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# High Prevalence and Lack of Parental Awareness of Pediatric Hypertension Among a Low-income Sample in Worcester, MA

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## Abstract

**Objectives—**To identify frequency and correlates of hypertension in a low income, ethnically diverse, sample of children as well as to assess parental awareness of hypertension.

**Methods—**This cross-sectional study included parent-child dyads (n=228), from which physical measurements of the child, and parent reported survey measures were collected. Child's blood pressure percentile was determined via 2017 American Academy of Pediatrics (AAP) clinical practice guidelines and categorized as normal (<90th percentile), elevated (≥90th percentile to <95th percentile), or hypertensive (≥95th percentile). Bivariate multinomial logistic regression models assessed the relative risk ratio for potential correlates of blood pressure categorization and frequency distribution of parental awareness of blood pressure status was examined.

**Results—**Median child age was 8.1 years (IQR 6.5-9.9). Half were female, 61.8% were Latino and 15.8% were Non-Latino Black. Median body mass index (BMI) percentile was 83.6 (IQR 58.4-97.1) and 31.6% exceeded the 95th percentile. AAP criteria for hypertension and elevated blood pressure were met by 30.7% and 14% of children respectively. After full adjustment, the relative risk of categorization as hypertensive versus normal increased by a factor of 1.15 (95% CI 1.02-1.3) per 10-unit increase in BMI percentile, and 0.84 (95% CI 0.72-0.98) per one-year increase in age. Less than five parents (redacted due to low sample size) reported their child having a history of high blood pressure.

**Conclusions—**In this low income, racially/ethnically diverse sample, we observed levels of hypertension and elevated blood pressure considerably higher than national estimates. However, in contrast, extremely low parental awareness was observed.

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Conflict of Interest

The authors declare that they have no conflict of interest.

**Keywords**

Health Equity; Overweight; Blood Pressure; Parental Awareness

## Introduction

Nationally, the prevalence of clinically defined hypertension in children aged 8 to 12 years is estimated to be 5.5% (Kibria, 2019). Hypertension places children at risk for lipid disorders, atherosclerosis, and impaired cognitive function (Adams et al., 2010; Liao et al., 2009). In adulthood, these children face greater risks of experiencing adult hypertension, metabolic syndrome, and cardiovascular disease (Chen & Wang, 2008; Singh et al., 2008; Sun et al., 2007). In children experiencing overweight/obesity, the prevalence of elevated blood pressure is higher, estimated to be 16.5% in 2013-2016 (Kibria, 2019). Although not as well recognized as disparities in childhood obesity, emerging evidence suggests the existence of racial/ethnic disparities in childhood hypertension. Higher prevalence of pediatric hypertension has been observed in Latino and non-Latino Black populations relative to non-Latino White populations (Kibria, 2019; Kit et al., 2015). However, few studies have examined potential associations between other psychosocial factors and pediatric hypertension.

Among adults, hypertension is often asymptomatic, undiagnosed, and untreated, leaving many individuals unaware of their blood pressure status (Vital Signs, n.d.; Why High Blood Pressure Is a “Silent Killer,” n.d.). Similarly, hypertension often goes undiagnosed in children where diagnosis is more complex (Flynn et al., 2017; Hansen et al., 2007; Underdiagnosis of Hypertension in Children and Adolescents | Pediatrics | JAMA | JAMA Network, n.d.). Although parental perception and monitoring have been highlighted as important factors in management of other pediatric disorders (Exploring the Relationship Between Parental Concern and the Management of Childhood Obesity | SpringerLink, n.d.), these factors have not been explored in relation to pediatric hypertension. Consideration of parental awareness could be an important step in understanding the role of parents in pediatric hypertension diagnosis and management. Such diagnosis and recognition of hypertension is important to ensure proper treatment, without which, hypertension can lead to serious long term clinical repercussions. The purpose of this study was, therefore, to identify the frequency and correlates of hypertension in a low income, ethnically diverse, pediatric sample as well as to assess parental awareness of hypertension.

## Methods

This cross-sectional study utilized data from the baseline assessment of the “Healthy Kids & Families” study, which was approved by an institutional review board and is described elsewhere (Borg et al., 2019). Parent-child dyads (n=247) were recruited through schools in racial/ethnically diverse, socioeconomically impoverished neighborhoods in Worcester, MA. Eligibility included English or Spanish speaking families with a child attending kindergarten through sixth grade, telephone access, and no plans to move within two years. In families

with multiple eligible children, the child whose birthdate was closest to the recruitment date was included.

