# Hypertension in Children: Could the Prevalence be on the Increase?

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## Abstract

**Background:** In children particularly in the developing world, there is a tendency to downplay the role of primary hypertension in their health. In adults, a number of factors have clearly been associated with the incidence of hypertension. Knowledge of the prevalence of hypertension and its associated factors among children in our environment is important and could inform the need for lifestyle changes and routine blood pressure (BP) checks in children so as to reduce BP-related health risks. **Aim:** The aim of this study is to document the prevalence of hypertension and its risk factors among children in Enugu, Nigeria. **Materials and Methods:** Children aged 6–17 years attending the outpatient clinic of a tertiary hospital, were enrolled for the study. Their socioeconomic status (SES), weight, height, BP, and dipstick urinalysis were measured using standardized methods. Adherence to Mediterranean diet was assessed using the Mediterranean Diet Quality Index (KIDMED). The prevalence of hypertension and the influence of these factors on their BP were analyzed. **Results:** Forty-six (9%) of the 491 participants had hypertension. Of these 46 hypertensive children, 72% were females while a significantly higher proportion 57% ($P = 0.006$), were in the age group 13–17 years. While age, gender, and the presence of protein in urine were significantly associated with hypertension in these children; body mass index, diet, family history of hypertension, and SES were not. **Conclusion:** The prevalence of hypertension in children in this environment is high and appears to be increasing. There is need for routine BP and urinalysis check for all children in our clinics and wards.

**Keywords:** Children, Enugu, hypertension, prevalence, risk factors

## INTRODUCTION

Hypertension has been defined by levels of blood pressure (BP) above which lowering BP will reduce the cardiovascular risk associated with elevated BP and this level has been classically documented at 140/90 mmHg in adults.[1] The new 2017 American College of Cardiology/American Heart Association guideline set hypertension stage 1 at >130/80 mmHg rather than 140/90 mmHg as in the European guidelines.[2] Factors such as age, height, and gender are important factors in interpreting BP values in children. The most widely used definition of hypertension in children is delineated as BP >95% of expected BP for age, gender, and height.[3]

Unlike in adults where essential hypertension is very common, both secondary and essential (primary) hypertension are seen in children– primary hypertension being influenced by factors such as birth weight, maturity during birth, heredity, and diet while secondary is influenced by renal abnormalities, coarctation of the aorta, medications, neoplasm, etc.[4] Worldwide, the prevalence of hypertension in children ranges between 1% and 5%, with a significant proportion of them underdiagnosed.[5] The prevalence of hypertension in children and adolescents in the United States of America is 3.3%, whereas in Europe, prevalence ranging from 2.2% to 22% has been documented.[4,6] Across Africa, the prevalence also varies between 0.2% and 24.8%, with a pooled figure of 5.5%.[7] In Nigeria, various studies have also demonstrated similar prevalence rates in the neighborhood of 3.5% and 6%.[8-12] In 2013 in Enugu, southeast Nigeria, Ujunwa et al.[8]

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**Access this article online**

**Quick Response Code:**

**Website:**
www.nigeriamedj.com

**DOI:**
10.4103/nmj.NMJ_51_19

reported a prevalence of 5.4%. A similar study in 2014 on pre-school children in Enugu, Nigeria, noted a comparatively low prevalence rate of elevated BP prevalence of 1.9%.[13] The authors opined that the prevalence of hypertension in children may still be on the increase.[13] A higher prevalence value, however, may be expected when other groups of children are considered since BP increases with growth and development and results in hypertension during the first two decades of life.[14] Although the pathogenesis of raised BP in obese children is not widely understood, evidence abounds on other comorbid conditions, which further accentuate the risk of hypertension.[15] Aside from the risks associated with it, childhood hypertension is a major killer and one of the most common health concerns in children worldwide. There is also substantive evidence linking it with long-term cardiovascular risk in adulthood.[4] Therefore, it is of public health importance.

BP measurement is usually done for adults and has proven to be crucial in the assessment of cardiovascular health.[3] This important measurement is not usually done routinely for children, although childhood hypertension detection is a measurement identifying potential future morbidity (essential hypertension) or existing underlying disease (secondary hypertension). In general, screening of children for hypertension is focused on essential hypertension since this is usually asymptomatic in children and may go unnoticed, but later becomes a risk in adulthood. Secondary hypertension comes to the fore with the presentation of the underlying disease. Consequently, childhood essential hypertension has been termed a strong predictor of hypertension in the adult population.[14]

Interestingly, identifying children with elevated BP and successfully treating them will have an impact on long-term outcomes of cardiovascular disease as well as a sizeable effect on hypertension-related morbidity and mortality. The cost implication of treating adults with raised BP will be addressed when attention is paid to childhood primary hypertension. To further understand the degree of attention that should be given to hypertension in childhood, knowledge of its prevalence and factors associated with it need to be continuously emphasized. It can also inform the need for routine BP check in children and adolescents in the routine children's clinic. This study was undertaken to determine the prevalence and risk factors for hypertension in children attending a tertiary health facility in Enugu, Nigeria.

