Is Waist-to-Height Ratio a Better Obesity Risk-Factor Indicator for Puerto Rican Children than is BMI or Waist Circumference?

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Objective: Puerto Rican children could have a higher prevalence of obesity, compared to US children or even to US Hispanic children. Obese youths are more likely to have risk factors for cardiovascular conditions, such as hypertension. Although BMI provides a simple, convenient measurement of obesity, it does not measure body fat distribution, associated with mortality and morbidity. Waist circumference (WC) and waist-to-height ratio (WHtR) have been suggested to estimate obesity health risks. This study aimed to explore the association of a single blood pressure reading with 3 different obesity indicators (WC, BMI, and WHtR).

Methods: A representative sample of students (first to sixth grade) from public and private schools in Puerto Rico was selected. The sample size consisted of 249 students, representing a 63% response rate. According to the sex-specific BMIs, approximately 38.1% of the children were obese or overweight. The prevalence of obesity was slightly higher when determined using WHtR but lower when using WC as the overweight indicator. The prevalence of high blood pressure among students was 12.5%; an additional 11.3% of the students were classified as possible pre-hypertensive.

Results: Regardless of the weight indicator used, overweight children were shown to have a higher risk of pre-hypertension/hypertension (as defined by a single BP measure) than were non-overweight children. The odds for high blood pressure were almost 3 times higher using WHtR. Logistic regression showed a stronger relationship between WHtR and the risk of pre-hypertension/hypertension than that between the former and either BMI or WC.

Conclusion: This study suggests the possibility of higher prevalence of high blood pressure in obese Puerto Rican children. The waist-to height ratio could be the best indicator to measure obesity and potential hypertension in Puerto Rican children. [*P R Health Sci J 2016;35:20-25*]

Key words: Obesity, Risk Factors, Puerto Rican Children, Hypertension, BMI, WHtR, WC

Despite some declines in overall childhood obesity (1,2), the condition continues to be a major public health concern, both in the US and worldwide (3,4). Children belonging to ethnic minorities, particularly those who are Hispanic, show a higher prevalence of obesity than do white non- Hispanic US children within the same age range (2). Children living on the island of Puerto Rico tend to have a higher prevalence of obesity than do children living on the US mainland (5).

Obese youths are more likely to have risk factors for metabolic and cardiovascular conditions, such as pre-diabetes, diabetes, high cholesterol levels, and hypertension (6–10), extending into adulthood and usually followed by serious health consequences (11–15). Hypertension occurs more commonly in obese children than in non-obese children (16–19) and is a predictor of adult hypertension (20). Hypertension in children is defined as a systolic or diastolic blood pressure (BP) value greater than or equal to the 95th percentile for age, gender, and height, according to normative data derived from the analysis of a large database of BP readings obtained from healthy children (21). A study of Puerto Rican adolescents suggested that this population has a high prevalence of hypertension associated with obesity (22). These studies underscore the need to identify Puerto

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The authors have no conflicts of interest to disclose.

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Rican children who are at a high risk for chronic conditions associated with obesity.

The body mass index (BMI; in kg/m2) is the standard indicator of obesity in adults, both in the US and worldwide (23–25). However, obesity-related health risks are mainly associated with body fat distribution, more so than with adiposity per se (26). The BMI cannot distinguish between body fatness, muscle mass, and skeletal mass, and its use can result in large errors in the estimation of body fatness (27–30). As posited by Jensen (31), a more important aspect of obesity is the regional distribution of excess body fat since mortality and morbidity vary with the distribution of body fat; the highest risk is linked to excessive abdominal fat (central obesity or abdominal obesity).

BMI-for-age is the accepted indicator of body fatness for children and adolescents in the USA and worldwide (32–35). As is the case with BMI among adults, concerns associated with using BMI for age, to estimate overweight and obesity among children have also been raised since it tends to measure excess weight rather than excess body fat (36–39). Other factors, including height and level of sexual maturation, may influence the relationship between BMI and body fat in children (40). Therefore, other anthropometric measures, such as waist-to-hip ratio (W/Hip), waist circumference (WC), and WHtR, have been recommended (41–42). These indicators are independently associated with a higher risk for cardiovascular disease and predict other overweight-related risk factors (43–45). For example, Chen et al. (45) found that 7-year-old children in the highest WHtR quartile had the highest prevalence of elevated BP and the highest adjusted odds ratio of elevated BP compared with children in the lowest quartile of WHtR.

