Bol Med Hosp Infant Mex 2013;70(1):11-17

RESEARCH ARTICLE

Discarding the first measurement and considering blood pressure as the average of three subsequent measurements reflect more stable blood pressure values in children

Miguel Klünder-Klünder,[1] Samuel Flores-Huerta[1]

ABSTRACT

Background. In childhood and adolescence, evaluating blood pressure requires an appropriately trained personnel team, taking more than one measurement and knowing the age, gender and weight/height percentile. However, there is little information as to why three or more measurements should be taken. It is also not known if the first measured values may reflect a reactive effect referred to as "white coat hypertension" in children. The objective of the present work was to estimate differences in prevalence rates and figures between consecutive measurements of blood pressure.
Methods. There were 2247 children and adolescents from 6 to 16 years of age who participated in the study. Weight and height were measured and blood pressure was taken four times at 1- to 2-min intervals. The average differences in blood pressure between different measurements were also compared. In addition, the prevalence of high blood pressure using different measurements were obtained and compared.
Results. Blood pressure readings obtained in the first measurement were higher than the values of the average of two to four measurements. With the first measurement, the prevalence of systolic blood pressure was 2.6 *versus* 1.9% of the average measurements, whereas for diastolic hypertension the prevalence rates were 4.8 *versus* 3.4%.
Conclusions. The highest value of the figures of the first blood pressure measurement may be the effect of the child's reaction without translating to a permanent increase. It confirms the importance of discarding the first measurement and avoidance of overestimation of the prevalence of high blood pressure.

Key words: blood pressure, obesity, children.

INTRODUCTION

Measurement of blood pressure should be an indicator for the health care of children and adolescents; however, today it is not. Due to the growing increasing of adult hypertension, the opinion of Task Force groups from developed countries recommend that blood pressure be measured consistently from 3 years of age in order to detect arterial hypertension.[1] The purpose of this is timely modification of factors that increase blood pressure values at an early age. Currently, among the independent factors that modify blood pressure in children and adolescents are inherited family history,[2] age, body mass index (BMI) and waist circumference,[3,4] and there are gender differences.[5-12] Thus, in children with normal weight, the prevalence of increase in blood pressure varies from 1.3–11%, whereas in children who are overweight, the prevalence ranges from 6.4–33%. In other studies, increased blood pressure was directly associated with increased BMI: children and adolescents with BMI <5th percentile had a prevalence of high blood pressure between 2 and 6%, whereas the prevalence for those who had a BMI >95th percentile was between 11 and 45%.[13-15]

Despite international efforts to create guidelines for determining hypertension in children, blood pressure values during the pediatric age remain to be precisely determined;[16] therefore, prevalence of high blood pressure values also has not been determined. Among the factors that explain this lack of information is the heterogeneity of the methods used to measure and evaluate blood pressure.[17]

[1] Departamento de Investigación en Salud Comunitaria Hospital Infantil de México Federico Gómez México D.F., México

Received for publication: 12-21-12
Accepted for publication: 1-24-13

As for the instruments used to measure blood pressure, oscillometric methods are increasingly common. However, the auscultatory method by a trained examiner with the use of a mercury sphygmomanometer is the method of choice for measuring blood pressure in the physician's office and even when working in community health situations.[18] Regarding the protocols for diagnosis of hypertension, methods consider the number of visits and measurements. As for the first (number of visits), these can be one to three and as for the measurements, from one to four.[8,13-15,19-22] It has been observed that when the study considers three visits, prevalence of high blood pressure differs between the first and third visits. In a study by Sorof et al., prevalence of hypertension was 16.8% during the first visit and decreased to 9.5% at the third.[15] In a subsequent study performed by the same group, a prevalence of 19.4% was found for hypertension during the first visit, which decreased to 4.5% during the third.[14]

Chiolero et al. found a prevalence of hypertension to be 11.4% during the first visit, which decreased to 2.2% at the third.[13] With these considerations, prevalence of hypertension in children may vary from 2.2–30% in a given population according to the number of visits. The instruments with which we measure blood pressure, interval between measurements and reference standard used are variables that are also seen in various reports, which consequently results in the difficulty in comparing patterns, prevalence, and blood pressure values in different populations.[8] Regarding the measurements, some studies take the average of all numbers of the values of blood pressure determined, although the majority use the average figure after eliminating the first measurement. This is done with the intention to eliminate the reactive increase of blood pressure referred to as "white coat hypertension." However, little is known about the magnitude of the differences between consecutive blood pressure measurements in children in one visit. Therefore, the objective of this study was to estimate the differences between the numbers and prevalence of consecutive measurements of blood pressure in children and adolescents in order to establish whether or not the first readings should be discarded.

