CUFF DIMENSION FOR CHILDREN AND ADOLESCENTS: A STUDY IN A NORTHEASTERN BRAZILIAN CITY[1]

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The goal of this study was to measure the arm circumferences (AC) and appropriated cuff sizes for children and adolescents and to relate these dimensions to specific age ranges. This is a cross-sectional study, developed in Fortaleza, Ceará, Brazil, with 596 people between 6 and 17 years old. The AC was measured at the midpoint between the olecranon and the acromion. The selected cuff width followed the recommended ratio of 40% the AC. The more suitable cuff sizes were 7×14 cm, 8×16 cm and 9×18 cm, at 19.8%, 26.5% and 25%, respectively. A statistically significant association between AC and age range was found in both genders, as well as between the cuff and the age range, showing that the 7×14 cm (38.9%) and 8×16 cm (29.6%) cuffs were more suitable for children, and 8×16 cm (23.7%) and 9×18 cm (36.1 %) cuffs were better for adolescents. Adequate cuffs were concluded to be different from the standard cuffs used for children and adolescents.

DESCRIPTORS: nursing; blood pressure; child; adolescent

DIMENSIONES DE MANGUITOS PARA NIÑOS Y ADOLESCENTES: UN ESTUDIO EN UNA CIUDAD EN EL NORESTE DE BRASIL

El objetivo de este estudio fue mensurar, en niños y adolescentes, las circunferencias braquiales (CB) y el ancho de los manguitos más adecuado, y relacionar estas dimensiones a los intervalos de edad. Es un estudio transversal desarrollado en Fortaleza, estado de Ceará, en Brasil, con 596 jóvenes de 6 a 17 años. La CB fue medida en el punto medio entre el olécranon y el acromio. El ancho del manguito seleccionado siguió la relación recomendada de 40% de la CB. Los manguitos más adecuados fueron los de 7x14, 8x16 y 9x18 cm, con 19,8%, 26,5% y 25%, respectivamente. Se encontró una asociación significativa entre la CB y el intervalo de edad, en ambos sexos, así como entre el manguito y el intervalo de edad; indicando que los manguitos de 7x14 cm (38,9%) y 8x16 cm (29,6%) fueron más adecuados para niños y de 8x16 cm (23,7%) y 9x18 cm (36,1%) para adolescentes. Se concluye que los manguitos adecuados son diferentes de los utilizados como estándar para niños y adolescentes.

DESCRIPTORES: enfermería; presión sanguínea; niño; adolescente

DIMENSÕES DE MANGUITOS PARA CRIANÇAS E ADOLESCENTES: ESTUDO EM UMA CIDADE NO NORDESTE DO BRASIL

O objetivo deste estudo foi mensurar, em crianças e adolescentes, as circunferências braquiais (CB) e as larguras dos manguitos mais adequadas e relacionar essas dimensões às faixas etárias. Estudo transversal foi desenvolvido em Fortaleza, Ceará, com 596 jovens de 6 a 17 anos. A CB foi medida no ponto médio entre o olécrano e o acrômio. A largura do manguito selecionado seguiu a relação recomendada de 40% da CB. Os manguitos mais adequados foram os de 7x14, 8x16 e 9x18 cm com 19,8, 26,5 e 25%, respectivamente. Encontrou-se associação significante entre CB e faixa etária, em ambos os sexos, bem como entre o manguito e a faixa etária, indicando que manguitos de 7x14 cm (38,9%) e 8x16 cm (29,6%) foram mais adequados para crianças e de 8x16 cm (23,7%) e 9x18 cm (36,1%) para adolescentes. Conclui-se que os manguitos adequados são diferentes daqueles utilizados como padrão para crianças e adolescentes.

