

## Prevalence of Elevated Blood Pressure and its Association with Obesity among Children Aged 7-12 Years Attending Private School in Jordan: A Cross-Sectional Study

Omayma Marar\*

Family Medicine Department, Ministry of Health, Jordan

\*Corresponding Author: Omayma Marar, Family Medicine Department, Ministry of Health, Jordan.

Email: dr.omayma-murrar@hotmail.com

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### Abstract

**Background:** Childhood obesity and elevated blood pressure (BP) are significant global health issues that contribute to early cardiovascular diseases. In Jordan, there is limited data regarding the prevalence of these conditions among school-aged children. This study aimed to determine the prevalence of obesity and elevated BP among children aged 7 to 12 years attending private schools in Amman and to explore the relationship between body mass index (BMI) and BP in this population.

**Methods:** A cross-sectional study was conducted with 249 children (65.86% female), aged 7-12 years, from private schools in Amman. Anthropometric measurements, including height and weight, were recorded to calculate BMI. Participants were classified into BMI categories of normal weight, overweight, obesity, and underweight. BP was measured according to American Heart Association guidelines, categorizing BP into normal, elevated, and stage 1 hypertension. Statistical analyses included chi-square tests for associations between BMI and BP categories, as well as logistic regression models to evaluate BMI as a predictor of elevated BP.

**Results:** The mean height and weight of the children were 134.42 cm and 33.33 kg, respectively. The prevalence of obesity was 16.87%, overweight was 24.9%, and underweight was 2.4%. Additionally, 14.06% of children had elevated BP, with 4.8% diagnosed with stage 1 hypertension. A weak negative correlation was observed between BMI and elevated BP. Chi-square analysis revealed no significant association between BMI categories and BP classifications. Logistic regression indicated that obesity, overweight, and underweight were not significant predictors of elevated BP, regardless of gender.

**Conclusion:** The study found a notable prevalence of obesity and elevated BP among children in Jordan's private schools. However, the weak association between BMI and elevated BP suggests that other factors, such as diet, physical activity, and genetics, may also play a crucial role. These findings underscore the need for early interventions in schools to address both obesity and hypertension, and further research is necessary to explore additional determinants of elevated BP.

**Keywords:** Childhood Obesity; Blood Pressure; BMI; Private Schools; Jordan

## **Introduction**

Hypertension, or high blood pressure, continues to be a global health issue. Annually, it caused 10.2 million fatalities and resulted in 208 million years of disability-adjusted life. According to a statement from the Saudi Minister of Health in 2021, the prevalence of hypertension among adults in the Middle East is 40%. Prior research conducted in Saudi Arabia revealed that the prevalence of hypertension (HTN) among adults was around 49% [3]. An increase in the occurrence of hypertension in children and adolescents may be linked to the high occurrence of hypertension in adults and adolescents [4]. In addition, chronic high blood pressure during childhood can result in hypertension during adulthood, along with other long-term illnesses [5,6].

The assessment of blood pressure (BP), identification of hypertension, and prevention of hypertension in children and adolescents have become a worldwide focus due to this rationale [7,8]. There is a strong correlation between hypertension in children and the occurrence of cardiovascular diseases (CVD) and end-stage renal diseases. Hence, the timely identification and management of high blood pressure in children would greatly influence the well-being of children [4,9-12]. Moreover, it can lead to complications such as heart failure, left ventricular hypertrophy, and stroke [5,12,13]. Hypertension in children can result from various factors, such as the narrowing of a blood vessel in the kidney or the development of a blood clot in an artery (renal artery stenosis-thrombosis) within the kidney. Children with kidney conditions, such as nephrotic syndrome and acute and/or chronic renal failure, are more susceptible to developing hypertension. Several other medical conditions, such as neurofibromatosis, tuberous sclerosis, and thyroid problems, have been identified as factors that increase the probability of developing hypertension [14,15].

However, the precise factors that contribute to the risk of hypertension in children are still not completely comprehended. Several risk factors, including age, gender, body size, socioeconomic status, family history of hypertension, changes in dietary habits, sedentary lifestyle, increased stress, and dietary sodium intake, were identified [16-22]. Obese or overweight children are consistently more susceptible to developing hypertension [23-25]. The prevalence of hypertension in children in studies conducted in Western countries varied between 7 and 19% [26-28]. The incidence of hypertension in children and adolescents in Saudi Arabia has experienced a substantial rise, rendering it a prominent concern in the realm of pediatric health. A previous nationwide study, conducted over a decade ago, comprised a sample of 16,226 Saudi children and adolescents aged seven to eighteen.