SUBJECTS AND METHODS

We performed a cross-sectional community study. The population consisted of a sample of 2247 children and adolescents aged 6 to 16 years of age from public and private schools in Mexico City.

After standardization of all procedures, measurements were done of weight, height and blood pressure of each individual. Internationally recommended procedures were followed when performing measurements.[23] Weight was determined using a digital scale to the nearest 100 g (Seca, Hamburg) and height using a stadiometer (Seca 225 stadiometer). Age was determined according to the difference between the date of birth and date of measurements. Values of weight and height were processed using Epi Info v.3.4.3 with the CDC reference 2000.[24,25] Percentiles and Z scores of BMI (kg/m^2), height for age and BMI for age were obtained. The nutritional status of children and adolescents was classified as normal (if BMI was <85th percentile), overweight (if BMI was ≥85th percentile and <95 percentile) and obese (if BMI was ≥95th percentile).

Children's blood pressure was determined after resting for 5 min, in a sitting position with the back supported by the back of the chair, feet on the floor, on the right arm at heart level (at a 45° angle). An appropriately sized cuff was placed so that the lower edge would be 1-2 cm above the fold of the antecubital fossa. Before measuring blood pressure by auscultation, the first number was measured by palpation. After these procedures, and with an interval of 1-2 min, four measurements were taken with the auscultatory method, inflating the cuff up to 30 mmHg above the figure where the pulse disappeared and releasing the air at a speed of 2 mmHg/sec. The first Korotkoff sound was taken into consideration to define the systolic pressure and the disappearance of Korotkoff sounds (or beginning of silence) marked the diastolic pressure. To estimate the prevalence of increased blood pressure, prehypertension was considered if blood pressure values were found between the 90th and <95th percentiles for age, gender and height percentile, or arterial hypertension if values were ≥95th percentile according to age, gender and height percentile.

Statistical analysis

Measures of central tendency and dispersion were done. Prevalence of prehypertension and mean and SD of the different measurements of blood pressure were obtained. The mean differences between the first, second, third, fourth and the average of 2-4 measurements were calculated. To

Table 1. Characteristics of the study population according to gender

	Male n =1031		Female n =1216	
	Mean	SD	Mean	SD
Age (years)	11.4	± 3.2	11.4	± 3.3
Weight (kg)	44.8	± 17.3	43.2	± 15.7
Height (cm)	145.7	± 18.9	142.3	± 16.2
BMI (kg/m^2)	20.2	± 4.2	20.5	± 4.3
BMI (%)	66.4	± 29.2	68.4	± 26.4
Blood pressure (mmHg)				
Systolic[1]	98.9	± 10.9	95.9	± 10.3
Systolic[2] (%)	31.0	± 24.1	28.4	± 23.8
Diastolic[1]	62.0	± 8.0	60.9	± 7.9
Diastolic[2] (%)	51.9	± 20.9	47.5	± 21.5

[1] Average of the rates of the second, third and fourth measurements.
[2] According to gender, age and height percentile.SD, standard deviation.

calculate the association among categorical variables, we used c^2 and for the differences, confidence interval. Data were analyzed using the statistical package Stata/SE v.8.0.

RESULTS

Among the characteristics of the study population, it was observed that BMI percentile in males was 66.4. Systolic blood pressure was placed at the 31st percentile and diastolic blood pressure in the 51.9 percentile of the reference values. In females it was 68.4, 28.4 and 47.5, respectively (Table 1).