DESCRITORES: enfermagem; pressão arterial; criança; adolescente

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INTRODUCTION

*T*he prevalence of hypertension in childhood and adolescence is not clearly defined. According to a specialized publication on hypertension[1], this disease is present in 2% to 13% of the child/adolescent population. Previously, only very serious alterations in blood pressure were identified in children or adolescents, and the secondary causes were the most prevalent. Nowadays, even though hypertension in young individuals is more likely to have its origin in secondary causes, the prevalence of the primary (or essential) form has been increasing in the younger age ranges[2].

Thus, the increased amount of hypertension cases in young people justifies the periodic measurement of blood pressure in children over three years old, and the inclusion of blood pressure verification as an integral part of the clinical appointment, with a view to preventing or minimizing the damaging effects of hypertension[3].

Precision in the measurement of blood pressure has been a great challenge, characterized by attempts to reducing mistakes introduced by the observer or the client, who can present an increase in blood pressure levels due to the measurement procedures and the presence of the healthcare professional, particularly because of the instruments used[4].

In children and adolescents, an important aspect of hypertension is the difficulty to define reference values to be adopted for diagnosis and the methodological standardization of the procedure[5]. This happens due to several factors, among them the selection of the appropriate cuff. The correct measurement, including the choice of the cuff, is extremely important for the reliability of the blood pressure measurement, since cuffs that are too narrow or wide in relation to the arm circumference tend to cause over- or under-estimates of the real blood pressure values, respectively.

The difficulty to use the correct cuff does not seem to be related with the inexistence of the material in the market, but with the lack of importance conferred to the correct measurement of blood pressure in children and adolescents. The low amount of systematic studies about the measurements of arm circumference in literature makes it difficult to indicate the correct cuff widths for use with children and adolescents. It is worth noting that, in Brazilian clinical practice, the choice of cuff, when it occurs, is related to age (models for children, adolescents and adults), a fact that could harm the correct diagnostic evaluation.

During the literature review, the fact of the standard-width cuff being considered adequate only for a small share of the population was intriguing. A study[6] found that the standard-width cuff was adequate to 5% of the adult population, with 93% requiring the use of widths narrower than 12 cm. An alert about its use in children and adolescents was made in another study, where the 12-cm cuff had no expressive use, even for the 17- and 18-year old individuals[7]. Despite evidences about the inadequacy of the standard cuff, the reality of the available cuff sizes and standard routines in institutions have not changed yet.

Since the deficit in clinical practice regarding blood pressure measurement in children and adolescent is known, the school environment, with its high concentration of individuals in this age range, can be considered a favorable place for the evaluation of healthcare conditions, especially in this parameter. In the face of this context, this study aimed at measuring, in children and adolescents aged 6 to 17 years old at a public school in Fortaleza, the arm circumferences and most adequate cuff widths, and also to relate the adequate cuff dimensions with each age range.

The development of this study is justified by the importance of using cuffs with the correct dimensions to guarantee the validity of the blood pressure measurement, which will certainly contribute as the base for therapeutic actions.

METHOD

This cross-sectional, exploratory study was performed at a public school for the elementary and high levels located in Fortaleza, where previous studies about the theme were performed with satisfactory results[8].

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The population consisted of 596 children and adolescents between 6 and 17 years old, enrolled in the school for daytime classes, in 2003, 2004 and 2005. The primary inclusion criteria were: minimum age of 6 and maximum of 17 years old; being present at school on the day and time scheduled for data collection, and acceptance by the child or adolescent and their legal guardians to participate in the study.

Data were collected in three distinct periods: September/2003 to February/2004, October/2004 to March/2005 and June/2005 to October/2005, with each student being evaluated only once. A form with topics was used for data collection in order to meet the proposed goals.

The arm circumference (AC) was measured with a non-stretchable measurement tape, with 0.1 cm intervals and total length of 100 cm, at the midpoint between the olecranon and the acromion. The cuff to be indicated for each participant was selected according to the recommended cuff width ratio, corresponding to 40% of the circumference of the arm used for blood pressure measurement[1].