In 2008, we conducted a study in a school district of Puerto Rico to measure the prevalence of childhood overweight among elementary school students (first to sixth grades) from public and private schools in the island. This article focuses on comparing the association of 3 different obesity indicators (WC, BMI, and WHtR) with blood pressure (measured 1 time, only) among children participating in the study.

Research design and Methods

This study adopted a cross-sectional design. A representative sample of first- to sixth-grade students from public and private elementary schools in a semi-urban municipality of Puerto Rico was selected, using a 2-stage stratified cluster sampling design. The computed sample size consisted of 398 students. A total of 250 students agreed to participate and a final sample of 249 was selected, after removing 1 student whose parents were found to have high blood pressure, representing a 63% response rate (249/398). Details regarding the design and execution of the study have been previously reported (5).

Data analysis

The data were analyzed using SPSS (Statistical Package for the Social Sciences) for Windows (version 15.0). Proportions were compared using chi-square tests. Simple logistic regression models were used to evaluate the strength of the association between overweight indicators and hypertension. This sample is representative of all the students from the first to the sixth grades in Cayey, and the results were weighted using the inverse of the probability of sample selection. All analyses were performed on weighted data.

Data collection

Anthropometric measurements

A single trained examiner took all anthropometric measurements. Using a portable scale, weight was measured to the nearest 0.1 kg. Height was measured to the nearest 0.1 cm using a portable stadiometer. The WC of each participant was measured at the umbilicus, using a flexible measuring tape, to the nearest 0.1 cm, with the child in a standing position. All the measurements were taken twice and the average of them was used for analysis purposes. Throughout the data collection, quality control checks were made, following the NHANES body measures procedures manuals, were made to minimize errors (46).

Classification of overweight

The weight status of the children was estimated using the 2000 sex-specific BMI-for-age growth charts from the Centers for Disease Control and Prevention (39). Children with a BMI-for-age ranging from 85th to less than the 95th percentile, were considered overweight , whereas children with a BMI-for-age at or greater than the 95th percentile for age and sex, using the most recent Centers for Disease Control and Prevention (CDC) National Center for Health Statistics (NCHS) growth curves, were considered obese (32). We used a waist circumference in the 90th percentile to classify obese children (47). The WHtR of each child was calculated dividing waist circumference (cm) by height (cm). A cutoff point greater than or equal to 0.5 has been suggested for classifying children as overweight/obese, independent of age and gender (48). However, in order to better identify a more sensitive cutoff-point value for our population, statistical analyses using receiver operating characteristic (ROC) curve analyses were performed. Based on these analyses, a WHtR of 0.47 was considered the best cutoff point value for obesity in our population.

Blood pressure measurement and Classification

Blood pressure was measured in a standardized manner using a size-appropriate digital sphygmomanometer (regularly calibrated), with the child in a sitting position and taken from the right arm after 5 to 7 minutes of rest. All the measurements were taken by the same examiner. Systolic and diastolic readings were converted to age-, sex-, and height-specific percentiles. These values were used to classify each child as possibly being pre-hypertensive (90th<95th percentile) or hypertensive (> 95th percentile) (21).

Results

The final sample comprised 249 students and their parents, representing a response rate of 63.0% for the children and 44.0% for the parents. Approximately half of the students (51.3%) were boys, and the mean age was 8.9 (±1.9) years; 78.6% of the participants were from public schools, 52.7% were located in rural areas, and 52.2% had the government-provided health insurance, "Mi Salud" (data not shown).