Systolic blood pressure figures are shown in Table 2 and diastolic blood pressure in Table 3, according to the order in which the measurements were taken. It was observed that the systolic blood pressure figures obtained in the first measurement (both male and female) were higher for all ages,

Table 2. Rates of SBP according to gender and age of the study population, following the order of measurement

		Males								Average measure*	
Age		1st measure		2nd measure		3rd measure		4th measure			
(years)	n	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
6	80	92.5	± 9.4	92.0	± 9.2	91.3	± 9.4	91.3	± 9.2	91.5	± 9.2
7	82	89.6	± 8.3	88.8	± 7.9	88.8	± 7.8	89.0	± 7.6	88.8	± 7.7
8	87	94.3	± 9.7	93.4	± 9.0	93.2	± 9.0	92.9	± 9.2	93.2	± 9.0
9	88	95.6	± 9.4	94.2	± 8.9	93.3	± 8.6	93.1	± 8.8	93.5	± 8.6
10	93	98.5	± 9.0	97.4	± 8.5	97.3	± 9.0	97.2	± 8.9	97.3	± 8.7
11	89	98.0	± 8.8	98.2	± 9.1	97.8	± 9.4	97.8	± 9.4	97.9	± 9.2
12	92	101.5	± 9.8	100.3	± 9.6	99.8	± 9.3	99.7	± 9.3	99.9	± 9.3
13	66	103.6	± 10.0	102.5	± 9.4	102.2	± 9.3	101.9	± 9.6	102.2	± 9.4
14	102	105.0	± 10.4	103.5	± 9.8	102.8	± 9.4	102.7	± 9.4	103.0	± 9.4
15	171	106.0	± 10.4	105.9	± 10.5	105.6	± 10.1	105.4	± 10.3	105.6	± 10.2
16	81	109.0	± 10.9	108.0	± 10.7	107.9	± 10.6	107.7	± 10.4	107.9	± 10.5
Total	1031	100.0	± 11.3	99.2	± 11.1	98.8	± 11.0	98.7	± 11.0	98.9	± 10.9
		Females									
6	86	90.2	± 9.8	89.2	± 9.6	88.8	± 10.1	88.6	± 9.7	88.9	± 9.7
7	102	88.2	± 7.7	87.5	± 8.0	87.0	± 7.8	87.0	± 7.7	87.2	± 7.7
8	114	90.9	± 7.9	90.4	± 7.4	90.3	± 7.6	90.3	± 7.9	90.3	± 7.6
9	102	94.2	± 9.5	93.6	± 9.0	93.1	± 9.0	93.1	± 9.1	93.3	± 8.9
10	111	96.7	± 10.6	95.7	± 10.2	95.4	± 10.4	95.2	± 10.4	95.4	± 10.3
11	99	98.5	± 8.7	98.0	± 8.8	97.6	± 9.3	97.7	± 9.4	97.8	± 9.0
12	110	100.3	± 10.4	99.7	± 10.4	99.5	± 10.4	99.3	± 10.2	99.5	± 10.3
13	83	99.0	± 10.5	97.7	± 10.2	97.5	± 10.1	97.4	± 9.7	97.6	± 9.9
14	73	102.1	± 10.7	101.5	± 10.6	100.8	± 10.7	100.7	± 10.3	101.0	± 10.4
15	237	100.1	± 9.0	99.1	± 9.0	99.4	± 8.9	99.3	± 8.8	99.3	± 8.8
16	99	103.0	± 10.1	102.1	± 9.6	102.0	± 9.5	102.1	± 9.4	102.1	± 9.4
Total	1216	96.9	± 10.5	96.1	± 10.4	95.9	± 10.4	95.8	± 10.4	95.9	± 10.3

*The value corresponds to the second, third and fourth measurements.
SBP, systolic blood pressure; SD, standard deviation.

