Published in final edited form as:

Pediatr Obes. 2014 December ; 9(6): e145–e148. doi:10.1111/ijpo.246.

High waist circumference is associated with elevated blood pressure in non-Hispanic White but not Hispanic children in a cohort of pre-adolescent children

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Summary

Purpose—Hispanics comprise the most rapidly growing demographic in the US, but little is known about the cardio-metabolic risk factors in Hispanic children. This study examined the association of high waist circumference (WC) and elevated blood pressure by race/ethnicity in a cohort of 9- to 13-year olds in New Haven, CT (N=824).

Methods—Waist circumference, overweight status, and blood pressure were measured in 2009, with follow-up in 2011.

Results—Logistic regression revealed Hispanic children had increased likelihood of elevated blood pressure at follow-up. High baseline WC was associated with increased likelihood of elevated blood pressure for non-Hispanic White but not Hispanic or non-Hispanic Black preadolescents, controlling for baseline age, gender, overweight, and blood pressure.

Conclusion—Potential racial/ethnic differences in the association between high waist circumference and elevated blood pressure may impact identification of children at risk for elevated blood pressure, especially among Hispanics.

Keywords

blood pressure; longitudinal; abdominal adiposity; race/ethnicity; waist circumference; Hispanic

Introduction

Identifying preadolescents at high risk for obesity-related conditions like hypertension is a critical focus for preventing chronic disease. Among preadolescents, some studies show that abdominal adiposity, as measured by waist circumference (WC), predicts elevated blood

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Conflict of interest: No authors had any conflicts of interest to report.

pressure (BP) independently of overall adiposity, as measured by body mass index (BMI) (1-4). However, it is unclear whether associations between WC and elevated BP vary by race/ethnicity. Although several studies show similar associations between WC and BP across races, these studies are predominantly cross-sectional and limited to non-Hispanic Whites and non-Hispanic Blacks (5-7). Given that Hispanics comprise the fastest growing US demographic (8), and are at high risk for obesity (9), better understanding of the relationship between WC and elevated BP in this population is critical.

Our objective was to examine whether the association between WC and elevated BP varied by race/ethnicity in a prospective preadolescent cohort comprised predominantly of non-Hispanic Blacks and Hispanics.

Methods

Participants

Fifth and sixth graders from 12 randomly selected K-8 public schools in New Haven, CT (N=1,161). Baseline measures were taken in autumn 2009 with follow-up in autumn 2011. The analytic sample included non-Hispanic White, non-Hispanic Black, and Hispanic participants with complete baseline and follow-up data (n=824).

Procedure

Yale University Human Subjects Committee and Board of Education approved procedures. Parental consent and child assent were obtained for participants in English or Spanish. Trained research staff measured height and weight, in light clothing, using a standardized stadiometer (Charder Electronic Co., Ltd., Taiwan) and digital scale (Seca Co, Hamburg, Germany). Researchers used a standard tape measure to take two measurements of WC to the nearest 0.1 cm, at the smallest diameter between the last rib and the top of hip (10) (Pearson correlation coefficient= 0.99). BP was measured twice using an automatic wrist cuff (BpTRU Medical Devices, Coquitlam, Canada), at least one minute apart (11). If measurements varied by more than 5 mmHg, a third reading was taken, and the first reading dropped.

Variable Definitions

Race/ethnicity was categorized as non-Hispanic White, non-Hispanic Black, and Hispanic from school records. Elevated BP was a dichotomous variable defined as average systolic or diastolic pressure >90th percentile for age, gender and height, or if average systolic BP >120 mmHg or average diastolic BP > 80 mmHg(12). High WC was defined as WC >90th percentile of gender- and age-adjusted reference values for children (13). Children were classified as overweight (including obese) if BMI percentile ≥ 85th percentile, according to CDC growth charts (14). The variance inflation factor test showed little evidence of multicollinearity between high WC and overweight, justifying inclusion of both covariates in analytic models (15).

Statistical analyses

Analyses were conducted using SAS 9.3 (SAS, Institute, Cary, NC). Survey procedures accounted for the school-clustered sampling design. Logistic regression was used to test the association of baseline WC and race/ethnicity with elevated BP at follow up, adjusting for age, gender, overweight, and baseline BP. A second model added an interaction term between race/ethnic dummy variables and WC to test whether the association between WC and elevated BP varied by race/ethnicity. Main effects were considered statistically significant at $p < 0.05$ and the interaction terms were considered statistically significant at $p < 0.10$.

Results

Twenty-six percent of preadolescents had high WC at baseline, and of these, 24.4% had elevated BP at follow-up (Table 1). The proportion of overweight children with high baseline WC was 54.8%, while the proportion of normal weight children with high WC was 1.3%.

