Obesity and Hypertension in School Children of Puerto Rico

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Objective: To determine the prevalence of obesity and hypertension and the association of hypertension with obesity in an island-wide sample of school children in Puerto Rico.

Methods: The quantitative descriptive study included 3,145 children, 5 to 17 years of age, from Puerto Rico; they were examined once during a 3-year (2014–2017) period for weight (lbs) and height (cm) to calculate their body mass index (BMI) based on their age and sex. Children with BMIs in or above the 95th percentile were considered obese. The systolic and diastolic blood pressures (mm Hg) were measured once to determine the prevalence of hypertension based on age, height, and sex. Children with blood pressures in or above the 95th percentile were considered hypertensive. The blood pressures of obese and non-obese children were compared using the independent samples t-test. The association between obesity status (obese/non-obese) and hypertensive status (hypertensive/non-hypertensive) was analyzed using the chi-square test.

Results: A total of 25.7% of the children were obese. Boys were 1.38 times as likely to be obese as girls were. 9.9% of the children were hypertensive. Obese children were 2.82 times as likely to be hypertensive as non-obese children were.

Conclusion: About 1 of every 4 children in the sample was obese; about 1 of 10 was hypertensive. Obese children were at a significantly higher risk for hypertension than non-obese children were. The study indicates the need for public health strategies that promote prevention and parental education to reduce the prevalence of obesity and the sequelae of hypertension. [*P R Health Sci J 2021;40:45-49*]

Key words: Obesity, Hypertension, Children, Puerto Rico, Prevalence

During most of the human evolutionary process, survival depended on increasing body weight to sustain the energy expenditures made in work and war. During the early 20th century, the consumption of high-energy foods was promoted to combat malnutrition. Eventually, the use of fats and sugar products along with sedentary lifestyles led to a higher prevalences of overweight and obesity (1).

The World Health Organization estimated that in 1975, approximately 4% of children and adolescents from 5 to 19 years of age were obese. The prevalence increased to 6% of girls and 8% of boys by 2016 (2). In 2016, the prevalence of obesity among children and youth aged from 2 to 19 years in the United States was 18.5%. Obesity has been associated with hypertension, asthma, type 2 diabetes, sleep apnea, hypercholesteremia, lower self-esteem, and impaired social functioning in children (3). The present study examined the prevalence of obesity and hypertension in a sample of 3,145 school children in 7 educational districts of Puerto Rico.

Materials and Methods

We conducted the study with the approval of the institutional review board of the Inter American University of Puerto Rico and the Division of Research of the Department of Education of Puerto Rico. The present study was part of a larger project that included an ocular examination, that explored, among other things, refractive error, ocular deviation, accommodation, and ocular pathologies. Parents signed written consents allowing the participation of their children and the acquisition of their children's individually identifiable health information.

Subjects

The population for the study was 374,521 students from 5 to 17 years old from the public-school system of Puerto Rico (4). The sample included 3,145 children from 5 to 17 years of age from 30 schools in the 7 school districts of the Commonwealth of Puerto Rico. A total of 1,584 of the children (50.4%) were male and 1,561 (49.6%) were female. At least 1 elementary, intermediate, and high school were chosen at random from

each district by the Director of the Health Nursing Services of the Department of Education of Puerto Rico. Each school had a maximum of 300 children. Once a school was selected all the children within that school were eligible to participate. The parents of the children received an informed consent form to decide if they allowed their child's participation in the study.

Procedure

Each school was visited in advance, at least 1 month before the examinations scheduled for that institution, to discuss the project's objectives and requirements with the school principal, social worker, nurse, and other assigned personnel and to distribute the consent forms. A site within each school that could accommodate the equipment, examination stations, and examination personnel was selected.

Each school required 2 to 4 visits to examine all the children. The examination personnel at each visited school included 2 or 3 licensed doctors of optometry and 6 to 8 advanced optometry students, who worked under the supervision of the optometrists from the Inter American University of Puerto Rico School of Optometry. All the members of the examination team were trained in the protocol of the study. Each child whose parent(s) or guardian(s) consented to his or her participation received a description of the testing procedure and, if willing to take part, was asked to give his or her assent. The examinations of the participating children in the 30 schools involved in the study started in August 2014 and finished in December 2017.

