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Blood pressure and associated cardiovascular risk factors in adolescents of Mexico City

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Summary

Objective: To determine the prevalence of high blood pressure and associated cardiovascular risk factors in Mexican adolescents. **Methods:** A cross-sectional study was conducted in 770 male and 1076 female students (12 to 16 years old) from eight randomly selected high schools in Mexico City. Anthropometry, blood pressure and fasting lipids and lipoproteins were measured. **Results:** Blood pressure levels were adjusted for age, gender, and height. The prevalence rates of hypertension (systolic blood pressure (SBP) and/or diastolic (DBP) ≥ 95th percentile), and pre-hypertension (SBP or DBP ≥ 90th but < 95th percentile) were 10.6 and 10%, respectively. Compared to normotensive subjects, those with high blood pressure showed a significantly higher prevalence of obesity, overweight, and dyslipidemia. A stepwise multiple regression analysis showed that waist (18.3%), Tanner stage (4.7%), age (2.1%), gender (0.6%), and body mass index (BMI, 0.3%) accounted for 26% of the variance in SBP; whereas BMI (8.7%), age (4.8%), Tanner stage (1.7%), waist (0.4%), and gender (0.4%) accounted for 15.9% of the variance in DBP. **Conclusions:** These results reveal a high prevalence of high blood pressure in adolescents living in Mexico City. Pre-hypertensive and hypertensive subjects showed a higher prevalence of cardiovascular risk factors, suggesting that, as adults, these adolescents will be at a higher risk of developing cardiovascular disease.

Resumen

TENSIÓN ARTERIAL Y SU ASOCIACIÓN CON FACTORES DE RIESGO CARDIOVASCULAR EN ADOLESCENTES DE MÉXICO, D.F.

Objetivo: Determinar la prevalencia de tensión arterial elevada y su asociación con factores de riesgo cardiovascular en adolescentes mexicanos. **Métodos:** Se realizó un estudio transversal en 770 hombres y 1,076 mujeres (12 a 16 años de edad) de ocho escuelas secundarias seleccionadas aleatoriamente de la Ciudad de México. Se determinaron las medidas antropométricas, la tensión arterial, los lípidos y las lipoproteínas. **Resultados:** Las mediciones de tensión arterial fueron ajustadas por edad, género y estatura. La tasa de prevalencia de hipertensión (tensión arterial sistólica y/o la tensión arterial diastólica ≥ a la percentila 95) y la prevalencia de pre-hipertensión (tensión arterial sistólica y diastólica ≥ percentila 90 y < a la percentila 95) fueron 10.6% y 10.0%, respectivamente. Comparados con los adolescentes normotensos, los hipertensos mostraron una prevalencia significativamente elevada de obesidad, sobrepeso y dislipidemia. El análisis de regresión múltiple mostró que la cintura (18.3%), el Tanner (4.7%), la edad (2.1%), el género y el índice de masa corporal (0.9%) contribuyeron con 26% de la variación en la tensión arterial sistólica, mientras que el índice de masa corporal (8.7%), la edad (4.8%), el Tanner (1.7%), la cintura (0.4%) y el género (0.4) contribuyeron con el 15.9% de la variación en la presión arterial diastólica. **Conclusiones:** Estos resultados muestran una elevada prevalencia de hipertensión arterial en los adolescentes de la Ciudad de México. Los ado-

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lescentes pre-hipertensos e hipertensos mostraron una mayor prevalencia de factores de riesgo cardiovascular, lo que sugiere que, como adultos, estos adolescentes tendrán un mayor riesgo de desarrollar enfermedad cardiovascular.
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Key words: Adolescents. Hypertension. Obesity. Cardiovascular risk.
Palabras clave: Adolescentes. Hipertensión. Obesidad. Riesgo cardiovascular.

Introduction

Coronary heart disease (CHD) is the leading cause of death in most of the developed[1,2] and in developing countries, like Mexico.[3] Available evidence indicates that atherosclerosis begins in childhood and is associated to different coronary risk factors.[4,5] These findings and the observations that these factors tend to track from childhood into adult life[1] emphasize the importance of identifying children with these conditions.

The prevalence of obesity has been increasing around the world[6] and is accompanied by increases of other coronary risk factors, such as arterial hypertension.[7,8] Numerous studies[9-11] conducted among different ethnic and racial groups have shown that there are geographic variations in the childhood hypertension prevalence (1 to 25%).