Table 3. Rates of DBP according to gender and age of the study population, following the order of measurement

Age (years)	n	1st measure Mean	1st measure SD	2nd measure Mean	2nd measure SD	3rd measure Mean	3rd measure SD	4th measure Mean	4th measure SD	Average measure* Mean	Average measure* SD
					Males						
6	80	59.2	6.6	59.0	6.5	58.8	6.7	58.9	6.4	58.9	6.4
7	82	55.0	5.4	54.2	5.2	54.1	5.1	54.0	5.4	54.1	5.2
8	87	58.4	6.8	57.8	7.4	57.5	7.2	57.2	7.0	57.5	7.1
9	88	58.2	6.3	57.9	6.0	57.7	6.2	57.6	6.3	57.8	6.0
10	93	62.0	7.4	61.3	7.3	60.8	7.3	61.0	7.3	61.0	7.1
11	89	62.4	6.1	62.0	6.3	62.1	6.4	62.0	6.3	62.0	6.3
12	92	64.7	7.1	64.1	7.3	64.0	7.4	64.0	7.4	64.0	7.3
13	66	63.2	6.7	63.1	6.8	63.2	7.3	63.3	7.4	63.2	7.0
14	102	64.9	8.3	64.3	7.6	64.0	7.5	64.2	7.4	64.2	7.3
15	171	66.5	7.9	66.6	7.8	66.4	7.7	66.3	8.0	66.4	7.7
16	81	68.5	7.9	68.5	7.6	68.4	7.6	68.5	7.7	68.5	7.6
Total	1031	62.5	8.1	62.1	8.1	62.0	8.1	62.0	8.2	62.0	8.0
					Females						
6	86	57.2	7.2	56.8	6.9	56.9	6.8	56.9	6.9	56.9	6.7
7	102	53.6	6.0	53.7	5.5	53.4	5.3	53.2	5.2	53.4	5.3
8	114	56.7	6.6	56.1	6.2	55.9	6.4	55.8	6.3	55.9	6.2
9	102	59.7	7.2	59.4	7.0	58.6	7.4	58.7	7.4	58.9	7.2
10	111	60.6	8.0	59.8	7.3	59.8	7.4	59.9	7.5	59.8	7.3
11	99	62.8	7.5	62.6	7.5	62.2	7.2	62.0	7.3	62.3	7.2
12	110	64.1	7.7	64.1	7.3	63.8	7.0	63.8	6.8	63.9	6.9
13	83	62.8	7.7	63.0	7.6	62.8	7.6	63.0	7.5	62.9	7.5
14	73	63.1	7.0	63.2	7.1	63.2	7.2	63.4	6.9	63.3	7.0
15	237	64.5	8.2	63.9	7.9	63.9	7.7	64.2	7.7	64.0	7.6
16	99	67.0	7.4	66.5	7.1	66.6	6.9	66.1	7.0	66.4	6.8
Total	1216	61.4	8.3	61.1	8.0	60.9	8.0	60.9	8.0	61.0	7.9

*The value corresponds to the average of the second, third and fourth measurements.
DPB, diastolic blood pressure; SD, standard deviation.

compared to those obtained in subsequent measurements, as well as the average of the last three measurements. The average systolic blood pressure in males aged 6-16 years was 91.5 to 107.9 mmHg and females from 88.9 to 102.1 mmHg. Diastolic blood pressure in males was 58.9 to 68.5 and for females, 56.9-66.4 mmHg.

The difference in the figures from the first systolic blood pressure measurements and the second demonstrated a significant reduction in all ages. This relationship was maintained when comparing the second, third and fourth measurements and the average of the last three measurements. It was noted that the difference between the first measurement and the average of the subsequent measurements could be up to 1.6 mmHg (Table 4). Also, differences in diastolic blood pressure at the same ratio as systolic blood pressure were observed, but with less intensity and without statistical significance.

With respect to the prevalence of hypertension in children and adolescents, it was found that the prevalence of hypertension varies differently between systolic blood pressure and diastolic blood pressure (Table 5). It can be appreciated that the joint prevalence of diastolic prehypertension and hypertension duplicates the same figures of systolic blood pressure (1.9% vs. 3.4%), whereas the frequency of children with increase in both pressures is ~1%. It is also shown that the overall prevalence of hypertension in this age group is 6.6% if only the first measurement is taken into consideration, compared with 4.5% of the average. Systolic blood pressure was 2.6% in the first measurement compared with 1.9% of the average, and for diastolic blood pressure, the prevalence was 4.8% vs. 3.4%.