Using a portable stadiometer, we measured the height of each child, without shoes, to the nearest millimeter. The weight (to the nearest tenth of a pound) of each child was determined using an electronic weight scale. The scale was calibrated with standard weights before each testing day. The systolic and diastolic blood pressures of each child were measured once using the following protocol: The cuff of a sphygmomanometer was wrapped around the upper arm of the seated child and that child's elbow flexed to heart level. The cuff size was chosen to fit the child's arm. The children were requested to sit for 3 minutes with their feet on the floor and their legs uncrossed before the blood pressure measurements were taken. Blood pressure readings were taken from 9 AM to noontime (5,6).

The age, weight, and height measurements were used to calculate the body mass index (BMI) of each child. Children with a BMI equal to or greater than the 95th percentile were considered obese (7). Children with blood pressure (systolic, diastolic or both) equal to or greater than the 95th percentile for their gender, height, and age were considered hypertensive (8). We used an EBMcalc Statistics application, which applies the current norms to identify obese and hypertensive children (9).

Data Analysis

The results regarding the prevalences of obesity and hypertension were weighted for each group of school children by age and gender. The weights were obtained by dividing the number of children (in the year 2014) in the population by the number of children in the study sample. We conducted statistical analyses using the weighted data (10).

We determined, for each age group (5 to 17 years of age), the 95% confidence interval of the proportion of children who were obese and/or hypertensive compared to the total number of children (11).

We compared the mean systolic and diastolic blood pressures of the non-obese and obese children using the independent samples t-test (12).

We used chi-square tests to determine the association between the nominal variables (obesity and hypertension) and the age-group variable (5 to 17 years of age) of the children. The strength of the association was determined using the Phi (Φ value) for the 2 X 2 contingency table comparisons (obesity status and gender or hypertensive status and gender). Cramer's V value was used for larger contingency tables (obesity status and age and hypertensive status and gender) (12). The adjusted residuals of the chi-square test were used to conduct post-hoc tests to determine the age categories in which obesity and hypertension were significantly different from each other (13). Finally, we performed a chi-square test to determine the odds ratio and the association between obesity and hypertension (14). All statistical analyses were conducted with IBM SPSS Statistics for Windows, Version 25, software (15).

Results

Obesity

A total of 25.7% (95% CI: 24.2 – 27.3%) of the children were obese. Of the boys, 28.7% (95% CI: 25.9 – 31.0%) were obese. A total of 22.6% (95% CI: 20.6 – 25.5%) of the girls were obese. There was a significant association ($\chi 2 = 15.24$; $p = 0.0001$) between the obesity status (obese, not obese) and gender (male, female) of the child. However, the strength of the association was low ($\Phi = 0.07$; $p = 0.0001$). The odds ratio was 1.38 (95% CI: 1.17 – 1.62), indicating that boys were approximately 1.4 times as likely to be obese as girls.

There was a significant association between obesity status and age ($\chi 2 = 31.71$; $p = 0.002$). The strength of the association was low (Cramer's V = 0.10). A post-hoc test using the adjusted residuals showed that obesity was significantly higher in the 8-year-old age category (35.3%) than it was in the other age categories, as shown in Table 1.

Hypertension

In total, 9.9% (95% CI = 8.9 – 11.0%) of the children were hypertensive. The association between hypertensive status (hypertension, no hypertension) and gender (male, female) was not significant ($\chi 2 = 0.426$; $p = 0.514$). The association of hypertensive status with the age of the child (5 to 17 years old) was also not significant ($\chi 2 = 20.51$; $p = 0.058$). Table 2 shows the weighted prevalence of hypertension by the age and gender of the school children.