As in many countries, the prevalence of excess body weight in Mexican children has increased during the past years.[12] Several epidemiologic studies in Mexican adult populations have shown a high and increasing prevalence of hypertension.[13,14] However, little is known about hypertension rates and its association with other cardiovascular risk factors in Mexican adolescents. Therefore, the purpose of the present study was to determine the prevalence of high blood pressure and associated cardiovascular risk factors in a population of adolescents residing in Mexico City.

Methods

Study design and participants

A cross-sectional survey was conducted as previously described.[15] Briefly, eight urban public junior high schools (Mexico City) were randomly selected from a list of high schools, provided by the Ministry of Education. The Epi-info software version 6.04 (CDC, USA; WHO, Geneva, Switzerland) was used to calculate the sample size, considering 5% of high blood pressure levels (intervals 3.5% to 6.5%) for a population survey or descriptive studies,[16] with a power of 80% and a 95% confidence interval. The calculated sample size was 810 adolescents.

Recruitment of participants

Because school authorities did not allow a random selection, all students 12 to 16 years of age attending the selected schools were invited to participate. A sample of 1,846 adolescents (770 males and 1,076 females) who accepted to participate and whose parents signed the informed consent were included. To assess potential bias introduced by differences between participants and non-participants, a random subsample of non-participants answered the questionnaire and had anthropometry and blood pressure measurements taken and no statistical differences were found. Adolescents with an organic pathology or under chronic medical treatment were excluded. The protocol was approved by the Research Coordination of the Department of Public Health at the Medical School of the National Autonomous University of Mexico and the authorities of the Ministry of Education.

Sources, methods, and techniques for data collection

Questionnaire application, anthropometry and blood pressure measurements were performed between 8:00 to 11:00 AM from Monday to Thursday. Adolescents answered individually questions about cigarette smoking and in order to encourage truthful answers, students were reassured that nobody (parents and/or teachers) would receive the information about smoking habits. A participant was defined as a smoker when he/she smoked at least one cigarette per week.[17] Adolescents, who did not participate in any sport or physical activity in their leisure time were considered to have a sedentary life style.[18]

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Blood pressure

After at least 10 minutes rest, systolic (Korotkoff phase I) and diastolic (Korotkoff phase V) blood pressure (SBP and DBP) values were recorded with a mercury sphygmomanometer (Welch Allyn Tycos, USA) using an appropriate cuff size for each student. Three readings were recorded for each individual. Average of the second and third measurements was defined as the subject's blood pressure. The blood pressure values were adjusted for age, height, and gender to classify subjects in three groups: 1) normotensives (NT) (SBP and DBP < 90^{th} percentile); 2) pre-hypertensives (Pre-HT) (SBP or DBP ≥ 90^{th} but < 95^{th} percentile); and 3) hypertensives (HT) (SBP and/or diastolic DBP ≥ 95^{th} percentile).[19]

Anthropometry measurements

Body weight was measured and recorded to the nearest 0.1 kg, height to 0.5 cm, and waist circumference to the nearest 0.5 cm at the midpoint between the bottom of the rib cage and above the top of the iliac crest. Body mass index (BMI) was calculated, and we used the cutoff points of overweight (25 kg/m^2) and obesity (30 kg/m^2) according to Cole.[20]

Lipid and lipoprotein measurements

Venous blood samples were obtained after 12-h overnight fast. Total cholesterol (TC) and triglycerides (TG) were measured by enzymatic methods (Roche-Syntex/Boehringer Mannheim, Germany). High density lipoprotein cholesterol (HDL-C) was quantified after precipitation of lipoproteins containing apo B with phosphotungstate/Mg^{2+}. Low density lipoprotein-cholesterol (LDL-C) was estimated by Friedewald´s formula.[21] Plasma glucose was determined by the glucose-oxidase method (Roche-Syntex/Boehringer Mannheim, Germany). Accuracy and precision were under the surveillance of the Center for Disease Control Lipid Standardization Program (Atlanta, GA). The intra-assay coefficient of variation (CV) for TC, TG, HDL-C, and glucose were 0.43, 0.89, 1.72, and 1.0%, respectively. The inter-assay CVs were 1.76, 2.03, 3.24, and 1.7 %, respectively. Hypercholesterolemia was defined as TC ≥ 200 mg/dL, high LDL-C as LDL-C ≥ 130 mg/dL, hypertriglyceridemia as TG level ≥ 150 mg/dL, and low HDL-C as HDL-C level < 35 mg/dL.[1]

Pubertal development

Sexual development was assessed using the method described by Tanner.[22] Self-assessment is a valid method to assess sexual maturity when feasibility of physician examination is low in clinical evaluation, and as a research tool.[23] In the case of girls, the date of menarche was also recorded.