## Assessments

Following written consent (parent) and assent (child), the parent and the child underwent a baseline assessment at a community location that included physical measurements of the child and parent reported survey measures pertaining to the parent and child.

## Physical Assessments

Physical assessments were measured by trained research staff according to specified protocol. Blood pressure was measured using DinamapPro100 oscillometric blood pressure device, three times at one occasion (Borg et al., 2019). Children were seated for 10 minutes prior to measurement, and cuff size most compatible with child's upper arm, as determined by trained research staff was used with at least one-minute between measurements. The average of the three measurements was used to determine blood pressure percentile based on child's age, gender, and height according to 2017 American Academy of Pediatrics (AAP) clinical practice guideline normative tables (Flynn et al., 2017), computed using STATA Version 15.1 with code created by Sørensen and Bruun (Blood Pressure Percentiles (z-Scores) in STATA?, n.d.). Blood pressure percentiles were categorized as normal ($<90^{th}$ percentile), elevated ($\geq 90^{th}$ percentile to $<95^{th}$ percentile), or hypertensive ($\geq 95^{th}$ percentile).

Child weight was measured with Tanita BWB-800 digital scale on a firm level surface. Shoes and coats were removed prior to weighing and weight was recorded to the nearest 0.10 pound. Standing height was measured with portable SECA 213 stadiometer, with shoes removed, back against the measurement bar and recorded to nearest 0.10 centimeter. Body mass index (BMI) percentile was calculated according to the Centers for Disease Control and Prevention's United States growth chart (Kuczmarski et al., 2002).

## Survey Measures

Parent and child sociodemographic variables were assessed via survey questions. Age was determined from child's date of birth. Gender was assessed as female or male. Race/ethnicity was assessed by Latino origin and race. Responses were combined to a single measure with categories of white non-Latino, Black non-Latino, Latino and other (including Asian non-Latino, more than one race and other non-Latino). Parental education from self-reported highest level of education was dichotomized to represent high school diploma, GED, or less versus higher education (including associate's, bachelor's, master's and doctoral degrees). Parental report of child's general health was assessed by asking "In general, would you say that [child's name]'s health is" with response options of excellent, very good, good, fair, or poor. Parental awareness of child's blood pressure status was assessed by a single item asking: "Does [child's name] have a history of high blood pressure?" with response options of yes or no.

### Statistical Analysis

Children were excluded if they had missing data on blood pressure (n=8), BMI (n=5), race/ethnicity (n=1), parent reported health status (n=3) and age ≥13 (n=2) given that AAP blood pressure categorization changes at age 13 (Flynn et al., 2017).

Descriptive statistics of medians with interquartile range and percentages were used to describe the population. The distribution of sample characteristics stratified by blood pressure category were computed and tests of differences were assessed through bivariate analysis of Chi-square test for categorical variables and One-way ANOVA for continuous variables. Bivariate multinomial logistic regression models were used to assess the relative risk ratio for each potential correlate (age, gender, race/ethnicity, parental educational attainment, perception of health, and BMI percentile) of blood pressure categorization. Next, we used a multivariable multinomial logistic regression model to assess the relationship between each correlate and blood pressure categorization adjusting for all other correlates studied. Frequency distribution of parental awareness of blood pressure status was examined.

## Results

The final sample included 228 children, with median age 8.1 years (IQR 6.5-9.9). The median BMI percentile was 83.6 (IQR 58.4-97.1) with 16.7% between the 85$^{th}$ to 94$^{th}$ percentile (overweight) and 31.6% at or exceeding the 95$^{th}$ percentile (obesity). The cohort was predominantly Latino (61.8%) and male and female genders were equally represented (50% each). When asked to report child's general health, 96.5% of parents reported good, very good or excellent. We found 30.7% of children met criteria for hypertension, and 14% met criteria for elevated blood pressure. Sample characteristics stratified by child blood pressure categorization are described in Table 1.

BMI and age were significantly associated with hypertensive blood pressure in bivariate and multivariable models (Table 2) with the models yielding similar results. Multivariable multinomial logistic regression revealed for every ten-unit increase in BMI percentile the relative risk of categorization as hypertensive relative to the normal blood pressure category increased by a factor of 1.15 (95% CI 1.02 to 1.3) after adjustment for all other correlates. The same model revealed the relative risk of categorization as hypertensive relative to normal decreased by a factor of 0.16 (95% CI 0.3 to 0.02) for each one-year increase in age. Other sociodemographic variables examined (child's gender, general health, race/ethnicity, and parent's education) were not found to have statistically significant relationships with hypertension.