Based on the sex-specific BMI-for-age, approximately 37.7% of the children were found to be obese or overweight. Compared to normal-weight and underweight children, obese and overweight students had a higher possibility of suffering from hypertension (18.3% vs. 7.9%) or pre-hypertension (13.8% vs. 10.0%). The prevalence of overweight or obesity was found to be slightly higher when the WHtR (42.2%) or WC (22.9%) weight indicators were used. Using any of the 3 weight indicators, we once again found that obese or overweight students had a higher possibility of having hypertension than did normal-weight or underweight children. However, when we used only the WC measure, we found that the possibility of suffering from pre-hypertension was higher in those who were not obese.

Overall, the prevalence of screening positive for hypertension (presenting a single high blood pressure measure) was 12.6% and a screening positive for pre-hypertension (after a single blood pressure measure), 11.4%. A significantly higher proportion of boys than girl might possibly have been suffering from high blood pressure (14.4% and 10.7%, respectively) or pre-hypertension (12.1% and 10.7%, respectively) (Table 1). Boys had 34% higher odds than girls of suffering from abnormal blood pressure measures (OR = 1.34; 95% CI: 0.74–2.40), but these results were not statistically significant.

The possibility that any given participant would be hypertensive/pre-hypertensive increased among children from the second to the fifth grades, with a slight decrease among sixth graders. About 1 out of every 4 fifth graders (24.9%) possibly had hypertension, and 12.7% may had pre-hypertension. The participating fifth-grade students had over 3 times higher odds of maybe having hypertension or pre-hypertension than did the participating first-grade students (OR = 3.34; 95% CI: 1.30–8.57).

Regardless of the weight indicator used, overweight children were at a higher risk of pre-hypertension/hypertension than non-overweight children were. Students with a BMI-for-age at or above the 85th percentile had twice the odds of (maybe) having pre-hypertension or hypertension (OR = 2.15; 95% CI = 1.17–3.94). The odds for high blood pressure were almost 3 times higher (OR = 2.70; 95% CI = 1.48–4.93) when the WHtR was used as the obesity indicator. However, although students classified as obese using the WC indicator had 88% higher odds of hypertension risk than did children who were not so classified (OR = 1.88; 95% CI = 0.98–3.60), this result was not statistically significant.

Discussion

Our study suggests that there could be high prevalence of hypertension and pre-hypertension (as defined in this study by using a single blood pressure measure), particularly among overweight and obese children, regardless of the obesity indicator used (BMI-for-age, WHtR, or WC). This possible prevalence of pre-hypertension/hypertension for Puerto Rican children was higher than the prevalence reported by Hansen and colleagues (49) for US children (3–15 y/o). In addition,

Table 1. Weighted frequency and prevalence estimates of possible Hypertension screening status by Gender, Grade, and Weight status for Elementary school students in Cayey, Puerto Rico, 2008

Characteristics	Possible Hypertension screening status				
	Normal N (%)	Pre-hypertension[1] N (%)	Hypertension[1] N (%)	Odds ratio (95% CI)†	Total N (%)
Gender					
Male	1,427 (73.4)	236 (12.1)	280 (14.4)	1.34 (0.74-2.40)	1,960 (51.3)
Female	1,462 (78.6)	198 (10.7)	199 (10.7)	Reference	1,860 (48.7)
Grade					
First	688 (85.7)	51 (6.4)	64 (8.0)	Reference	820 (21.5)
Second	160 (87.4)	23 (12.6)	0 (0.0)	0.56 (0.06-5.02)	183 (4.8)
Third	675 (81.7)	93 (11.3)	58 (7.0)	1.28 (0.46-3.54)	826 (21.6)
Fourth	462 (72.0)	100 (15.6)	80 (12.5)	2.25 (0.82-6.16)	643 (16.8)
Fifth	490 (62.3)	100 (12.7)	196 (24.9)	3.34 (1.30-8.57)	786 (20.6)
Sixth	415 (73.8)	67 (11.9)	80 (14.2)	2.08 (0.73-5.92)	562 (14.7)
*Sex-Specific BMI-for-Age**					
Obese/overweight (≥85th percentile)	944 (68.0)	191 (13.8)	254 (18.3)	2.15 (1.17-3.94)	1,390 (37.7)
Normal/underweight (<85th percentile)	1,872 (82.1)	228 (10.0)	181 (7.9)	Reference	2,298 (62.3)
*Waist-to-Height ratio***					
Obese (≥0.5)	1,054 (65.3)	236 (14.6)	323 (20.0)	2.70 (1.48-4.93)	1,614 (42.2)
Not obese (<0.5)	1,836 (83.8)	198 (9.0)	156 (7.1)	Reference	2,206 (57.8)
*Waist circumference***					
Obese	579 (66.2)	80 (9.2)	215 (24.6)	1.88 (0.98-3.60)	874 (22.9)
Not obese	2,311 (78.9)	354 (12.1)	264 (9.0)	Reference	2,946 (77.1)
Total	*2,890 (76.0)*	*434 (11.4)*	*479 (12.6)*		*3,820 (100)*