Table 1. Weighted Prevalence of Obesity in School Children in Puerto Rico, by Age and Gender

Age* (N)	Female**		Male**		Total	
	Percent (n)	95% CI	Percent (n)	95% CI	Percent (n)	95% CI
5 (80)	25.0 (10)	14.0 – 40.4	27.5 (11)	16.0 – 43.0	26.3 (21)	17.9 – 36.9
6 (243)	25.6 (31)	18.6 – 34.1	26.2 (32)	19.2 – 34.7	25.9 (63)	20.8 – 31.8
7 (247)	19.8 (24)	13.7 – 27.9	31.0 (39)	23.5 – 39.5	25.5 (63)	20.5 – 31.3
8 (249)	37.4 (46)	29.3 – 46.2	33.3 (42)	25.7 – 42.0	35.3 (88)	29.7 – 41.5
9 (256)	23.8 (30)	17.8 – 32.0	27.7 36)	20.7 – 36.0	25.8 (66)	20.8 – 31.5
10 (256)	27.2 (34)	20.1 – 35.6	31.3 (41)	24.0 – 39.7	29.3 (75)	24.1 – 35.2
11 (255)	24.0 (30)	17.3 – 32.2	30.8 (40)	23.5 – 39.2	27.5 (70)	22.3 – 33.2
12 (260)	25.0 (32)	18.3 – 33.2	37.1 (49)	29.3 – 45.6	31.2 (81)	25.8 – 37.0
13 (269)	20.0 (27)	14.1 – 27.6	26.1 (35)	19.4 – 34.2	23.0 (62)	18.4 – 28.5
14 (290)	18.5 (27)	13.0 – 25.6	27.1 (39)	20.5 – 34.8	22.8 (66)	18.3 – 27.9
15 (283)	14.3 (20)	9.4 – 21.1	28.7 (41)	21.9 – 36.6	21.6 (61)	17.2 – 26.7
16 (273)	19.3 (27)	13.6 – 26.7	18.8 (25)	13.0 – 26.3	19.0 (52)	14.8 – 24.1
17 (184)	16.5 (15)	10.1 – 25.6	26.9 (25)	18.9 – 36.7	21.7 (40)	16.4 – 28.3
Total (3145)	22.6 (353)	20.6 – 25.5	28.7 (455)	25.9 – 31.0	25.7 (808)	24.2 – 27.3

N = Number of children by age, n = Number of obese children by age and gender, 95% CI = 95% confidence interval of percent weighted prevalence, *p = 0.00009; chi-square test for obesity and age, **p = 0.0001; chi-square test for obesity and gender; odds ratio = 1.38

Obesity and Hypertension

Of the obese children, 17.8% (95% CI: 15.4 – 20.6%) were hypertensive, and 82.2% (95% CI: 79.4 – 84.7%) were not hypertensive. Of the non-obese children, 7.1% (95% CI: 6.2 – 8.2%) were hypertensive, and 92.9% (95% CI: 91.7 – 93.9%) were not hypertensive. A chi-square test for the association between obesity and hypertension showed a statistically significant association between the 2 variables ($\chi2 = 77.244$; p<0.001). The strength of the association between hypertension and obesity was low ($\Phi = 0.157$; p<0.001). The odds ratio (OR) indicated that obese children were 2.82 times as likely to be hypertensive than non-obese children were (95% CI = 2.23 – 3.59).

The mean systolic blood pressure (mm Hg) of the subjects was significantly higher in the obese children (107.4 ± 16.6) than in the non-obese children (100.6 ± 14.6). The mean diastolic blood pressure was significantly higher in the obese children (68.4 ± 10.7) than in the non-obese children (63.9 ± 9.9). The difference in the systolic and diastolic blood pressures was also significantly higher in the obese females and males than in the non-obese females and males, respectively (Table 3).

Discussion

Approximately 1 of every 4 children in our sample of 5- to 17-year-old school children (25.7%) living in Puerto Rico was obese. A previous study of 352 children residing in Puerto Rico from 12 to 16 years of age from a single school in San Juan (the capital city of Puerto Rico) conducted in 1999 and 2000 found a prevalence of obesity of 14.2% (95% CI: 10.9 – 18.3%) (16). The prevalence of obesity among 12- to 16-year-old children in our study was 23.4% (95% CI: 21.3 – 25.8%). One difference was that our sample in this age group was larger (1,375 children) and included children from 7 educational regions of Puerto Rico not just the San Juan region. The San Juan children's study was also completed nearly a decade before ours. The prevalence of obesity has been increasing in children in the United States (including the 50 states and the District of Columbia), and similar trends might be occurring in the children of Puerto Rico (17). Our obesity prevalence is similar to that of 25.8% in Hispanics from 2 to 19 years of age in the United States (17).