Less than five parents (redacted due to low sample size) reported their child had a history of high blood pressure.

## Discussion

In this low socioeconomic, racially/ethnically diverse sample, we observed levels of hypertension and elevated blood pressure that were considerably higher than national

prevalence estimates (30.7% vs. 5.5% and 14% vs. 7.1%, respectively).[1] Of the potential correlates analyzed, only BMI and age were significantly associated with hypertension. In contrast to the high rate of hypertension, extremely low parental awareness was observed.

These high rates could be due in part to the large proportion of children with BMIs above the range considered healthy in the present sample. Previous studies have shown an approximately three-fold increase in prevalence of hypertension when comparing overweight to non-overweight children (Friedemann et al., 2012). The influence of weight on hypertension has been described through sympathetic nervous system activation, as well as renal, hormonal and endothelial pathways (Kotsis et al., 2010). Regular screening for hypertension is needed especially among children who are at greater risk due to their weight. Clinical practice guidelines have acknowledged this, recommending yearly blood pressure screenings in all children ≥3 years and at every health encounter for those experiencing overweight (Flynn et al., 2017). However, health care provider compliance with this recommendation is unknown, and the rate of routine primary care well-child visits is lower in school-aged and adolescent children compared to those aged <6 years (Products - Data Briefs - Number 248 - May 2016, 2019). Efforts to maintain regular well-child visits, focused follow-up and consistent blood pressure screening need to be prioritized especially in children at higher risk.

Racial/ethnic disparities have been found in relation to both pediatric obesity and hypertension in previous studies (Isong et al., 2018; Kibria, 2019; Kit et al., 2015), with those of Latino and Non-Latino Black origins often experiencing the highest rates. In contrast, disparities were not detected in the present sample. The present sample was young, diverse and socioeconomically impoverished. The sample also had high rates of overweight and obesity. The intersectionality of race/ethnicity and socioeconomic status as risk factors for overweight and hypertension as well as how these conditions interact are areas needing more investigation in larger populations.

Although stability in blood pressure readings and the strength of blood pressure tracking into adulthood both increased with age, excess weight has been linked to cardiovascular disease risk factors in children as young as age 2 (Chen & Wang, 2008; Schultz et al., 2016). Our results also identified high rates of hypertension in young children, and found younger age to be a significant correlate of hypertension. Similarly, previous studies have found higher prevalence of hypertension in children aged 8-13 years versus children aged 13-17 years (Kibria, 2019). Differences in blood pressure variability with age (Falkner et al., 2008) and in relation to hormonal changes (Song et al., 2019) complicate the relationship between age and hypertension. In younger children, hypertension may be identified even less than in older children; data from 2012 found a lower percentage of well-care and problem-focused primary care pediatric visits for children aged 6-11 with documented blood pressure measurements than similar visits for children aged 12-17 (Products - Data Briefs - Number 248 - May 2016, 2019). Pediatric hypertension has been found to be associated with vascular changes which are strongly associated with cardiovascular disease endpoints in adulthood (Khoury & Urbina, 2018). Experiencing hypertension earlier in childhood may provide more time for these vascular changes to occur potentially increasing adulthood risk. Further research, especially among younger children, is needed.

There is a clear need to prevent and manage the long-term negative consequences of unhealthy pediatric weight and hypertension (Chen & Wang, 2008; Singh et al., 2008). However, it is unlikely this can be achieved without improving regular pediatric blood pressure screening and increasing parental awareness. We observed a near complete lack of parental awareness of child's blood pressure status, and a high frequency of parental report of generally good health that did not differ by child blood pressure status. Some of this lack of awareness may be warranted as the children we identified to have high or hypertensive blood pressure may have previously had blood pressure screenings within the normal range. However, the near complete lack of parental awareness suggests that it may also stem from a lack of screening, lack of diagnosis, and/or inadequate communication between providers and parents. Furthermore, there may be a need for increased recognition of available treatment for and implications of childhood hypertension among providers. Uptake of clinical practice guidelines is often lacking due to systemic and provider level challenges (Fischer et al., 2016). Efforts should be focused to understand the challenges of guideline adherence specific to pediatric blood pressure screening. Identification of barriers and facilitators to effective communication between providers and parents regarding pediatric hypertension is also needed. Parental awareness is integral to parents' ability to advocate for and effectively manage their children's health.