Statistical analysis

Descriptive statistics, including mean and standard deviations (SD) for continuous variables and proportions for categorical variables, were used. All variables were tested for normality using the Kolmogorov-Smirnov test. Variables that were not normally distributed were log-transformed and then parametric statistics were used. Comparison of means by gender was evaluated by two-tailed t-test. Differences between more than two groups were evaluated using ANOVA test. Prevalence values between genders and between adolescents with normal and those with high blood pressure levels were compared using χ^2 test. Pearson correlation analysis was used to examine the association between systolic and diastolic blood pressure and other cardiovascular risk factors. The independence of associations was determined by stepwise multiple regression analysis. A p value < 0.05 indicated statistical significance. Statistical analysis was performed using SPSS version 10 software (SPSS, Chicago, IL).

Results

The clinical, anthropometric, and metabolic characteristics according to gender are shown in *Table I*. Compared with girls, boys had significantly lower mean values of BMI, DBP, TC, LDL-C, and TG; whereas, girls had significantly lower glucose and SBP values than boys.

The prevalence of Pre-HT (9.6%) and HT (9.9%) among boys was lower but not significantly different from that among girls (Pre-HT 10.3%; HT 11.1%). The cardiovascular risk factors studied were generally more common in HT and Pre-HT adolescents of both genders than in normal blood pressure subjects. As shown in *Figure 1a*, overweight and low HDL-C levels were the most frequent risk factors observed in HT boys, but obesity, high total and LDL cholesterol were also more prevalent than in NT subjects. In Pre-HT adolescents, overweight and obesity were also significantly higher than in normotensive sub-

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jects. Although several risk factors were more commonly seen in HT than in Pre-HT subjects, the differences did not reach statistical significance. Among girls *(Fig. 1b)*, physical inactivity was the most common risk factor irrespective of blood pressure group. As in boys, HT girls showed higher prevalence of overweight, obesity, and elevated total and LDL cholesterol than normotensive ones. Smoking and low HDL-C was significantly higher in Pre-HT than in those girls with normal blood pressure. As in boys, no significant differences were observed between Pre-HT and HT girls. Compared with boys, girls had higher overweight prevalence in the NT group, were more physically inactive in all three groups, and had lower prevalence of low HDL-C in the NT and HT groups. In addition, there were fewer smokers among girls than among boys in the NT group.

Because overweight and obesity were observed in almost one fourth of adolescents and because these two conditions are associated to higher prevalence of both hypertension and dyslipidemia, we examined the effect of body mass index and blood pressure levels on lipid concentrations. For this analysis, we considered two blood pressure groups: hypertensive (HT) and non-hypertensive (Pre-HT and NT combined), and according to their BMI they were categorized as obese, overweight, and normal weight adolescents. As expected, obese boys and girls were significantly more common in the HT group as compared with the non-HT group *(Table II)*. For males and females, in both HT and non-hypertensive groups, TC, LDL-C, TC/HDL-C ratio, and TG mean values were higher in obese, intermediate in overweight, and lower in normal weight adolescents, except for TC and LDL-C in HT girls; whereas, HDL-C mean values were low, intermediate, and high for obese, overweight, and normal weight adolescents, respectively. When non-HT and HT subgroups were compared, the only difference observed was in

Table I. Clinical characteristics, blood pressure values, and plasma levels of lipids and lipoproteins of the population studied.

	Boys n = 770	Girls n = 1,076	p *
Age (years)	13.2 ± 1.1	13.2 ± 1.0	NS
BMI (kg/m^2)	20.2 ± 3.4	21.3 ± 1.0	< 0.001
Waist (cm)	73.3 ± 9.8	71.0 ± 8.4	< 0.001
SBP (mm Hg)	107.6 ± 11.0	106.4 ± 9.6	0.012
DBP (mm Hg)	62.4 ± 7.8	64.1 ± 7.4	< 0.001
Glucose (mg/dL)	86.9 ± 9.7	84.9 ± 9.1	< 0.001
TC (mg/dL)	149.7 ± 27.6	156.0 ± 26.6	< 0.001
LDL-C (mg/dL)	91.8 ± 24.2	96.1 ± 23.1	< 0.001
HDL-C (mg/dL)	43.9 ± 10.3	44.4 ± 9.7	NS
TG (mg/dL)	87.6 ± 41.0	96.5 ± 41.6	< 0.001
TC/HDL-C	3.56 ± 0.97	3.64 ± 0.89	NS

Values are mean ± SD. BMI = Body mass index, SBP = systolic blood pressure, DBP = diastolic blood pressure, TC = total cholesterol, TG = triglycerides, LDL-C = low density lipoprotein cholesterol, and HDL-C = high density lipoprotein cholesterol. * = Two-tailed t-test, NS = not significant.