In our study, the prevalence in boys (28.7%) was significantly higher than was the prevalence in girls (22.6%). In Hispanics from 2 to 19 years of age in the United States (including the 50 states and the District of Columbia), the prevalence was also higher in boys (28.0%) than in girls (23.6%), although this difference was not statistically significant (17).

The 8-year-old group in our study had the highest prevalence of obesity, with 35.3% (95% CI: 29.7 – 41.5%). This finding agrees with the prevalence of obesity in Hispanic children in the United States (including the 50 states and the District of Columbia), in the middle age group (6 to 11 years old), which is higher than what is found in the other age groups (18). Between 1971 and 2016, inclusive, the middle age group has also shown the highest increase in obesity (4X), compared to the other age

Table 2. Weighted Prevalence of Hypertension in School Children in Puerto Rico, by Age and Gender

Age* (N)	Female**		Male**		Total	
	Percent (n)	95% CI	Percent (n)	95% CI	Percent (n)	95% CI
5 (80)	7.5 (3)	1.9 – 20.6	12.5 (5)	5.0 – 26.6	10.0 (8)	4.9 – 18.8
6 (243)	6.7 (8)	3.2 – 12.7	6.7 (8)	3.2 – 12.7	6.6 (16)	4.0 – 10.5
7 (247)	11.5 (14)	6.9 – 18.6	4.0 (5)	1.5 – 9.2	7.7 (19)	4.9 – 11.8
8 (249)	10.6 (13)	6.2 – 17.4	8.7 (11)	4.8 – 15.0	9.6 (24)	6.5 – 13.9
9 (256)	12.6 (16)	7.8 – 19.6	9.8 (13)	5.8 – 16.4	11.2 (29)	7.9 – 15.7
10 (256)	6.4 (8)	3.1 – 12.3	11.5 (15)	7.0 – 18.3	9.0 (23)	6.0 – 13.2
11 (255)	4.0 (5)	1.5 – 9.3	7.6 (10)	4.1 – 13.6	5.9 (15)	3.5 – 9.5
12 (260)	10.9 (14)	6.5 – 17.6	12.1 (16)	7.5 – 18.9	11.5 (30)	8.2 – 16.0
13 (269)	14.8 (20)	9.7 – 21.9	9.0 (12)	5.1 – 15.1	11.9 (32)	8.5 – 16.4
14 (290)	11.6 (17)	7.2 – 17.7	15.4 (22)	10.3 – 22.3	13.5 (39)	10.0 – 17.9
15 (283)	7.9 (11)	4.3 – 13.7	14.0 (20)	9.2 – 20.7	10.9 (31)	7.8 – 15.2
16 (273)	10.8 (15)	6.6 – 17.1	12.8 (17)	8.0 – 19.6	11.8 (32)	8.4 – 16.2
17 (184)	5.4 (5)	2.0 – 12.4	8.6 (8)	4.2 – 16.3	7.0 (13)	4.0 – 11.8
Total: (3145)	9.5 (149)	8.2 – 11.1	10.2 (162)	8.8 – 11.8	9.9 (311)	8.9 – 11.0

N = Number of children by age, n = Hypertensive children by age and gender, 95% CI = 95% confidence interval of percent weighted prevalence, *p = 0.058; chi-square test for hypertension and age, **p = 0.514; chi-square test for hypertension and gender

Table 3. Mean (±SD) Levels of Systolic and Diastolic Blood Pressures, by Gender and Level of Obesity, in School Children of Puerto Rico