Based on the research, it has been observed that both males and females undergo a gradual increase in their blood pressure as they age. The average annual increase in systolic blood pressure (SBP) was 1.66 mm Hg for boys and 1.44 mm Hg for girls. An observable distinction was noted between the two groups. At the age of 18, there was a significant increase in diastolic blood pressure (DBP) for boys, while the increase was even more pronounced for girls in the same age range [29-31]. The average DBP for boys was 0.83 mm Hg, whereas for girls it was 0.77 mm Hg. The review of the relevant literature [32,33] revealed the presence of a gradual correlation between hypertension in adulthood and childhood. Therefore, we have chosen to undertake this study to examine the frequency of hypertension and the factors that contribute to it among children aged 7 to 12 years old in the Amman Governorate of Jordan.

## **Methods**

### **Study design**

A cross-sectional analysis aimed at determining the prevalence of elevated blood pressure and its association with obesity among school children from 7 to 12 years in a private school in Amman, Jordan. The major advantage of conducting cross-sectional research is the opportunity it presents to assess these health conditions at an exact point in time, providing great insight into the prevailing health status of the population under study.

### **Setting**

The study was conducted in one private school, which exists in Amman, Jordan. This was the school selected to be represented as part of the private schools that exist in the city. The school lies in a central urban area and thus, is easily accessed by children from different socio-economic backgrounds.

### **Sampling and sample**

The sample comprises 249 students aged between 7 to 12 years, purposively selected from the selected private school. Since the present study is restricted in such a way that the study was carried out at one school only, convenient sampling has been applied. All the students of the age group 7 to 12 who were present on-site during the data collection period and whose parents agreed to their participation composed the research sample.

### **Data collection**

Data collection took two weeks in May 2023. The measurements and instruments used were collected by trained healthcare professionals. Anthropometric measurements: The heights and weights of the children were measured by standard procedures. Height was measured to the nearest 0.1 cm using a portable stadiometer, and weight was recorded to the nearest 0.1 kg using a digital weight scale. Body mass index was calculated as the ratio of weight in kilograms to the square of height in meters:  $BMI = \text{weight (kg)}/\text{height (m}^2\text{)}$ . The classification of obesity was based on age- and sex-specific cut-offs for body mass index according to the World Health Organization growth reference standards.

**Blood pressure measurement:** The blood pressure was measured using a calibrated automatic sphygmomanometer. Measurements were performed on the sitting child, who rested for at least five minutes. Three readings were taken at one-minute intervals and the average of these three readings was recorded as the blood pressure of the child under investigation. Elevated blood pressure was based on American Academy of Pediatrics (AAP) guidelines that base the determination on age, sex, and height.

### **Instrument**

The tools used included a portable stadiometer for taking height measurements, a digital scale for weight, an automatic sphygmomanometer for taking blood pressure measurements, and a structured questionnaire. Validation of these instruments was done through measurement against set standards or procedures. Operational validation on calibration ensured data accuracy and reliability.

### **Statistical analysis**

Descriptive statistics were used to summarize the demographic characteristics of the sample; moreover, the prevalence of obesity and elevated blood pressure was also estimated. The association between obesity and the status of elevated blood pressure was determined using a chi-square for categorical data and an independent t-test for continuous data. A logistic regression analysis was also done to adjust for the confounding variables of age, sex, physical activity, and dietary habits. The associations were assessed using odds ratios (OR) and 95% confidence intervals (CI). Statistical significance was set at  $p\text{-value} < 0.05$ .

### **Ethical considerations**

The administration of the selected private school was permitted to conduct the study. In this regard, informed consent was acquired from the parents or guardians of all participating children, whereas the children themselves were asked to provide assent. Participants were given information on the purpose of the study and procedures to be involved; they were also notified of the right to withdraw at any time without penalty. Confidentiality was adhered to by ensuring data anonymity and securely storing all records.

**Results**

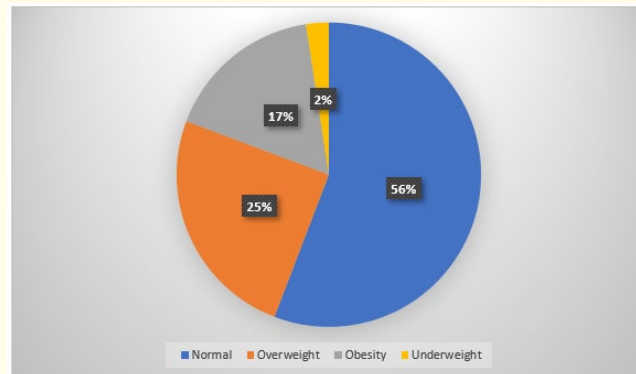
In our study, 249 students participated from various schools, and their blood pressure (BP) was measured, along with their height and weight, following a standardized protocol. The measurements were taken with the arm at the level of the heart after a five-minute rest.