*p<0.05, **p<0.01, †pre-hypertension/hypertension vs. normal, [1]using a single blood pressure measure

we found discrepancies among obesity indicators, both in terms of estimating the prevalence of childhood obesity and when exploring the odds of possible hypertension/pre-hypertension with obesity. The prevalence of overweight/obesity was higher when computed by WHtR than it was when computed by either BMI or WC. Likewise, the estimated association between overweight/obesity and hypertension differed considerably for each of the obesity indicators used. Logistic regression analyses showed a stronger relationship of WHtR to the odds of possibly having pre-hypertension/hypertension, than the relationship of either BMI or WC to these same odds.

This study raises considerable concerns regarding the morbidity and mortality risks of Hispanic children, particularly those living in Puerto Rico, of cardiovascular diseases and regarding, as well, the importance of the early diagnosis of both obesity and obesity associated conditions, such as hypertension. Specifically, our results show that some overweight/obese children who may be at high risk for hypertension may not be correctly identified as such when only the BMI-for-age is used to determine their weight category. Despite the fact that BMI has been the accepted indicator of overweight/obesity, factors such as growth and ethnicity could make both defining obesity and estimating risk, more complex. This may represent a considerable public health issue given the fact that Hispanic children in the US have a higher prevalence of obesity, compared to white and black children of similar residence. Furthermore, the study of Suglia and colleagues (50) suggests that obese Hispanic adolescents may be at higher risk of adult hypertension than are normal-weight Hispanic adolescents; the odds for hypertension were almost 3 times higher (OR = 2.7) for Hispanic males and almost 7 times higher (OR = 6.5) for Hispanic females, compared to those odds for normal-weight Hispanics. Given the long-term consequences of obesity during childhood, particularly in terms of adulthood cardiovascular diseases linked to hypertension, careful attention should be given to the timely identification of obesity and to the design of obesity-prevention interventions that target Hispanic children. Moreover, our results call for a deeper examination of the most appropriate obesity indicators for minorities in the US and, in addition, point to the need for hypertension screenings and interventions targeted at these populations, particularly the Puerto Rican youth population, which is part of the second largest Hispanic group in the US. Despite the large proportion of Puerto Ricans on the US mainland and their high obesity and chronic disease prevalence, few nationwide studies have looked at their individual health needs. In fact, our previous analyses show higher obesity prevalence for Puerto Rican children than for Mexican American children, as previously reported by Ogden (2). Therefore, our study underscores the need for an accurate identification of at-risk children within the Hispanic population and for the systematic documentation of their health and nutritional needs.