Note the BMI percentile distribution of the population as shown in Figure 1. As the BMI percentile increases, the numbers of children and adolescents with hyper-

Table 4. Mean and 95% CI of the differences in the SBP and DBP rates according to age, among measurements

		Systolic					
Age (years)	*n*	1st-2nd		1st-4th		1st-average*	
6	166	-0.78	(-1.34; -0.22)	-1.43	(-2.11; -0.75)	-1.17	(-1.77; -0.57)
7	184	-0.78	(-1.21; -0.35)	-0.95	(-1.45; -0.45)	-0.92	(-1.37; -0.47)
8	201	-0.66	(-1.13; -0.20)	-0.94	(-1.47; -0.41)	-0.80	(-1.27; -0.34)
9	190	-0.92	(-1.37; -0.46)	-1.72	(-2.42; -1.01)	-1.41	(-2.00; -0.83)
10	204	-1.03	(-1.49; -0.56)	-1.36	(-1.93; -0.78)	-1.21	(-1.73; -0.69)
11	188	-0.13	(-0.60; 0.35)	-0.51	(-1.10; 0.09)	-0.39	(-0.90; 0.12)
12	202	-0.89	(-1.45; -0.33)	-1.43	(-2.02; -0.83)	-1.18	(-1.75; -0.62)
13	149	-1.21	(-1.86; -0.56)	-1.62	(-2.38; -0.87)	-1.42	(-2.09; -0.74)
14	175	-1.09	(-1.89; -0.29)	-1.90	(-2.70; -1.10)	-1.58	(-2.34; -0.83)
15	408	-0.64	(-1.04; -0.24)	-0.72	(-1.18; -0.27)	-0.64	(-1.04; -0.25)
16	180	-0.97	(-1.66; -0.28)	-1.07	(-1.85; -0.29)	-1.01	(-1.73; -0.30)
		Diastolic					
Age (years)	*n*	1st-2nd		1st-4th		1st-average*	
6	166	-0.25	(-0.65; 0.14)	-0.28	(-0.79; 0.23)	-0.29	(-0.72; 0.14)
7	184	-0.32	(-0.75; 0.12)	-0.65	(-1.13; -0.16)	-0.49	(-0.93; -0.05)
8	201	-0.63	(-1.06; -0.21)	-1.07	(-1.55; -0.59)	-0.85	(-1.30; -0.41)
9	190	-0.27	(-0.69; 0.15)	-0.81	(-1.33; -0.28)	-0.64	(-1.08; -0.19)
10	204	-0.72	(-1.14; -0.29)	-0.83	(-1.39; -0.28)	-0.83	(-1.29; -0.37)
11	188	-0.27	(-1.14; 0.16)	-0.63	(-1.13; -0.14)	-0.46	(-0.91; -0.02)
12	202	-0.23	(-0.62; 0.16)	-0.49	(-1.00; 0.03)	-0.39	(-0.82; 0.05)
13	149	0.01	(-0.49; 0.51)	0.11	(-0.53; 0.75)	0.04	(-0.51; 0.59)
14	175	-0.25	(-0.77; 0.27)	-0.29	(-0.89; 0.32)	-0.33	(-0.88; 0.21)
15	408	-0.27	(-0.60; 0.06)	-0.21	(-0.57; 0.14)	-0.28	(-0.60; 0.05)
16	180	-0.23	(-0.70; 0.24)	-0.48	(-1.08; 0.13)	-0.31	(-0.80; 0.19)

*The value corresponds to the average of the second, third and fourth measurements.
CI, confidence interval.