## MATERIALS AND METHODS

The sample size was calculated using the formula for calculating sample size for a cross-sectional study.[16] Where *z* is the standard score corresponding to a confidence level of 1.96, *d* corresponds to a precision of 0.07 and P corresponds to a prevalence rate of hypertension of 5.4%.[8]

$$N = \frac{Z^2 pq}{d^2}$$

where: N = minimum sample size Z = 1.96; *d* = total width of the expected confidence interval set at 0.07;

P = prevalence from similar study in Enugu (5.4%);[8] q = 1-p, i.e., $N = 1.96 \times 1.96 \times 0.54 \times 0.46 = 0.95425344/0.0049 = 195$. Minimum sample size calculated was 195; however, total sample collected was 500.

After obtaining ethical approval from the Health Ethics Research Committee of the Enugu State University Teaching Hospital (ESUTH) Parklane (ESUTHP/C-MAC/RA/034/075), Enugu, Nigeria, informed consent from the caregiver and assent from older children; children aged 6–17 years attending the outpatient clinic of ESUTH, Enugu, Nigeria, with minor illnesses such as upper respiratory tract infections, skin rash, and children on follow-up who were apparently well, whose parents gave consent for the study were consecutively enrolled for the study over 4 months period (April to July 2017). Children with chronic illnesses, fever, body swelling as well as those with known renal diseases or on steroids; were not included in the study.

An interviewer-administered pro forma was used to collect the biodata, parents' education and occupation and presenting symptoms from eligible children. Socioeconomic status (SES) was ascertained using the socioeconomic classification tool by Oyedeji.[17] This tool has five classes (Class I–V). Classes I and II were further classified as upper class; class III as middle class, while Classes IV and V were classified as lower class. Their diet was scored by assessing their adherence to Mediterranean diet using the KIDMED test tool which was developed and validated by Serra-Majem *et al*.[18] The KIDMED questionnaire consists of 16 items, where there are four questions denoting a negative connotation to the Mediterranean diet (consumption of fast food, baked goods, sweets, and skipping breakfast) and 12 questions denoting a positive connotation (consumption of oil, fish, fruits, vegetables, cereals, nuts, pulses, pasta or rice, dairy products, and yoghurt). Questions denoting negative connotations are scored with −1, whereas positive connotation questions are scored with +1. According to the KIDMED index, a score of 0–3 reflects poor adherence to the Mediterranean diet, a score of 4–7 describes average adherence, and a score of 8–12 good adherence.[18]

The weight was measured using a spring balance scale and stadiometer (SECA model 786 2021 994) was used to measure the height. The BP of the study participants was measured toward the end of the assessment when the child is calm using a Riester sphygmomanometer (Germany, CE 0124; 13094 4 958) with appropriate sized cuff applied on the right arm of each child. An interval of 30 min was allowed and the cuff was completely deflated between readings. The systolic reading was taken as the first Korotkoff sound, and the diastolic pressure was taken as the 5th Korotkoff sound. The determined systolic and diastolic pressures were ascertained using the mean value of the three readings measured by the same person. The children were diagnosed to have hypertension if the BP was ≥95th percentile for age, gender, weight, and height measured in at least three separate occasions.[19]

The body mass index (BMI) was calculated for each participant and the U.S. BMI-for-age percentile chart for boys and girls were used to group subjects into underweight, normal weight, overweight, and obese. Underweight was taken as BMI <5th percentile, healthy weight as BMI of 5th up to the 85th percentile, overweight as BMI of 85th to <95th percentile, and obese as BMI equal to or >95th percentile for age and gender. [20,21]

Early morning urine samples were collected for dipstick urinalysis, and the presence of proteinuria was ascertained and recorded in the pro forma. Prevalence of hypertension was analyzed as well as the influence of age, gender, BMI, diet, proteinuria, and socioeconomic class on the BP.

### Statistical analysis

All the data obtained was recorded and analyzed using the Statistical Package for the Social Sciences (SPSS®) software for Windows® version 22.0. IBM® Corp., Armonk, NY, USA released 2013. Continuous variables were reported as mean, median, and standard deviation, whereas categorical variables were reported as the number or percentage of participants with a particular characteristic. Test probability value of $P < 0.05$ was considered statistically significant. Results were presented in tables and prose.