There are several limiting factors to be considered when examining the results of this study. The principal limitation of this study was the use of only 1 measurement of blood pressure to estimate hypertension. The Fourth Task Force on the diagnosis, evaluation, and treatment of high blood pressure in children and adolescents of the National High Blood Pressure Education Program Working Group on High Blood Pressure in Children and Adolescents (21) recommends that pre-hypertension/hypertension be diagnosed after measuring blood pressure (BP) on 3 different occasions, with at least 2 BP readings performed on each occasion, and using the manual auscultatory BP method. However, since the initial purpose of this study was to measure the prevalence of childhood obesity and not to diagnose hypertension or reduce the respondents' burdens, only 1 BP reading, at only 1 point in time, and using an automated and not auscultatory method was employed to estimate pre-hypertension/hypertension. Thus, we cannot definitively report a specific prevalence of pre-hypertension/hypertension in this population but are able to suggest instead that there is a possible risk of pre-hypertension/hypertension among study participants. Moreover, pre-hypertension/hypertension categories cannot be defined. Future studies should comply with the recommendations of the National High Blood Pressure Education Program Working Group on High Blood Pressure in Children and Adolescents. Moreover, given that the same blood pressure values were used to explore the associations of possible hypertension or pre-hypertension estimates with the 3 different obesity indicators, our study may suggest the possible existence of cardiovascular risks in obese Puerto Rican children. In addition, based on our results, we would suggest that WHtR might be the most appropriate indicator for estimating the risk of hypertension among obese Puerto Rican children. The second limitation of our study pertains to its cross-sectional design. Hypertension is a chronic condition that develops over time; therefore, the reported significant association of obesity (measured via each of the 3 weight-status indicators) with a possible estimate of hypertension does not necessarily mean that there is a causal relationship: Other confounders not explored in our study may contribute to this association.

On the other hand, our study has many strengths worth mentioning. This is the first study conducted on the island measuring childhood obesity in a representative sample of elementary school–aged children. In addition, it is the first study attempting to compare the association of pre-hypertension/hypertension with each of 3 obesity indicators: BMI, WC, and WHtR. Our results lead us to conclude that it might be possible to use WHtR to estimate obesity and chronic disease risk; should that be the case, this measure might could be incorporated into the current monitoring systems at schools. In addition, it is a convenient and easy technique that can be used instead of the BMI-for-age since it requires only a measuring tape and no costly or sophisticated equipment to estimate obesity/overweight. Further studies should be conducted to confirm our observations and to better establish the most appropriate cutoff point for determining obesity using the WHtR.

Resumen

Los niños puertorriqueños podrían tener mayor prevalencia de obesidad que los niños estadounidenses, aun entre hispanos. Los niños obesos tienen mayor riesgo a condiciones cardiovasculares, como hipertensión. Aunque el IMC se ha utilizado para diagnosticar la obesidad, no considera la distribución de grasa corporal asociada a mortalidad y morbilidad. La circunferencia de la cintura (CC) y la razón cintura-estatura (RC/E) se sugieren para estimar riesgos de salud por obesidad. Objetivos: Este estudio exploró la asociación entre una medida de presión sanguínea con tres distintos indicadores de obesidad: CC, IMC y RC/E. Métodos: Se seleccionó una muestra representativa de niños de primero a sexto grado de escuelas públicas y privadas de Puerto Rico. Resultados: El tamaño final de la muestra fue de 249 estudiantes, para una tasa de respuesta de 63%. Basado en el IMC por sexo y edad, 38.1% de los niños estaban sobrepeso/obesos. La prevalencia de obesidad fue mayor basado la RC/E y más baja cuando utilizamos la CC como indicador de sobrepeso/obesidad. La posible tasa de hipertensión (usando una medida de presión sanguínea) entre los estudiantes fue de 12.5% con un 11.3% adicional clasificado con posible pre-hipertensión. Independientemente del indicador, los niños con sobrepeso tuvieron un mayor riesgo de posible hipertensión/pre-hipertensión que los niños sin sobrepeso. El riesgo relativo para alta presión era tres veces con RC/E comparado con IMC o CC. Conclusiones: El estudio sugiere la posibilidad de una alta prevalencia de alta presión entre niños obesos. El RC/E puede ser un mejor indicador para estimar de obesidad y el potencial de hipertensión en niños de Puerto Rico.

Acknowledgments

We would like to acknowledge the Agency for Healthcare Research and Quality (AHRQ), the US Department of Health and Human Services, and the Puerto Rico Health Services Research Institute (PRHSRI) of the UPR Graduate School of Public Health (grant #5 R24 HS014060-06).

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