Global Burden of Disease Study 2017. Lancet. 2019;393(10184):1958–72.
24. He FJ, Tan M, Ma Y, MacGregor GA. Salt Reduction to Prevent Hypertension and Cardiovascular Disease. J Am Coll Cardiol [Internet]. 2020 Feb;75(6):632–47. Available from: https://linkinghub.elsevier.com/retrieve/pii/S0735109719386929
25. Mozaffarian D, Fahimi S, Singh GM. Global sodium consumption and death from cardiovascular causes. J Vasc Surg. 2015;61(2):567.
26. Erni Astutik, Septa Indra Puspikawati, Desak Made Sintha Kurnia Dewi, Ayik Mirayanti Mandagi, Susy Katikana Sebayang. Prevalence and Risk Factors of High Blood Pressure among Adults in Banyuwangi Coastal Communities, Indonesia. Ethiop J Health Sci [Internet]. 2020 Nov 1;30(6). Available from: https://www.ajol.info/index.php/ejhs/article/view/201963

27. El Assar M, Álvarez-Bustos A, Sosa P, Angulo J, Rodríguez-Mañas L. Effect of Physical Activity/Exercise on Oxidative Stress and Inflammation in Muscle and Vascular Aging. Int J Mol Sci [Internet]. 2022 Aug 5;23(15):8713. Available from: https://www.mdpi.com/1422-0067/23/15/8713
28. Butryn ML, Crane NT, Lufburrow E, Hagerman CJ, Forman EM, Zhang F. The Role of Physical Activity in Long-term Weight Loss: 36-month Results From a Randomized Controlled Trial. Ann Behav Med [Internet]. 2023 Feb 4;57(2):146–54. Available from: https://academic.oup.com/abm/article/57/2/146/6594650
29. Meyer SE, Kimber M, Maier LE, Matenchuk B, Moldenhauer R, de Waal S, et al. The impact of exercise training on muscle sympathetic nerve activity: a systematic review and meta-analysis. J Appl Physiol [Internet]. 2024 Aug 1;137(2):429–44. Available from: https://journals.physiology.org/doi/10.1152/japplphysiol.00060.2024
30. Adeke AS, Chori BS, Neupane D, Sharman JE, Odili AN. Socio-demographic and lifestyle factors associated with hypertension in Nigeria: results from a country-wide survey. J Hum Hypertens. 2024;38(4):365–70.
31. Liu X, Zhang D, Liu Y, Sun X, Han C, Wang B, et al. Dose-response association between physical activity and incident hypertension: a systematic review and meta-analysis of cohort studies. Hypertension. 2017;69(5):813–20.
32. Tomé-Carneiro J, Visioli F. Plant-Based Diets Reduce Blood Pressure: A Systematic Review of Recent Evidence. Curr Hypertens Rep [Internet]. 2023 Jul 13;25(7):127–50. Available from: https://link.springer.com/10.1007/s11906-023-01243-7
33. LAURA (Laboratorium Antropologi Untuk Riset dan Aksi). Pengembangan Model Penguatan Partisipasi dan Dukungan Komunitas Untuk Meningkatkan Akses Anak pada Pendidikan Yang Berkualitas. Yogyakarta; 2015.
34. Jiang W, Hu C, Li F, Hua X, Zhang X. Association between sleep duration and high blood pressure in adolescents: a systematic review and meta-analysis. Ann Hum Biol. 2018;45(6–8):457–62.
35. Tai BWS, Dawood T, Macefield VG, Yiallourou SR. The association between sleep duration and muscle sympathetic nerve activity. Clin Auton Res. 2023;33(6):647–57.
36. Isayeva G, Shalimova A, Buriakovska O. The Impact of Sleep Disorders in the Formation of Hypertension. Arter Hypertens [Internet]. 2022 Dec 29;26(4):170–9. Available from: https://journals.viamedica.pl/arterial_hypertension/article/view/86807
37. Hosokawa R, Tomozawa R, Fujimoto M, Anzai S, Sato M, Tazoe H, et al. Association between sleep habits and behavioral problems in early adolescence: a descriptive study. BMC Psychol. 2022;10(1):254.
38. Sic A, Bogicevic M, Brezic N, Nemr C, Knezevic NN. Chronic Stress and Headaches: The Role of the HPA Axis and Autonomic Nervous System. Biomedicines [Internet]. 2025 Feb 13;13(2):463. Available from: https://www.mdpi.com/2227-9059/13/2/463
39. Anavekar N. Stress and high blood pressure: What's the connection? [Internet]. High Blood Pressure. 2024. Available from: https://www.mayoclinic.org/diseases-conditions/high-blood-pressure/in-depth/stress-and-high-blood-pressure/art-20044190?p=1
40. Laffin L. Do Stress and Anxiety Cause High Blood Pressure? Heart Health. 2022.