### Compliance with ethical standards

This study was funded by the authors. There are no conflicts of interest. Ethical approval for this study was obtained from the Health Research Ethics Committee of ESUTH, Enugu, Nigeria.

## RESULTS

Five hundred children were recruited in the study, but 491 of them were analyzed. Nine (1.8%) were not included in the analysis due to incomplete data. Fifty-five percent of the children were females giving a male: female ratio of 1: 1.2. The age ranged from 6 to 17 years and 62.7% were within the school-age of 6–12 years, whereas 62.3% of teenagers (13–17) were females.
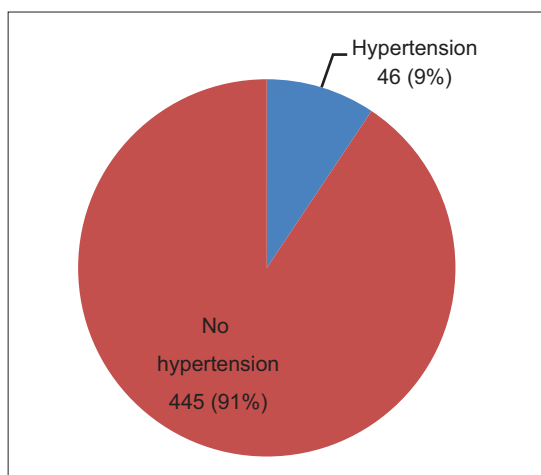


**Figure 1:** Prevalence of hypertension in children attending the outpatient clinic

The prevalence of hypertension was 9% [Figure 1]. Of this 46 hypertensive children, 72% were females while approximately 57% were in the age group 13–17 years.

Comparing the two age groups (6 12 years, 13–17 years), there was a significantly higher proportion of teenagers with hypertension (14.2%) than school-age children (6.5%) ($P = 0.006$). No significant difference was found between the mean weight and height of hypertensive and nonhypertensive children in the two age groups [Table 1]. There were more females with hypertension than males (12.1% and 5.9%, respectively). This difference was found to be statistically significant ($P = 0.022$) [Table 1].

### Family history of hypertension and socioeconomic status

Positive family history of hypertension was obtained in 40.7% of the children, but this was not significantly associated with raised BP in the children [Table 1]. The socioeconomic classes were grouped into upper (Oyedeji Classes I and II), middle (Oyedeji Class III), and lower (Oyedeji Classes IV and V). Approximately 76% of the children belong to the middle socioeconomic class, whereas 9.4% and 15% belong to upper and lower socioeconomic classes, respectively. No significant difference was found in the prevalence of hypertension in children belonging to the different socioeconomic classes ($P = 0.103$) [Table 2].

### Body mass index

There was no significant association between the BMI and hypertension [Table 3].

### Proteinuria

Protein in urine (range trace to ++) was detected in 64 children. There is a significant association of proteinuria with hypertension. Seventeen percent of those with documented proteinuria were hypertensive, whereas only 8.2% of children without protein in urine were hypertensive, $P = 0.021$ [Table 4].

### Diet (KIDMED score)

Using the scoring system for adherence to the Mediterranean diet used Serra-Majem *et al*.,[18] 86.6% of the children had medium score, while 4.1% and 9.4% had high and poor scores, respectively. There was no significant association between the scores and hypertension [Figure 2].
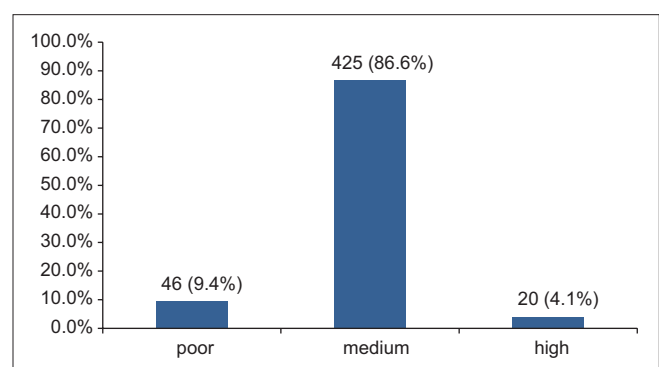


