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Research Briefs

Child and Maternal Factors That Influence Child Blood Pressure in Preschool Children: An Exploratory Study

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ABSTRACT

Purpose: Hypertension is a risk factor for cardiovascular disease (CVD) in adults and children and has its origins in childhood. While the prevalence of hypertension in children is estimated to be 2 to 5%, instance elevations in blood pressure readings (BPRs) in school-age children and adolescents are more common, track to adulthood, and are an independent risk factor for CVD. Less information is available about BPR in the preschool period and what child factors could influence those BPR. The primary aims of this exploratory study were to determine child blood pressure (BP) levels and determine effect sizes of the relationships between child and maternal factors that can influence child BP.
Methods: A convenience sample of 15 rural and 15 urban children enrolled in Head Start programs (13 males; 14 females; all black) with ability to understand and speak English and with mothers who gave consent and could understand, read and speak English were enrolled. Mothers completed demographic information about their child including, gender, birth history and age. Height, weight, waist circumference and BP were measured in the mothers and the children. Children gave saliva specimens for cortisol and C-reactive protein.
Results: Over 37% of the children had elevated BPR with over 20% at or above the 95th percentile. Effect sizes of relationships ranged from very small to large.
Conclusion: Elevations in BPR may be seen as early as preschool. It is important to examine factors, both child and maternal that influence BP.

An estimated 80 million adults and 2 to 3 million children in the US have hypertension (Mozaffarian et al., 2015; Rosner, Cook, Daniels, & Falkner, 2013). Diagnosed hypertension in children is rising (Hansen, Gunn, & Kaelber, 2007), but is surpassed by elevations in blood pressure readings (BPR) without diagnosed hypertension, particularly in school-age children and adolescents (Rosner et al., 2013). Elevated BPR on even one occasion are concerning in that they can track to adulthood (Gauer & Qiu, 2012) and are an independent risk factor for cardiovascular disease (Daniels, 2012). Few studies (Shapiro, Hersh, Caban, Sutherland, & Patel, 2012; Williams, Strobino, Bollella, & Brotanek, 2004) have examined BPR in the preschool period (ages 3-5 years) and none have examined what factors, both child and maternal, could influence these readings.

Child factors such as weight and weight distribution (body mass index (BMI), waist circumference (WC)) (Leung et al., 2011; Rosner et al., 2013) gender (Rosner et al., 2013), birth status (pre-term/term) (Zhang, Kris-Etherton, & Hartman, 2014), socioeconomic status (SES) (Mozaffarian et al., 2015) and stress response (salivary cortisol levels) (Dowd, Simanek, & Aiello, 2009) are known to influence BP in older children and adolescents. More recently, systemic inflammation (C-reactive protein (CRP)) has been considered and is thought to be the underlying mechanism for BP elevations (Brown et al., 2010;

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Hage, 2014). The location of the child's residence (rural or urban), can also differentially influence BPR (Grotto, Huerta, & Sharabi, 2008; U.S. Department of Agriculture, 2013). Evidence indicates that those living in rural areas have less access to care (Harris, Aboueissa, Baugh, & Sarton, 2015), higher poverty (U.S. Department of Agriculture, 2013), and lower educational attainment (U.S. Department of Agriculture, 2013); all factors that can influence BP.

Maternal factors, such as BMI, WC, and BP have also been associated with child BP (Malbora et al., 2010). These associations may be a reflection of genetic determinants and/or environmental influences (Cui, Hopper, & Harrap, 2002). Among the influences in the environment that can influence BP are socioeconomic status, maternal educational attainment, stress, industrial pollution, and tobacco exposure (Braveman & Gottlieb, 2014).

The purposes of this pilot study were to: 1) determine BP levels of preschool children enrolled in rural and urban Head Start (HS) programs and 2) determine the effect sizes of the relationships between child (gender, birth status (preterm or term), BMI, WC, cortisol, CRP levels) and maternal factors (BMI, BP, and WC) and child BPR. Eligibility to enroll in HS is limited to those of low SES, defined as family income at or below the federal poverty guidelines (U.S. Department of Health & Human Services Administration for Children & Families, 2015). Low SES children were enrolled to control for SES since SES is associated with elevated BP in older children, adolescents, and adults (Braveman & Gottlieb, 2014; Expert Panel on Integrated Guidelines for Cardiovascular Health and Risk Reduction in Children and Adolescents, 2012).

1. Methods

A convenience sample of 30 children and their mothers were enrolled from HS programs in a southeastern rural county (N = 15) and urban (N = 15) area. Inclusion criteria for the children included: being 3-5 years of age, able to speak and understand English, and have parental consent. The inclusion criteria for mothers were: be able to understand and speak English, complete study questionnaires, and be willing to provide informed consent. This study was approved by the Institutional Review Board of the first author's institution.