Table 5. Prevalence of hypertension and systolic and diastolic hypertension, according to the number of the measurement

	Measurement number				
	1st	2nd	3rd	4th	Average 2-4th
Systolic					
Normal	97.4	98.0	98.1	98.3	98.1
Prehypertension	1.5	1.2	1.1	1.0	1.2
Hypertension	1.1	0.8	0.8	0.8	0.7
Pre- and hypertension	2.6	2.0	1.9	1.7	1.9
Diastolic					
Normal	95.2	96.1	96.4	96.3	96.6
Prehypertension	3.7	2.9	2.7	2.9	2.6
Hypertension	1.1	0.9	0.9	0.8	0.8
Pre- and hypertension	4.8	3.9	3.6	3.7	3.4
Both	0.9	0.7	0.9	0.8	0.9
Total	6.6	5.2	4.6	4.6	4.5

Prehypertension: percentile 90 – <95th percentile according to age, gender and height percentile.
Hypertension: percentile ≥95 percentile according to age, gender and height percentile.

tension increases. Those with a BMI <85th percentile had a prevalence of 0.6% of hypertension, whereas those with BMI >95th percentile had a prevalence of 6.6%. Regarding the diastolic blood pressure, the prevalence was 2.3% vs. 7.3%. In this sense, the biggest difference between the prevalence of the different measurements was observed in children with BMI >95th percentile because between the first and second measurement, the systolic blood pressure decreased 1.9 percentage points and for the diastolic blood pressure this difference was 3.4 percentage points, whereas in children with a BMI <85th percentile, these differences were 0.3 and 0.4 percentage points, respectively.

DISCUSSION

High blood pressure is a health problem that runs silently with a perception that only adults experience this con-

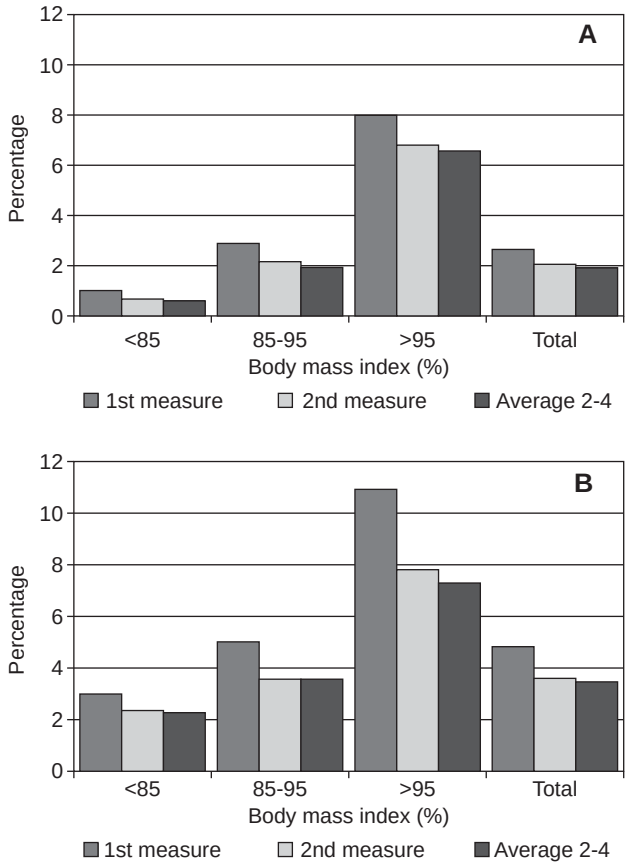

Figure 1. Prevalence of pre- and systolic **(A)** and diastolic **(B)** arterial hypertension according to measurement number and BMI percentile.

dition. Its prevalence in children compared with that in adults is lower; however, hypertension during the indicated period reached 4.5%. It was confirmed that hypertension begins from childhood and increases progressively with age. Overweight and obesity and height percentile also showed clear differences with respect to gender and between systolic or diastolic blood pressure.[26,27]

Considering the figures obtained from the average of two to four measurements, prevalence of high blood pressure in our study is similar to what has been reported in the U.S.[14] and Italy,[21] higher than that reported in Switzerland[13] and lower than previously reported in children and adolescents in Africa[20] and Canada.[22] Similarly, a study by Castillo et al. in a population of 7- to 24-year-old subjects in metropolitan Mexico City reported a higher prevalence of hypertension (11.5%), a difference that may be explained by the amplitude in the age range. In order to evaluate blood pressure, the average of three measurements, including the first, were taken into account.[19]