Limitations of the present study include small sample size and blood pressure readings limited to one occasion. Readings were collected in accordance with AAP guidelines. However, they were limited to a single visit rather than a series of three as is necessary for clinical diagnosis. Previous pediatric hypertension studies have also used readings from a single occasion, including those providing national prevalence estimates (Flynn et al., 2017; Kibria, 2019; Liao et al., 2009). The use of oscillometric assessment may have led to overestimated blood pressure measurements and weighing children while clothed may have led to overestimation of weight (Flynn et al., 2017). However, these measurement techniques are commonly used in clinical practice. The strength of the present study comes from the uniqueness of the sample and the assessment of parental awareness. We were able to explore the rate, correlates, and parental awareness of hypertensive blood pressure readings in a young, ethnically diverse underserved population.

## Conclusion

In this young, racially and ethnically diverse population of children ages 4 to 12, we observed high levels of elevated and hypertensive blood pressures, particularly among children who were overweight or experiencing obesity. Parental awareness of high blood pressure was almost non-existent. Public health officials and clinicians should continue efforts to prevent and treat overweight in children as more detrimental sequelae including pediatric hypertension become more prevalent. Further research is needed to focus on understanding barriers to blood pressure screening, diagnosis of pediatric hypertension and communication of child's blood pressure status to parents. Our findings highlight the need for interventions to promote regular blood pressure screening, appropriate hypertension diagnosis, parental awareness and education for management of hypertension in young overweight children.

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**Significance:**

Pediatric hypertension affects many US children, especially those who are overweight however parental awareness of this condition is largely unknown. This racially/ethnically diverse sample of children aged 4 to 12 years revealed high levels of elevated blood pressure however, very few parents reported awareness of their child's blood pressure status.

**Table 1:**

Baseline Characteristics of Children Ages 4-12 According to Blood Pressure Classification in the Healthy Kids & Families Study, 2015-2017 (n=228).

| | **Normal Blood Pressure 55% (n=126)** | **Elevated Blood Pressure 14.3% (n=32)** | **Hypertensive Blood Pressure 30.7% (n=70)** |
|---|---|---|---|
| **Sociodemographic** | | | |
| Age (years), *median (IQR)* | 8.5 (6.8-10.2) | 8.1 (6.2-9.6) | 7.2 (6.1-9.4) |
| Gender (female) | 53.2% | 46.9% | 45.7% |
| Race/Ethnicity | | | |
| Latino | 65.1% | 56.3% | 58.6 |
| Black or African American Non-Latino | 17.5% | 15.6% | 12.9 |
| White Non-Latino | 11.9% | 25% | 17.1 |
| Other or more than one race Non-Latino | 5.6% | 3.1% | 11.4% |
| Parental Education > high school/GED | 19.1% | 15.6% | 14.3% |
| **Health Status** | | | |
| Perception of Overall Health | | | |
| Excellent | 51.6% | 34.4% | 40% |
| Very Good | 28.6% | 18.8% | 35.7% |
| Good | 16.7% | 40.6% | 21.4% |
| Fair | 2.4% | 40.6% | 2.9% |
| Poor | 0.8% | 6.3% | 0% |
| **Clinical** | | | |
| BMI Percentile, *median (IQR)* | 80.8 (46.9-96.3) | 74.6 (54.1-95.7) | 91.8 (66.3-98.6) |

**Table 2:**

Associations of Sample Characteristics with Blood Pressure Characterization using Multinomial Logistic Regression Models in Children Ages 4-12 from Healthy Kids & Families Study, 2015-2017 (n=228).

| | Elevated Blood Pressure v. Normal | Hypertensive v. Normal |
|---|---|---|
| **Sociodemographic** | | |
| Age (years) | 0.87 (0.71- 1.05) | 0.86 (0.74- 1.0) * |
| Gender (female) | 0.76 (0.34- 1.7) | 0.73 (0.4- 1.36) |
| Race/Ethnicity | | |
| White Non-Latino | Reference | Reference |
| Latino | 0.4 (0.15- 1.11) | 0.64 (0.27- 1.52) |
| Black or African American Non-Latino | 0.45 (0.12- 1.66) | 0.54 (0.18- 1.64) |
| Other or More than one race Non-Latino | 0.25 (0.02- 2.59) | 1.66 (0.42- 6.61) |
| Parental Education > high school/GED | 0.91 (0.3- 2.75) | 0.54 (0.22- 1.3) |
| **Health Status** | | |
| Perception of Overall Health (good or better) | 0.4 (0.06- 2.51) | 0.78 (0.13- 4.72) |
| **Clinical** | | |
| BMI Percentile per 10 units | 1.0 (0.87- 1.16) | 1.16 (1.02- 1.3) * |

Each correlate is adjusted for all other variables listed; *Indicates significant difference ($p<0.05$). BMI: body mass index