Out of the 249 students, 164 (65.86%) were females, and 85 (34.14%) were males. The participants’ ages ranged from 7 to 12 years, with the majority being around 9 years old. The mean age of the students was 9.06 years, with a standard deviation of 1.55 years. The average weight was approximately 33.33 kg, and the mean height was 134.42 cm (Table 1).

Characteristics	Frequency (N = 249)	Percentage
<b>Gender</b>		
Female	164	65.9%
Male	85	34.1%
<b>Age (9.06 ± 1.55)</b>		
7 years	51	20.5%
8 years	51	20.5%
9 years	51	20.5%
11 years	49	19.7%
12 years	12	4.8%

**Table 1:** Sociodemographic characteristics of study participants.

In the BMI analysis, 55.82% (139 individuals) were in the normal weight range. However, 24.90% (62 individuals) were overweight, and 16.87% (42 individuals) were obese, signaling significant health concerns. Additionally, 2.41% (6 individuals) were underweight, indicating the need for targeted nutritional interventions (Figure 1).



**Figure 1:** BMI category distribution.

Among 35 children with abnormal blood pressure, 65.7% (23 individuals) had elevated BP, indicating higher-than-normal levels, while 34.3% (12 individuals) were diagnosed with Stage 1 Hypertension, requiring further medical attention (Table 2).

BP Category	Frequency	Percentage
Elevated BP	23	65.7%
Stage 1 Hypertension	12	34.3%

**Table 2:** Distribution of BP in children with elevated BP and hypertension.

Table 3 illustrates the relationship between Body Mass Index (BMI) categories and various characteristics of the study participants. It categorizes participants into four BMI groups: underweight, normal weight, overweight, and obesity, and further analyzes the distribution of these categories based on gender, age, maternal employment, and blood pressure status. The data shows a relatively even distribution of males and females across the BMI categories, with the majority falling into the normal weight group. Age-wise, participants aged 8 to 12 show varying numbers across the BMI categories, but no significant association was found ( $p = 0.14$ ). The mother’s employment status did not significantly influence the BMI categories ( $p = 0.799$ ). Furthermore, the blood pressure categories indicate that most participants maintained normal blood pressure, while a small proportion fell into elevated or stage 1 hypertension categories, with no significant association between BMI and blood pressure status ( $p = 0.462$ ). Overall, the findings suggest that the examined characteristics do not show significant differences across BMI categories among the participants.

Characteristic	BMI category				P value
	Underweight	Normal	Overweight	Obesity	
<b>Gender</b>					
Male	3	53	14	15	0.146
Female	3	86	48	27	
<b>Age</b>					
7	0	32	9	10	0.14
8	2	35	7	7	
9	2	24	15	10	
10	0	17	13	5	
11	2	24	14	9	
12	0	7	4	1	
<b>Mother employment</b>					
Yes	2	64	30	17	0.799
No	4	75	32	25	
<b>Blood pressure category</b>					
Normal	5	117	55	37	0.462
Elevated	0	14	4	5	
Stage 1 HTN	1	8	3	0	

**Table 3:** Relationship between BMI categories and characteristics of study participants.

## Discussion

The study aimed to assess the prevalence of elevated blood pressure and its association with obesity among school children aged 7 to 12 years in a private school in Amman, Jordan. The findings indicate that a significant proportion of participants were categorized

as overweight or obese, with 16.87% classified as obese. Notably, 14.06% of the children exhibited elevated blood pressure, with a portion diagnosed with stage 1 hypertension. This suggests a concerning trend where a considerable number of children are not only facing obesity but also associated health risks such as elevated blood pressure, highlighting the urgent need for effective public health interventions and educational programs to address these issues in this population. The cross-sectional design of the study allows for a snapshot of health status at a specific point in time, facilitating the identification of health trends; however, it does not establish causality.

Updated recommendations from the American Academy of Pediatrics mitigate the NIH-recommended bias toward higher blood pressure readings in youngsters. After its threshold was lowered, the prevalence of hypertension in children decreased. Because of its association with obesity, hypertension is a leading cause of cardiovascular disease. There have been a number of international studies, but the 2017 AAP recommendations have received very little attention. A research showed 15.9% of children aged 10-12 had elevated blood pressure and 35.1% had hypertension; additionally, the children at greatest risk of developing high blood pressure were those who were overweight or obese [34]. The prevalence was 5.58% in [35] research for children aged 6-13, with 3.19% having hypertension (stage 1), 2.16% having raised BP, and 0.23% having stage 2 hypertension.