**Figure 2:** Adherence to mediterranean diet

**Table 1: Association between factors of age, sex, and female history of hypertension with hypertension in children**

| | Hypertension | | OR | 95% CI for OR | P |
|---|---|---|---|---|---|
| | Yes, n (%) | No, n (%) | | | |
| Age (years) | | | | | |
| 6-12 | 20 (6.5) | 288 (93.5) | 0.419 | 0.227-0.775 | 0.006 |
| 13-17 | 26 (14.2) | 157 (85.8) | | | |
| Gender | | | | | |
| Male | 13 (5.9) | 206 (94.1) | 0.457 | 0.234-0.892 | 0.022 |
| Female | 33 (12.1) | 239 (87.9) | | | |
| Family history of hypertension | | | | | |
| Yes | 25 (12.5) | 175 (87.5) | 1.837 | 0.997-3.382 | 0.051 |
| No | 21 (7.2) | 270 (92.8) | | | |

OR – Odds ratio; CI – Confidence interval

**Table 2: Hypertension and socioeconomic distribution among the children**

| Socioeconomic class | Hypertension | | $\chi^2$ | P |
|---|---|---|---|---|
| | Yes, n (%) | No, n (%) | | |
| Upper | 16 (6.9) | 217 (93.1) | 4.549 | 0.103 |
| Middle | 19 (10.3) | 165 (89.7) | | |
| Lower | 11 (14.9) | 63 (85.1) | | |

**Table 3: Body mass index and hypertension**

| BMI (percentiles) | Hypertensio | | OR | 95% CI for OR | P |
|---|---|---|---|---|---|
| | Yes, n (%) | No, n (%) | | | |
| 5th-85th | 36 (10.1) | 319 (89.9) | | | |
| <5th | 4 (4.8) | 79 (95.2) | 0.449 | 0.155-1.298 | 0.139 |
| 85th-95th | 4 (10.8) | 33 (89.2) | 1.074 | 0.360-3.205 | 0.898 |
| >95th | 2 (13.3) | 13 (86.7) | 1.363 | 0.296-6.284 | 0.691 |

OR – Odds ratio; CI – Confidence interval; BMI – Body mass index

**Table 4: Hypertension and the presence of protein in urine**

| Protein | Hypertension | | $\chi^2$, P |
|---|---|---|---|
| | Yes, n (%) | No, n (%) | |
| Positive | 11 (17.2) | 53 (82.8) | 5.299, 0.021 |
| Negative | 35 (8.2) | 392 (91.8) | |

## DISCUSSION

The prevalence rate for hypertension in this study was 9%. In developing countries, particularly African countries, there is a wide variation in the estimated prevalence of hypertension in children and adolescent population ranging from <5% to as high as 20%.[22-24] The prevalence of 9% in our study is high compared with prevalence rates in studies done by Okpokowuruk *et al.*[12] in Etoi Uyo (Akwa Ibom State, southern Nigeria) who reported a rate of 3.5% in primary and secondary schools and Umar *et al.* in Kano, northern Nigeria, 3% in primary school children.[25] This study was carried out in ill children (at least those who had reasons to present to the hospital) while the comparative study was carried out among apparently healthy children in schools. In Ghana, West Africa, and in Tunisia in North Africa, closer prevalence rates of 6% and 9.6%, respectively, were obtained by Addo *et al.* and Harrabi *et al.*[26,27] A study, in the same city of Enugu, among adolescents in a secondary school by Uwaezuoke *et al.* found a prevalence of 8.2% and as high as 30% among obese students.[28] In general, systematic reviews estimates of hypertension in children in Africa and America are 5% and 3.5%, respectively.[29,30] The prevalence rate of hypertension in children can be affected by the age of the child (increases with age), the sex (higher in adolescent girls), and BMI (higher in obesity). In our study, 62.3% of 13–17 year-old are females, whereas 56% of 13–17 year-old are females in Akwa Ibom study and the age range for the study population in Kano was 6–14 years. The higher number of adolescent girls and higher age of our children compared with Akwa Ibom and Kano studies, respectively, may partly explain the high prevalence rate of hypertension in our study.

There is a significant association of high BP with gender in our study. Of the 46 children with hypertension 72% are females and 12.1% and 5.9% of females and males, respectively, are hypertensive. A study in Dar es salam, Tanzania, and Fort Worth, Texas found no gender difference in the prevalence of hypertension among school children aged 6–17 years and 8–13 years, respectively.[31,32] In Nigeria, while Okpokowuruk *et al.*[12] in Uyo reported no significant association with gender, Uwaezuoke *et al.*[28] in Enugu reported significant association of gender and hypertension (8.2% in females and 3.3% in males) in secondary school students. The finding is also in consonance with that of a prospective study done in Finland by Hu *et al.*[33] Higher risk of obesity in adolescent girls (who constitute 62.3% of our 13–17 year-old), among other factors, may explain the increased prevalence of hypertension in them.