In this study, blood pressure was determined by the auscultatory method after training of personnel and standardization of the procedure. To obtain the prevalence, the average value of the last three blood pressure measurements were taken into consideration, discarding the first one by having statistically significant differences with the average of the last three numbers. From this, blood pressure values were compared with benchmark figures of the Task Force 2004[1] that assigns values according to gender, age and height, and prevalence of prehypertension and hypertension were obtained. It is also important to note that the systolic blood pressure figures in this study, adjusted by gender and age, were lower than the mentioned reference values. This may be explained because we considered that the average height for males in our population was in the 44.6 percentile and height for females in the 40.1 percentile; as a consequence the blood pressure corresponds to these percentiles. These and other peculiarities of our population suggest the need to generate regional reference values.

Moreover, it is notable that children 6 years of age have higher blood pressure numbers, systolic and diastolic, compared with children 7 years of age. This phenomenon is also described in another study in the Mexican population associated with a higher variability in the numbers[28] explained by the fact that children at 6 years of age are more susceptible of presenting what has been described as "white coat hypertension."[1]

This study confirms that blood pressure figures obtained in the first measurement, both systolic and diastolic, are different than the average of the second to fourth measurements. Therefore, with this difference, it is confirmed that evaluation of blood pressure cannot be done with a single measurement because additional measurements are required.

In the present study, the value considered as useful was the average of the second, third and fourth measurements. Therefore, evaluation of this important clinical parameter, whose increase in the numbers of hypertension makes up part of the components of the so-called metabolic syndrome which, in turn, is strongly associated with obesity, must be determined appropriately. It should be taken into consideration in the protocol to eliminate the first measurement so as to not overestimate the prevalence

of high blood pressure in the categories of prehypertension or hypertension, in addition to evaluating the figures for age, gender, and height, as recommended by the Task Force for this health problem.[1]