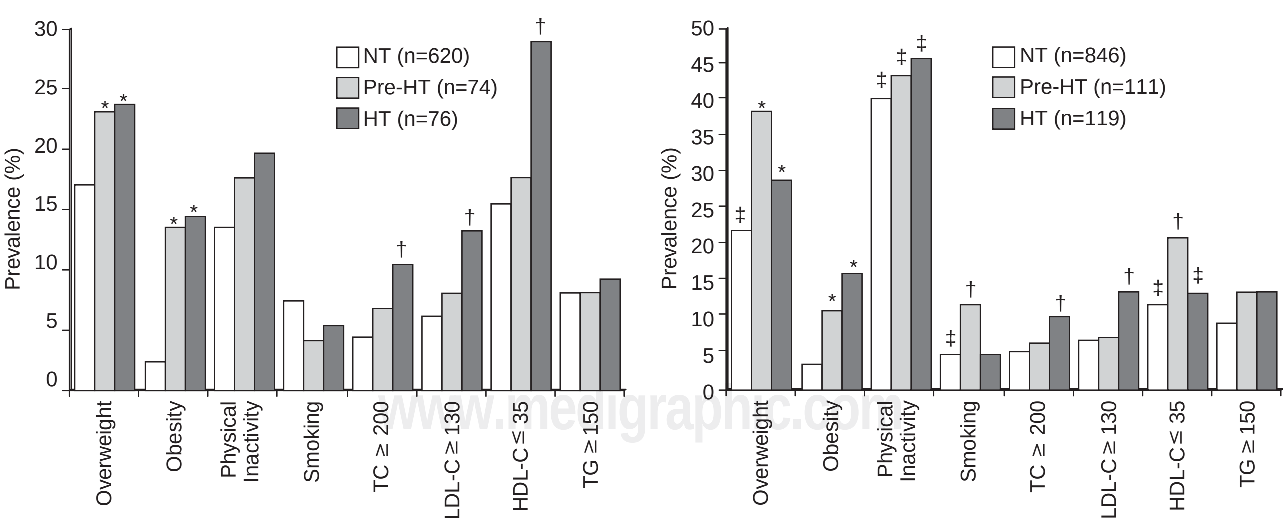

Fig. 1a Boys **Fig. 1b Girls**

Fig. 1. Prevalences of cardiovascular risk factors by gender and blood pressure levels. NT = normotensives (SBP and DBP < 90th percentile), Pre-HT = pre-hypertensives (SBP or DBP ≥ 90th but < 95th percentile), HT = hypertensives (SBP and/or diastolic DBP ≥ 95th percentile); and TC = total cholesterol, LDL-C = low density lipoprotein cholesterol, HDL-C = high density lipoprotein cholesterol, and TG = triglycerides. * = p < 0.001 *versus* NT; † = p < 0.05 *versus* NT; ‡ = p < 0.05 *versus* boys.

Table II: Mean lipid values for boys and girls according to blood pressure values and body mass index.