The prevalence of hypertension rose with age, according to another research in Uttar Pradesh that assessed blood pressure in people aged 10 to 19 years old [36]. The AAP reported a frequency of around 22.5% while the NHBPEP found a prevalence of about 15.2% among 864 adolescents with hypertension. In contrast to [35] research, this one found a very high prevalence of hypertension. One possible explanation for the increased prevalence might be the older age group that was participated in this research. A link between body mass index and hypertension was also hinted at in this research. Similarly, a research comparing youngsters in the US from 2005-2008 and 2013-2016 found a significant frequency. Similar to our research, the prevalence was 5.7% from 2005-2008 and 3.5% from 2013-2016 [37], according to the 2017 AAP standards.

A prior research conducted in 2018 in accordance with 2004 National Institutes of Health criteria in Delhi, India, indicated that 3.1% of children aged five to fifteen were classified as having prehypertension [35]. Children with hypertension are more likely to have a parent with diabetes or obesity. The incidence of prehypertension was determined to be 5% and hypertension to be 4.6% in a comparable research conducted in West Bengal in 2004 according to NIH recommendations; however, both conditions were more prevalent among children aged >15 years (10.3% and 15.5%, respectively). Although AAP 2017 criteria were used, the prevalence of hypertension is almost same to previous studies [35]. Our results are consistent with those of the aforementioned research in showing that hypertension is more frequent with increasing age.

Even though there is a lot of evidence from research conducted on urban people showing a high frequency, it is safe to assume that rural communities are also impacted. A meta-analysis and systematic review conducted in India found that children living in urban areas had a somewhat greater prevalence of hypertension (7% vs. 5%) than children living in rural areas [38]. A research found a prevalence of 5.58 percent of hypertension, and it was performed entirely in rural regions. This research indicates that hypertension has been steadily increasing since 2005. In 2005, the prevalence was 3%; from 2006 to 2010, it increased to 9%; from 2011 to 2015, it decreased to 7%; and from 2016 to 2020, it increased to 6% [35]. Additionally, it was found that hypertension is much more common among those who are overweight or obese, and that the incidence of hypertension has been steadily increasing over the last 15 years [35]. Both Tamil Nadu and Uttar Pradesh have a prevalence of about 10% in this systematic study [38].

An increasing number of people are suffering from obesity-related health problems, including high blood pressure, metabolic syndrome, and cardiovascular disease. According to a systematic research that analyzed prevalence data from 28 states, the northern region of India has a higher obesity rate than the southern region. This research drew on information from 52 studies spread over 16 Indian states. Prevalence estimates for childhood overweight and obesity range from 16.3% in 2001-2005 to 19.3% in 2010 and later

years [39]. Kids between the ages of 10 and 18 in one Chennai study reported an obesity prevalence of 5.9% in 1981 and 6.2% in 1998 [40]. The percentages of those who were overweight (6.03%) and obese (25%) in [35] survey demonstrate a rising trend over time.

Hypertension and obesity are on the increase worldwide, according to many research. The incidence of persistent hypertension was 5.7% in rural regions and 8.4% in urban areas, according to a research conducted in Delhi [41]. Obesity affected 2.7% of rural schoolchildren and 11% of urban schoolchildren. Not only that, but out of 5,155 pupils surveyed in Odisha, 10.4% were overweight and 3.6% were obese, according to another health research. Sustained hypertension was detected in 190 pupils, or 3.68% of the total. Hypertension affected 4.47 percent of female students compared to 3.22 percent of male pupils [42]. Consistent with [35] findings, these studies also found a statistically significant correlation between obesity and hypertension when compared to overweight individuals with normal blood pressure.

Despite the valuable insights gained from this research, certain limitations must be acknowledged. First, the study's findings are confined to a single private school, which may limit the generalizability of the results to the broader population of school children in Jordan. The use of purposive sampling may introduce selection bias, as the sample may not represent children from different socio-economic backgrounds or those attending public schools. Furthermore, the reliance on self-reported data regarding dietary habits and physical activity could lead to inaccuracies, as these measures are subject to participant bias. Lastly, the cross-sectional nature of the study restricts the ability to determine long-term trends and causal relationships between obesity and elevated blood pressure, indicating the need for future longitudinal studies to better understand these dynamics.

## Conclusion

This study highlights a concerning prevalence of elevated blood pressure and obesity among school children in Amman, emphasizing the need for targeted health interventions. The findings indicate that a significant number of children are facing health risks that could have long-term implications for their well-being. Addressing these issues requires collaborative efforts involving parents, schools, and healthcare professionals to promote healthy lifestyle choices and preventive measures. Additionally, further research is necessary to explore the underlying factors contributing to these health challenges and to evaluate the effectiveness of interventions aimed at improving the overall health of children in this demographic.

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