Two BP measurements (Dinamap PRO 100) taken two minutes apart for both mother and child were assessed in the right arm after a five minute rest period (James et al., 2014; National High Blood Pressure Education Program Working Group on High Blood Pressure in Children and Adolescents, 2004). The two measurements of the systolic blood pressure (SBP) reading and the diastolic blood pressure (DBP) reading were averaged and the average used for analysis. Information from the Eighth Joint National Committee (James et al., 2014) was used to determine adult percentiles. National pediatric guidelines were used to determine BP percentiles for children based on an algorithm using age, gender and height (National High Blood Pressure Education Program Working Group on High Blood Pressure in Children and Adolescents, 2004). Data about child age, gender, and birth were obtained from the mothers. Height for mother and child was measured in inches using a portable stadiometer (Heyward & Wagner, 2004), while weight was measured in pounds by a standard balance beam scale. BMI for both mother and child was deterhe/height in meters squared (Centers for Disease Control & Prevention). WC for both mother and child was measured in inches (US Centers for Disease Control and Prevention, 2007) and compared to WC references for children (Fernandez, Redden, Pietrobelli, & Allison, 2004) and adults (Fryar, Gu, & Ogden, 2012). Salivary samples were used to measure cortisol and CRP. Specimens were collected at approximately the same time of the day (10:00 – 10:30 AM, one hour after breakfast) to minimize the potential influence of circadian variability. Saliva samples were assayed for cortisol and CRP by ELISA immunoassay (Salimetrics, 2014).

Data were analyzed by computing frequencies on categorical variables and means on continuous variables. Effect sizes were determined based on bivariate correlations of child (gender, birth status, BMI, WC, cortisol, CRP levels) and maternal factors (BMI, BP, WC) and child BP percentiles. The reported magnitude of the effect sizes was based on the guidelines described by Cohen (1988) for Pearson's r and Phi coefficients. Small effect sizes are correlations of .1, medium effect sizes are those of .3 and large effect sizes are .5. The relevance threshold was set at .2 so any observed effect size that did not meet this threshold was considered not likely to be relevant.

Table 1
Descriptive Statistics for Demographic and Study Variables.

	Mean	Standard Deviation	Range
Child Factors			
Ages:	3.9 years	.78	3 – 5 years
Body Mass Index:	15.00	3.00	8.4 - 24.18
Waist Circumference:	19.92	1.57	17.72 – 25.69
Systolic Blood Pressure:	105	8.03	86-121
Diastolic Blood Pressure:	63	4.40	54 – 69
Systolic BP Percentile	78.05	19.03	31.75-99.17
Diastolic BP Percentile	79.18	14.21	37.75-94.24
Cortisol (mg/L):	0.76	2.66	0.04 – 12.37
C Reactive Protein (pg/ml)	9387.06	24811.52	89.98-93295.38
Mother Factors			
Body Mass Index	32.49	8.20	17.23 – 52.39
Waist Circumference	40.47	7.68	28.75 – 56.06
Systolic Blood Pressure:	119	15.6	84 - 152
Diastolic Blood Pressure:	69.75	11.07	49.5 – 97.5

2. Results

A total of 14 female and 13 male black children and their mothers participated in this study. Sample characteristics and descriptive statistics for the demographic (age) and study variables (BMI, WC, BP, cortisol CRP) are included in Table 1. The majority of children (87.3%) were in the normal or underweight category for BMI with one child being overweight and two obese based on the BMI percentiles (US Centers for Disease Control and Prevention, 2015). Only 1 child had WC at or above the 90th percentile (Fernandez et al., 2004). Of the children with birth status information, 18 were full term and six were preterm. The majority of the CRP and cortisol levels were not elevated. The mean SBP percentile was 78; mean DBP percentile was 79.

Of the child BP levels, 37.5% (n = 9) of the children in the sample with age, height and gender reported (n = 24) had elevated BPR at or above the 90th percentile. Of the 9 children (7 females and 2 males) with elevated BP, 4 (16.67%) had BPR in the 90th to 94th percentile (prehypertension level) and 5 (20.83%) had BPR at or above the 95th percentile (hypertensive level). Most of the elevations were of SBP. Over 77% of the children with elevated BPR were normal weight or underweight.

Pearson correlation coefficients for the child and maternal factors and associated effect sizes are presented in Table 2. Among the relationships with effect sizes that reached the level of relevance were child cortisol and child DBP percentile (large), child CRP and child DBP percentile (medium), maternal BMI and both child SBP percentile (medium) and child DBP percentile (small to medium), maternal WC and both child SBP percentile (small to medium) and child DBP (medium). Phi Coefficients for the relationships between nominal variables and associated effect sizes were calculated for child gender and child BP status (normal, prehypertensive, or hypertensive reading) and child birth status and child BP status. There was a medium to large effect size (.43) of gender and child BP status, with girls more likely to have a high BPR. In addition, there was a medium effect size (.35) of child birth status with child BP status, with children born preterm more likely to have a high BPR.

3. Discussion

Over 37% of the participants in this study had pre-hypertensive or hypertensive BPR. This finding coincides with those noted in school-