	HT				No-HT			
	Obese	Overweight	Normal weight		Obese	Overweight	Normal weight	
	n = 11	n = 18	n = 47		n = 25	n = 123	n = 546	
Boys	(14.5%)	(23.7%)	(61.8%)	p*	(3.6%)‡	(17.7%)	(78.7%)‡	p*
TC	175 ± 26	159 ± 31	147 ± 30	0.013	169 ± 37	159 ± 32	146 ± 25	< 0.001
LDL-C	116 ± 27	103 ± 25	89 ± 27	0.008	108 ± 34	101 ± 28	88 ± 21	< 0.001
HDL-C	34 ± 6	39 ± 10	46 ± 10	< 0.001	38 ± 10	40 ± 9	45 ± 10	< 0.001
TG	161 ± 54	108 ± 36	69 ± 24	< 0.001	146 ± 63	112 ± 49	79 ± 32 †	< 0.001
TC/HDL-C	5.4 ± 1.4	4.3 ± 0.9	3.3 ± 0.8	< 0.001	4.8 ± 1.6	4.1 ± 1.1	3.3 ± 0.8	< 0.001
	n = 19	n = 34	n = 66		n = 42	n = 227	n = 688	
Girls	(16.0%)	(28.6%)	(55.5%)		(4.4%)‡	(23.7%)	(71.9%)‡	
TC	160 ± 36	167 ± 27	159 ± 30	NS	161 ± 25	161 ± 29	154 ± 25	0.001
LDL-C	101 ± 30	108 ± 23	98 ± 27	NS	102 ± 23	102 ± 25	94 ± 22	< 0.001
HDL-C	38± 8	41±9	48 ± 10	< 0.001	38 ± 8	42 ± 10	46 ± 10	< 0.001
TG	127 ± 67	112 ± 56	84 ± 38	0.001	130 ± 49	107 ± 45	91 ± 37	< 0.001
TC/HDL-C	4.3 ± 0.9	4.3 ± 1.4	3.4 ± 0.8	0.001	4.4 ± 0.9	4.0 ± 1.0	3.5 ± 0.8	< 0.001

Values are mean ± SD. HT = systolic blood pressure and/or diastolic blood pressure ≥ 95th percentile, adjusted by age, height, and gender; obesity defined as Cole (see methods). * = ANOVA. NS = not significant. ‡ = p < 0.001 *versus* HT; χ^2. † = p < 0.05 *versus* HT; Student's t test.

triglycerides, which were higher in lean non-HT than in lean HT boys (p = 0.038).

A stepwise multiple regression analysis was used to determine the independent contribution of age, gender, Tanner stage, cigarette smoking, physical inactivity, and anthropometric and metabolic measurements to the variance in blood pressure levels. Waist circumference (18.3%), Tanner stage (4.7%), age (2.1%), gender (0.6%), and BMI (0.3%) accounted independently for 26% of the variance in SBP *(Table III)*; whereas BMI (8.7%), age (4.8%), Tanner stage (1.7%), waist circumference (0.4%), and gender (0.4%) explained 15.9% of the variance in DBP *(Table IV)*.

Discussion

Because adolescence is often considered a critical period for the development of some cardiovascular risk factors, several studies have suggested the screening of children to identify those at high risk for developing essential hypertension as adults.[1,6] In the present study, a high prevalence of elevated blood pressure levels was found (10% for pre-hypertension, and 10.6% for hypertension). In addition, boys and girls with high blood pressure showed higher prevalence of other coronary risk factors as compared with normotensive subjects. The multiple regression analysis showed that the most important determinants of blood pressure were waist circumference for systolic and BMI for diastolic pressure. The prevalence of high blood pressure observed in our adolescents was generally higher than that

Table III: Stepwise multiple regression analysis of systolic blood pressure as dependent variable.

	β	R^2, (%)	p
Model 1			
Waist	0.428	18.3	< 0.001
Model 2			
Model 1 + Tanner	0.479	23.0	< 0.001
Model 3			
Model 2 + Age	0.501	25.1	< 0.001
Model 4			
Model 3 + Gender	0.506	25.6	< 0.001
Model 5			
Model 4 + BMI	0.510	26.0	0.003

Model 1 included waist circumference, total cholesterol, low density lipoprotein cholesterol, high density lipoprotein cholesterol, triglycerides, glucose, cigarette smoking, and physical inactivity, as independent variables. β refers to standardized coefficient.

Table IV. Stepwise multiple regression analysis of diastolic blood pressure as dependent variable.

	β	R^2, (%)	p
Model 1			
BMI	0.295	8.7	< 0.001
Model 2			
Model 1 + Age	0.367	13.0	< 0.001
Model 3			
Model 2 + Tanner	0.390	15.2	< 0.001
Model 4			
Model 3 + Waist	0.395	15.6	0.003
Model 5			
Model 4 + Gender	0.399	15.9	0.006

Model 1 included body mass index, total cholesterol, low density lipoprotein cholesterol, high density lipoprotein cholesterol, triglycerides, glucose, cigarette smoking, and physical inactivity, as independent variables. β refers to standardized coefficient.

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found in other Latin American populations: 9.5% in Chileans,[24] 12% in Argentineans,[25] and 3.0% in Colombians.[26] It is also higher than the prevalence reported in European countries: 15% in North Ireland,[9] 12% in Germany,[10] and 7.2% in Spain;[11] or in Asian countries: < 10% in India[27] and 4.8% in Turkey.[28] Age, life style, dietary habits, environment, and differences in criteria to define high blood pressure levels may be the underlying factors for these variations in the prevalence of high blood pressure among adolescents from different countries.