Gender	Obesity Status	n	Blood Pressure, mm Hg			
			Systolic Mean (±SD)	p value*	Diastolic Mean (±SD)	p value*
Both sexes	Overall	3145	102.3 (±15.4)	<0.0001	65.1 (±10.4)	<0.0001
	Non-obese	2337	100.6 (±14.6)		63.9 (±9.9)	
	Obese	808	107.4 (±16.6)		68.4 (±10.7)	
Female	Overall	1561	101.2 (±14.5)		65.1 (±10.5)	
	Non-obese	1208	99.7 (±13.6)	<0.0001	64.0 (±10.1)	<0.0001
	Obese	353	106.2 (±16.2)		68.8 (±11.1)	
Male	Overall	1584	103.4 (±16.3)		65.0 (±10.3)	
	Non-obese	1129	101.5 (±15.6)	<0.0001	63.8 (±10.5)	<0.0001
	Obese	455	108.3 (±16.9)		68.1 (±9.9)	

*p value for independent samples t-test, n = number of children by gender and obesity status

groups (19). Further studies should address the factors that make this age group more vulnerable to increases in obesity.

As we discovered with our single screening, 1 in 10 (9.9%) of the children in our sample was hypertensive. This prevalence is comparable to the prevalence of 9.5% that was arrived at after 2 screenings in a study of multiethnic children in Houston, Texas (3). The prevalence of hypertension in the obese children in our study (17.8%) was similar to the prevalence of 18.0% in the overweight Hispanic children in Texas. We replicated the finding of a significant association between children's hypertension and obesity found in some studies (3,20). Our results showed that an obese child was 2.82 times as likely to be hypertensive as a non-obese child was; slightly higher than the odds of 2.10 for overweight Hispanic Texan children (20).

The American Heart Association has recommendations for the optimal determination of blood pressure in children (5), including the use of the mean of 2 blood pressure measures per session. Additionally, the National Heart, Lung, and Blood Institute recommends that measures be made over the course of 3 separate sessions for a diagnosis of high blood pressure in children (8,21). Although we followed most of the recommendations, the results of our study were limited by the use of a single blood pressure measure taken in 1 session. Our conclusions were also limited by the 12% drop in the population of school children in Puerto Rico that has occurred since the beginning of the study in 2014, which drop may potentially affect the current prevalence values (4,22).

Although life expectancy has steadily increased over many years, the obesity epidemic may nullify or even reverse this trend. As a result, some researchers conclude that the current generation of children and adolescents may have a shorter lifespans than their parents do (23). The results of our study indicate that there is an urgent need to establish island-wide policies to limit the growth of the prevalence of obesity and hypertension in children. Such policies should include the promotion of healthy lifestyles, the education of parents, and the early identification of obese and hypertensive children.

Resumen

Objetivo: Determinar la prevalencia de la obesidad y la hipertensión y la asociación de la hipertensión con la obesidad en una muestra de escolares de toda la isla de Puerto Rico. Métodos: El estudio descriptivo cuantitativo incluyó a 3,145 niños de 5 a 17 años de Puerto Rico. Fueron examinados una vez durante un período de 3 años (2014-2017) para determinar el peso (lb) y la altura (cm) para calcular su índice de masa corporal (IMC) en función de su edad y sexo. Los niños con IMC en o por encima del percentil 95 se consideraron obesos. Las presiones arteriales sistólica y diastólica (mm Hg) se midieron una vez para determinar la prevalencia de hipertensión según la edad, la altura y el sexo. Los niños con presión arterial dentro o por encima del percentil 95 se consideraron hipertensos. La presiones arteriales de niños obesos y no obesos se compararon utilizando la prueba t de muestras independientes. La asociación entre el estado de obesidad (obeso / no obeso) y el estado de hipertensión (hipertenso / no hipertenso) se analizó mediante la prueba de chi-cuadrado. Resultados: El 25.7% de los niños eran obesos. Los niños tenían 1.38 veces más probabilidades de ser obesos que las niñas. El 9.9% de los niños eran hipertensos. Los niños obesos tenían 2.82 veces más probabilidades de ser hipertensos que los niños no obesos. Conclusión: Aproximadamente 1 de cada 4 niños de la muestra era obeso; aproximadamente 1 de cada 10 era hipertenso. Los niños obesos tenían un riesgo significativamente mayor de hipertensión que los niños no obesos. El estudio indica la necesidad de estrategias de salud pública que promuevan la prevención y educación de los padres para reducir la prevalencia de la obesidad y las secuelas de la hipertensión.

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