Hispanic race/ethnicity was associated with increased likelihood of elevated BP at follow-up compared to non-Hispanic Whites (OR 2.01, CI 1.01, 3.98). Overweight was associated with increased likelihood of elevated BP (OR 2.42, CI 1.33, 4.40), but the association between high WC and elevated BP was not statistically significant (OR 1.66 CI 0.93, 2.95). However, Model 2 revealed that the association between high WC and elevated BP differs by race/ethnicity, such that high baseline WC was associated with increased likelihood of elevated BP for non-Hispanic Whites, but not Hispanics ($p < 0.001$ for interaction) or non-Hispanic Blacks ($p = 0.070$ for interaction) (Figure 1).

Discussion

Our key finding is that Hispanic preadolescents were at increased risk of elevated BP, even after controlling for overweight and WC. These results are surprising, considering that most studies have shown that race-BP associations in children disappear after accounting for weight status (6, 16, 17).

A second important finding is that high WC is associated with increased likelihood of elevated BP in non-Hispanic White but not Hispanic preadolescents. For Hispanic preadolescents, abdominal adiposity may not be as strong a risk factor for elevated BP as among non-Hispanic Whites. Another possibility is that the 90th percentile cutpoint for high WC does not adequately reflect excess abdominal adiposity in Hispanics. Fernandez showed that Mexican-American children have higher WC at equivalent BMI percentiles compared to other race/ethnicities, suggesting that the same WC cutpoint applied across race/ethnicities may not capture risk attributable to abdominal adiposity in some Hispanic populations (13).

These results are less conclusive regarding whether high WC is associated with increased likelihood of elevated BP in non-Hispanic Blacks. Non-Hispanic Blacks with high WC are approximately two times as likely to have high BP compared to non-Hispanic Blacks with normal WC; however, this difference is statistically non-significant. Moreover, the

interaction for high WC and non-Hispanic Black is significant, indicating that high WC is more strongly associated with elevated BP among non-Hispanic Whites than Blacks. It is possible that the lack of statistical significance is due to small sample sizes for non-Hispanic Whites and Blacks, and requires further examination.

Unfortunately, sample size limitations and the use of dichotomous cutpoints for overweight and high WC precluded finer examination of WC-BP associations, nor could we differentiate between Hispanic sub-populations. These results require replication in a larger longitudinal sample to better understand the link between WC and BP during childhood physical development.

Despite limitations, this study suggests that Hispanic preadolescents face increased risk of elevated BP and may experience cardio-metabolic risk factors differently than other race/ethnicities.. Future research is required to understand cardio-metabolic risk factors in this rapidly growing demographic.

Acknowledgments

JJ and ACS were responsible for study design and data collection. LPS and KGH were responsible for data analysis. JJ, LPS, KGH, and ACS were involved in data interpretation, writing the paper, and had final approval of the submitted and published versions.

This study and the authors' time were generously funded by the National Institute of Child and Human Development (1R01 HD070740), Aetna Foundation, Kresge Foundation and The Patrick and Catherine Weldon Donaghue Medical Research Foundation. For LPS, we thank the Carolina Population Center for training support (T32 HD007168) and for general support (R24 HD050924). No funder had a role in the design, analysis, or writing of this article.

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Figure 1.

Predicted probabilities of elevated blood pressure at follow-up by baseline WC, adjusted for age, gender, overweight, and blood pressure at baseline.

Table 1

Baseline characteristics of a multi-ethnic cohort of preadolescents elevated blood pressure at follow-up, 2009 and 2011^a

Baseline Characteristics	Total N	Elevated Blood Pressure at Follow-up		<i>p</i> ^c
		Yes (N=104)	No (N=720)	
		% or Mean (SD) ^b	% or Mean (SD) ^b	
Age (years)	824	11.0 (0.6)	10.9 (0.7)	0.217
Race/ethnicity				0.170
Hispanic	408	14.0	86.0	
Non-Hispanic Black	316	12.7	87.3	
Non-Hispanic White	100	7.0	93.0	
Gender				0.007
Female	443	9.7	90.3	
Male	381	16.0	84.0	
Blood pressure				<0.001
Elevated	75	40.0	60.0	
Normal	749	9.9	90.1	
Weight status ^d				<0.001
Overweight, CDC	385	20.5	79.5	
Healthy weight, CDC	439	5.7	94.3	
Overweight, IOTF	400	19.8	80.2	<0.001
Healthy weight, IOTF	424	5.9	94.1	
Overweight, WHO	469	19.2	80.8	<0.001
Healthy weight, WHO	355	3.9	96.1	
Waist circumference				<0.001
High	217	24.4	75.6	
Normal	607	8.4	91.6	

^aElevated blood pressure is defined as age, sex, and height adjusted systolic or diastolic blood pressure >90th percentile. High waist circumference is defined as age and sex adjusted waist circumference >90th percentile.

^bRow percents

^cDerived from χ^2 for categorical variables or *t*-test for continuous

^dUsing the Centers for Disease Control (CDC) growth charts, overweight is defined as BMI ≥ 85th percentile(14). Using the International Obesity Taskforce (IOTF) reference, overweight is BMI ≥ 25 kg/m², based on BMI centile curves extrapolated from adults(18). Using the World Health Organization (WHO) growth standard, overweight is defined as BMI ≥ 1 standard deviation above the reference mean(19). For all references, overweight includes obese children.