Several studies have shown that age,[19] gender,[29] race,[30] heritability,[19,29] physical activity, and nutrition[19,30] are associated to blood pressure in adolescents. Furthermore, it has been reported[31] that obesity increases the occurrence of hypertension and the development of dyslipidemia. Our results clearly confirm these findings by showing that excess body weight (obesity and overweight) was significantly ($p < 0.001$) more prevalent among HT (males, 38.2%; females, 44.5%) than among non-HT (males, 21.3%; females, 28.1%) and by demonstrating that greater adiposity explained the higher values for TC, LDL-C, TG, and TC/HDL-C ratio, as well as lower concentrations of HDL-C, not only in HT but also in non-HT subjects *(Table II)*. Further, as already mentioned, in the multiple regression analysis, waist circumference and BMI accounted for most of the variance in SBP and DBP, respectively.

In both, children and adults, obesity increases 3 to 8 times the prevalence of hypertension.[6,32] Previous studies[7,33] in over 56,300 children found that, irrespective of race, gender, or age, the risk of elevated blood pressure was significantly higher for children in the upper than in the lower BMI group, with odd ratios for hypertension ranging from 2.4 to 4.5. In another study,[34] overweight was found to be the primary contributing factor to hypertension among different ethnic groups. In addition, Rosner[33] reported a linear increase in the prevalence of diastolic hypertension in children of all races, gender and age combinations as BMI increased above the "normal" range.

Obesity-induced hypertension is likely due to an overlap or combinations of three main pathophysiological mechanisms. First, the link between obesity and hypertension may be mediated in part by sympathetic nervous system hyperactivity.[35] Second, the insulin resistance associated with obesity may prevent insulin-induced glucose uptake but leave the renal sodium retention effects of insulin relatively preserved, thereby resulting in chronic volume overload and maintenance of blood pressure elevation.[8] Third, lower arterial compliance, lower distensibility, and lower endothelium-dependent and independent function in severely obese than in control children have been reported.[36]

Recent research has shown that the pathogenesis of obesity may be, in part, inherited, but genetics cannot account for the rapid increases in overweight around the world.[2] Lack of safe outdoor play areas and households with two working parents or a single parent limit children's ability to engage in active physical exercise or recreational sports, and reliance on sedentary entertainment, including television viewing, video games, and computers, has increased. In the present study, sedentary life style was significantly more prevalent in girls than in boys (40.9% vs. 14.5%, $p < 0.001$). The higher prevalence of overweight in girls (20.3% *vs* 18.3% in boys; $p < 0.001$) might be a reflection of the lower physical activity in girls. Health professional caring for children and adolescents are in a key position to help prevent and treat obesity by promoting behavioral and environmental changes.

This study has several limitations. First, Tanner scores were obtained by self-assessment. There are some studies, conducted mainly in obese children[37,38] showing inconsistent percentages of agreement between physician's evaluation and self-assessment. However, other studies[23,39,40] have found a good agreement between the scoring by this method and that obtained by direct observation. Therefore, it is unlikely that our results are invalidated by the use of self-assessed puberty. Second, we were unable to obtain information about diet, which is a factor with an important influence on blood pressure levels. Third, our study is based on cross-sectional data and it cannot address questions of causality inferences. Finally, because geographic, socio economic, cultural and ethnic characteristics are different around the country, the results obtained in this work, cannot be generalized to all Mexican adolescents. However, the data provide insights for the risk of cardiovascular disease in adolescents of Mexico City.

In conclusion, these results reveal a high prevalence of high blood pressure in adolescents living in Mexico City. Pre-hypertensive and hypertensive subjects also showed a high preva-

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lence of other cardiovascular risk factors, mainly overweight and obesity. Our findings suggest that, as adults, these adolescents will be at a higher risk of developing cardiovascular disease. There is an urgent need to establish preventive measures to decrease high blood pressure in this population. Avoidance or correction of excess body weight should be the main target.