The significant association of hypertension with age (higher in 13–17 years) found in this study is supported by findings in Uyo, Nigeria and Dar es salam, Tanzzania.[31] A similar cross-sectional study in a developing setting like Chennai, India, documented a higher prevalence of hypertension among the same age range.[34] Documentation of the higher prevalence of hypertension in this age range is not surprising knowing the hormonal and accompanying physiological changes and increasing incidence of obesity during puberty. Urrutia *et al.*[32] in Texas in their study did not find any significant relationship between the ages of children and hypertension, the narrow age range (8–13 years) of the children they studied could explain their findings.

Proteinuria documented in 13% of the study population was significantly associated with hypertension. Gui *et al.*, using a different method, in their study of Turkish school-aged

children found no significant association of proteinuria with hypertension but documented increasing prevalence rate of proteinuria with increasing age of the children (0.5%, 3.0%, 16.7% in 6–9, 10–13, and 14–18 year-old, respectively).[35] The prevalence of proteinuria in their study was also higher in obese (11.3%) compared with nonobese (6.2%) children. Malla *et al.* in India, using dipstick, had a prevalence of 6.2% but no significant association with hypertension among 12–14-year-old school children. [36] Proteinuria usually benign in the form of transient or orthostatic proteinuria may represent underlying renal disease. Its association with hypertension in this study calls for further study, which could include ruling out renal pathologies such as acute glomerulonephritis in children who have hypertension and proteinuria.

There is no significant association between BMI and hypertension in this study. Other studies in Nigeria found a significant association of hypertension with obesity.[12,22,28] However, two of these studies were done among adolescents with a high prevalence of obesity. Only 3% of our study population were obese and 72% had normal BMI. The low prevalence of obesity may explain the finding in our study.

In this study, a positive family history of hypertension was not significantly associated with hypertension in the study population. A significant positive relationship between a family history of hypertension and the presence of hypertension in children was documented by Okoh and Alikor in Port-Harcourt and Mijinyawa *et al.* in Kano in Nigeria.[7,37] A study among adolescents in Latin American population showed a strong link between family history of hypertension and the development of hypertension among adolescents.[38] The study was however conducted among obese adolescents in contrast to our study of school-age and adolescents with majority having normal weight. The finding in this study is in corroboration with a study in India by Buch *et al.*[39] and Okpokowuruk *et al.*[12] in Uyo, Nigeria that found no significant relationship between family history of hypertension and hypertension in children. Genetic predisposition, obesity, and environmental factors (psychosocial stressors) contribute to the development of hypertension, especially in adults. The interplay between these factors may explain the difference in the studies.

There is no significant relationship between parental socioeconomic class and the development of hypertension in our study population. This finding was contrary to that of a similar cross-sectional study in Poland, which documented disparities in BPs with respect to SES.[40] The finding in the latter appears reasonable as weight and obesity which are strong risk for hypertension; have strong socioeconomic inclinations, and the study was among adolescents who have relatively higher rate of obesity. [41] In Indonesia, Julia *et al.* also found the BP of rural and poor urban children to be significantly higher than that of nonpoor urban children.[42] However, Balogun *et al.*, in their study of Nigerian children, aged 8–20 years, found no significant association between parental SES and the BP of the children.[43] Although not statistically significant, the table shows that the proportion of children in low socioeconomic class with hypertension (1 in 7) is about two times that of those in upper class (1 in 15). However, the skewed distribution of population observed among the different socioeconomic strata in our study (upper 9.4%, middle 75.6%, and lower 15.1%) may partly explain our findings.

KIDMED scores were not significantly associated with hypertension in this study. In their analysis, Psaltopoulou *et al.* found adherence to the Mediterranean diet to be inversely associated with high systolic and diastolic BP.[44] However, their study was in adults and effect of diet on hypertension might only become evident with increasing age.

## Conclusion

The prevalence of hypertension among children in our study population is high and appears to be on the increase when compared to figures from earlier studies in the same environment. Age, gender, and proteinuria were significantly associated with hypertension in these children. Sensitization of health workers for routine BP checks in the pediatric clinics and wards, combined with health education of caregivers and older children are necessary interventions in forestalling the morbidity/mortality due to hypertension.

The association between proteinuria and hypertension in children needs to be further investigated. There is a need for a large scale community-based study to further investigate demographic variables that may explain the varied prevalence of hypertension and correlates in different parts of Nigeria.

### Financial support and sponsorship

### Conflicts of interest
There are no conflicts of interest.

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