Correspondence: Dr. Samuel Flores Huerta
E-mail: floreshuertamd@gmail.com

REFERENCES

1. National High Blood Pressure Education Program Working Group on High Blood Pressure in Children and Adolescents. The fourth report on the diagnosis, evaluation, and treatment of high blood pressure in children and adolescents. Pediatrics 2004;114(2 suppl 4th Report):555-576.
2. Klünder-Klünder M, Cruz M, Medina-Bravo P, Flores-Huerta S. Do children of parents with overweight and obesity have an increased risk of developing obesity and changes in the blood pressure? Bol Med Hosp Infant Mex 2011;68:404-411.
3. Genovesi S, Antolini L, Giussani M, Brambilla P, Barbieri V, Galbiati S, et al. Hypertension, prehypertension, and transient elevated blood pressure in children: association with weight excess and waist circumference. Am J Hypertens 2010;23:756-761.
4. Flores-Huerta S, Klünder-Klünder M, Reyes de la Cruz L, Santos JI. Increase in body mass index and waist circumference is associated with high blood pressure in children and adolescents in Mexico City. Arch Med Res 2009;40:208-215.
5. Boyd GS, Koenigsberg J, Falkner B, Gidding S, Hassink S. Effect of obesity and high blood pressure on plasma lipid levels in children and adolescents. Pediatrics 2005;116:442-446.
6. Chuang SY, Chou P, Hsu PF, Cheng HM, Tsai ST, Lin IF, et al. Presence and progression of abdominal obesity are predictors of future high blood pressure and hypertension. Am J Hypertens 2006;19:788-795.
7. Drøyvold W, Midthjell K, Nilsen TI, Holmen J. Change in body mass index and its impact on blood pressure: a prospective population study. Int J Obes (Lond) 2005;29:650-655.
8. Flores-Huerta S, Klünder M. Is obesity a predictor of high blood pressure in children and adolescents? Pediatric Health 2008;2:53-63.
9. Francischetti EA, Genelhu VA. Obesity-hypertension: an ongoing pandemic. Int J Clin Pract 2007;61:269-280.
10. Sinaiko AR, Donahue RP, Jacobs DR Jr, Prineas RJ. Relation of weight and rate of increase in weight during childhood and adolescence to body size, blood pressure, fasting insulin, and lipids in young adults. The Minneapolis Children's Blood Pressure Study. Circulation 1999;99:1471-1476.
11. Sorof J, Daniels S. Obesity hypertension in children: a problem of epidemic proportions. Hypertension 2002;40:441-447.
12. Standing Committee on Nutrition. Overweight and obesity: a new nutrition emergency? SCNNews 2005. Available at: http://www.unsystem.org/scn/Publications/SCNNews/scnnews29.pdf
13. Chiolero A, Cachat F, Burnier M, Paccaud F, Bovet P. Prevalence of hypertension in schoolchildren based on repeated measurements and association with overweight. J Hypertens 2007;25:2209-2217.
14. Sorof JM, Lai D, Turner J, Poffenbarger T, Portman RJ. Overweight, ethnicity, and the prevalence of hypertension in school-aged children. Pediatrics 2004;113:475-482.
15. Sorof JM, Poffenbarger T, Franco K, Bernard L, Portman RJ. Isolated systolic hypertension, obesity, and hyperkinetic hemodynamics states in children. J Pediatr 2002;140:660-666.
16. Chiolero A, Bovet P, Paradis G, Paccaud F. Has blood pressure increased in children in response to the obesity epidemic? Pediatrics 2007;119:544-553.
17. Flores-Huerta S, Klünder-Klünder M, Medina-Bravo P. Has the time come to replace mercury sphygmomanometers by automated devices for measuring blood pressure in children? Pediatric Health 2009;3:25-31.
18. Pickering TG, Hall JE, Appel LJ, Falkner BE, Graves J, Hill MN, et al. Recommendations for blood pressure measurement in humans and experimental animals. Part I. Blood pressure measurement in humans. A statement for professionals from the Subcommittee of Professional and Public Education of the American Heart Association Council on High Blood Pressure Research. Circulation 2005;111:697-716.
19. Halley Castillo E, Borges G, Talavera JO, Orozco R, Vargas-Alemán C, Huitrón-Bravo G, et al. Body mass index and the prevalence of metabolic syndrome among children and adolescents in two Mexican populations. J Adolesc Health 2007;40:521-526.
20. Chiolero A, Madeleine G, Gabriel A, Burnier M, Paccaud F, Bovet P. Prevalence of elevated blood pressure and association with overweight in children of a rapidly developing country. J Hum Hypertens 2007;21:120-127.
21. Genovesi S, Giussani M, Pieruzzi F, Vigorita F, Arcovio C, Cavuto S, et al. Results of blood pressure screening in a population of school-aged children in the province of Milan: role of overweight. J Hypertens 2005;23:493-497.
22. Paradis G, Lambert M, O'Loughlin J, Lavallée C, Aubin J, Delvin E, et al. Blood pressure and adiposity in children and adolescents. Circulation 2004;110:1832-1838.
23. World Health Organization. Physical status: the use and interpretation of anthropometry. Report of a WHO Expert Committee. Technical Report Series 854. Available at: http://www.who.int/childgrowth/publications/physical_status/en/index.html.
24. Lobstein T, Baur L, Uauy R; IASO International Obesity Task Force. Obesity in children and young people: a crisis in public health. Obes Rev 2004;5(suppl 1):4-104.
25. Kuczmarski RJ, Ogden CL, Guo SS, Grummer-Strawn LM, Flegal KM, Mei Z, et al. 2000 CDC Growth Charts for the United States: methods and development. Vital Health Stat 2002;246. Available at: http://www.cdc.gov/growthcharts/2000growthchart-us.pdf
26. Kollias A, Pantsiotou K, Karpettas N, Roussias L, Stergiou GS. Tracking of blood pressure from childhood to adolescence in a Greek cohort. Eur J Public Health 2012;22:389-393.
27. Feber J, Ahmed M. Hypertension in children: new trends and challenges. Clin Sci (Lond) 2010;119:151-161.
28. Arcila-Herrera H, Alcalá-Guerrero K, Montero-Cervantes L, González-Franco MF. Relación entre la tensión arterial, el peso corporal y la estatura en un grupo de niños de Yucatán. Rev Biomed 1997;8:1-8.