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References

1. Kavey RE, Daniels SR, Lauer RM, Atkins DL, Hayman LL, Taubert K: *American Heart Association. American Heart Association guidelines for primary prevention of atherosclerotic cardiovascular disease beginning in childhood*. Circulation 2003; 107: 1562-6.
2. Williams CL, Hayman LL, Daniels SR, Robinson TN, Steinberger J, Paridon S, Bazzarre T: *Cardiovascular health in childhood: A statement for health professionals from the Committee on Atherosclerosis, Hypertension, and Obesity in the Young (AHOY) of the Council on Cardiovascular Disease in the Young, American Heart Association*. Circulation 2002; 106: 143-60.
3. Lara A, Rosas M, Pastelin G, Aguilar C, Attie F, Velazquez Monroy O: *Hipercolesterolemia e hipertensión arterial en México. Consolidación urbana actual con obesidad, diabetes y tabaquismo*. Arch Cardiol Mex 2004; 74: 231-45.
4. Berenson GS, Srinivasan SR, Bao W, Newman WP 3rd, Tracy RE, Wattigney WA: *Association between multiple cardiovascular risk factors and atherosclerosis in children and young adults. The Bogalusa Heart Study*. N Engl J Med 1998; 338: 1650-6.
5. Newman WP 3rd, Freedman DS, Voors AW, Gard PD, Srinivasan SR, Cresanta JL, et al: *Relation of serum lipoprotein levels and systolic blood pressure to early atherosclerosis. The Bogalusa Heart Study*. N Engl J Med 1986; 314: 138-44.
6. Bao W, Threefoot SA, Srinivasan SR, Berenson GS: *Essential hypertension predicted by tracking of elevated blood pressure from childhood to adulthood: the Bogalusa Heart Study*. Am J Hypertens 1995; 8: 657-65.
7. Haffner SM, Miettinen H, Gaskill SP, Stern MP: *Metabolic precursors of hypertension. The San Antonio Heart Study*. Arch Intern Med 1996; 156: 1994-2001.
8. Sorof J, Daniels S: *Obesity hypertension in children: a problem of epidemic proportions*. Hypertension 2002; 40: 441-7.
9. Boreham C, Savage JM, Primrose D, Cran G, Strain J: *Coronary risk factors in schoolchildren*. Arch Dis Child 1993; 68: 182-6.
10. Michel U, Riechers B: *Cardiovascular risk factors in schoolchildren*. J Am Coll Nutr 1992; 11: 36S-40S.
11. Elcarte Lopez R, Villa Elizaga I, Sada Goni J, Gasco Eguiluz M, Oyarzabal Irigoyen M, Sola Mateos A, et al: *The Navarra study. Prevalence of arterial hypertension, hyperlipidemia and obesity in the infant-child population of Navarra. Association of risk factors*. An Esp Pediatr 1993; 38: 428-36.
12. Del Rio-Navarro BE, Velazquez-Monroy O, Sanchez-Castillo CP, Lara-Esqueda A, Berber A, Fanghanel G, et al: *Encuesta Nacional de Salud 2000 Working Group, National Health Survey 2000. The high prevalence of overweight and obesity in Mexican children*. Obes Res 2004; 12: 215-23.
13. Rosas M, Pastelin G, Martinez-Reding J, Herrera-Acosta J, Attie F: *Comité Institucional para el Estudio y Prevención de la Hipertensión Arterial Sistémica. [Hypertension guidelines in Mexico]*. Arch Cardiol Mex 2004; 74: 134-57.
14. Lorenzo C, Serrano-Rios M, Martinez-Larrad MT, Gabriel R, Williams K, Gonzalez-Villalpando C, et al: *Prevalence of hypertension in Hispanic and non-Hispanic white populations*. Hipertension 2002; 39: 203-8.
15. Yamamoto-Kimura L, Posadas-Romero C, Posadas-Sanchez R, Zamora-Gonzalez J, Cardoso-Saldana G, Mendez Ramirez I: *Prevalence and interrelations of cardiovascular risk factors in urban and rural Mexican adolescents*. J Adolesc Health 2006; 38: 591-8.
16. Kish L: *Survey sampling*, New York, John Wiley & Sons, 1965.
17. Bewley BR, Day I, Ide L: *Smoking by children in Great Britain. A review of the literature*. Medical Research Council and Social Science Research Council, London, 1972.
18. Salonen JT, Slater JS, Tuomilehto J, Rauhramee R: *Leisure time and occupational physical activity. Risk of death from ischemic heart disease*. Am J Epidemiol 1988; 127: 87-94.
19. National High Blood Pressure Education Program Working Group on High Blood Pressure in Children and Adolescents: *The Fourth Report on the*

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Diagnosis, Evaluation, and Treatment of High Blood Pressure in Children and Adolescents. Pediatrics 2004; 114 (Suppl 2): 555-76.
20. Cole TJ, Bellizzi MC, Flegal KM, Dietz WH: *Establishing a standard definition for child overweight and obesity worldwide: international survey*. BMJ 2000; 320: 1240-3.
21. DeLong DM, DeLong ER, Wood PD, Lippel K, Rifkind BM: *A comparison of methods for the estimation of plasma low- and very low-density lipoprotein cholesterol. The Lipid Research Clinics Prevalence Study*. JAMA 1986; 256: 2372-7.
22. Tanner JM: *The Development of the reproductive system*. In: Growth at Adolescence. (Tanner JM, ed.). Oxford. Blackwell Scientific. 1962; pp 28-39,
23. Schmitz KE, Hovell MF, Nichols JF, Irvin VL, Keating K, Simon GM, et al: *A Validation Study of Early Adolescents Pubertal Self-Assessments*. Journal Early Adolescence 2004; 24: 357-84.
24. Norero C, Vargas NA, Mayne D, Monti A, Kutz M, Saito R: *Blood pressure levels in urban school-age population in Chile*. Hypertension 1981; 3: 238-41.
25. Ennis IL, Gende OA, Cingolani HE: *Prevalence of hypertension in 3154 young students*. Medicina (B. Aires) 1998; 58: 483-91.
26. Uscategui Penuela RM, Alvarez Uribe MC, Laguado Salinas I, Soler Terranova W, Martinez Maluendas L, Arias Arteaga R, et al: *Cardiovascular risk factors in children and teenagers aged 6-18 years old from Medellin (Colombia)*. An Pediatr (Barc) 2003; 58: 411-7.
27. Singh AK, Maheshwari A, Sharma N, Anand K: *Lifestyle associated risk factors in adolescents*. Indian J Pediatr 2006; 73: 901-6.
28. Ucar B, Kilic Z, Colak O, Oner S, Kalyoncu C: *Coronary risk factors in Turkish schoolchildren: randomized cross-sectional study*. Pediatr Int 2000; 42: 259-67.
29. Sinaiko AR: *Hypertension in children*. N Engl J Med 1996; 335: 1968-73.
30. *Update on the 1987 Task Force Report on High Blood Pressure in Children and Adolescents: a working group report from the National High Blood Pressure Education Program. National High Blood Pressure Education Program Working Group on Hypertension Control in Children and Adolescents*. Pediatrics 1996; 98(4 Pt 1): 649-58.
31. Freedman DS, Dietz WH, Srinivasan SR, Berenson GS: *The relation of overweight to cardiovascular risk factors among children and adolescents: the Bogalusa Heart Study*. Pediatrics 1999; 103(6 Pt 1): 1175-82.
32. Schmieder RE, Messerli FH, Ruddel H: *Risks for arterial hypertension*. Cardiol Clin 1986; 4: 57-66.
33. Rosner B, Prineas R, Daniels SR, Loggie J: *Blood pressure differences between blacks and whites in relation to body size among US children and adolescents*. Am J Epidemiol 2000; 151: 1007-19.
34. Sorof JM, Lai D, Turner J, Poffenbarger T, Portman RJ: *Overweight, ethnicity, and the prevalence of hypertension in school-aged children*. Pediatrics 2004; 113(3 Pt 1): 475-82.
35. Gutin B, Owens S, Slavens G, Riggs S, Treiber F: *Effect of physical training on heart-period variability in obese children*. J Pediatr 1997; 130: 938-43.
36. Tounian P, Aggoun Y, Dubern B, Varille V, Guy-Grand B, Sidi D, et al: *Presence of increased stiffness of the common carotid artery and endothelial dysfunction in severely obese children: a prospective study*. Lancet 2001; 358: 1400-4.
37. Hergenroeder AC, Hill RB, Wong WW, Sangi-Haghpeykar H, Taylor W: *Validity of self-assessment of pubertal maturation in African American and European American adolescents*. J Adolesc Health 1999; 24: 201-5.
38. Bonat S, Pathomvanich A, Keil MF, Field AE, Yanovski JA: *Self-assessment of pubertal stage in overweight children*. Pediatrics 2002; 110: 743-7.
39. Duke PM, Litt IF, Gross RT: *Adolescents' self-assessment of sexual maturation*. Pediatrics 1980; 66: 918-20.
40. Brooks-Gunn J, Warren MP, Rosso J, Gargiulo J: *Validity of self-report measures of girls' pubertal status*. Child Dev 1987; 58: 829-41.

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