For the evaluation of the association between the AC and age range, and adequate cuff and age range, the bidirectional Monte Carlo Simulation method was used, with a confidence interval of 99% for the calculation of Fisher's exact probability. The data were organized in MS-Excel v. 8.0, processed and analyzed with SPSS software, version 13.0, and presented as tables. The adopted level of significance was 5% ($p < 0.05$).

Administrative procedures to request permission for the execution of the research were performed, by using memorandums and contacting the subjects involved. The project only started after authorization from the institution's board management. Besides, according to Resolution 196/1996, the study proposal was sent to and approved by the Review Board of Complexo Hospitalar da Universidade Federal do Ceará (COMEPE), complying with the requirements of the aforementioned resolution for research involving human beings[9]. Data collection started after being approved, and also after meetings with the students' parents, where the proposed goals were clarified and their authorization was requested so that the children and adolescents could participate in the research, by signing the term of consent.

RESULTS AND DISCUSSION

A total of 596 children and adolescents, from 6 to 17 years old, were included in the study. The characterization of the group by gender, age and arm circumference (AC) is presented next (Tables 1 and 2).

Table 1 – Distribution of children and adolescents according to gender and age. Fortaleza, 2005

Variables	No.	%	Statistics	
1. Gender			Trust Interval (IC) 95%	
Male	301	50.5	46.4%	54.6%
Female	295	49.5	45.4.0%	53.6%
Total	596	100		
2. Age (years)			Average: 11.75	Standard deviation: 3.06
6 - 11	280	47	Median: 12	Minimum: 6
12 - 17	316	53	Mode: 11	Maximum: 17
Total	596	100	25-percentile: 10	75-percentile: 14

In the evaluated group, there are 301 (50.5%) male participants and 295 (49.5%) females. The higher presence of male children and adolescents was also reported in other studies[8,10]. The most frequent age was 11 years, and the average age was 11.75 years old, with a standard deviation of 3.06 years and median of 12 years old.

Table 2 - Distribution of children and adolescents according to arm circumference (AC). Fortaleza, 2005

Variable	No.	%	Statistics	
1. AC (cm)				
13.5 - 18.8	142	23.8	Average: 21.51	Standard deviation: 3.64
19.0 - 24.8	348	58.4	Median: 21	minimum: 13.5
25.0 - 30.5	97	16.3	Mode: 19	Maximum: 36
31.0 - 36.0	9	1.5	25-percentile: 19	75-percentile: 23.5
Total		596	100	

The AC varied between 13.5 and 36 cm, averaging 21.51 cm and standard deviation of 3.64 cm. 384 individuals (58.4%) in the population, of both genders, presented an AC between 19 and 24.8 cm; 142 (23.8%) between 13.5 and 18.8cm; 97 (16.3%) between 25 and 30.5 cm, and 9 (1.5%) between 31 and 36 cm.

Although the arm circumference is an essential parameter for the choice of cuff, and consequently for the precise measurement of blood pressure, few data about this parameter in children and adolescents were found in the consulted literature.

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The distribution of the population is presented next, in function of the arm circumference and age range.

Table 3 - Distribution of children and adolescents according to age and arm circumference (BC). Fortaleza, 2005

Age range (years)	AC (cm)				Total
	13.5 - 18.8	19 -24.8	25 -30.5	31 - 36	
6 - 11	133	125	21	1	280
Line %	47.5	44.6	7.5	0.4	100.0
Column %	93.7	35.9	21.6	11.1	47.0
12 - 17	9	223	76	8	316
Line %	2.8	70.6	24.1	2.5	100.0
Column %	6.3	64.1	78.4	88.9	53.0
Total	142	348	97	9	596
Line %	23.8	58.4	16.3	1.5	100.0
Column %	100.0	100.0	100.0	100.0	100.0

Fisher's exact test, $p < 0.001$
Initial seed for Monte Carlo simulation: 2000000

A higher frequency of individuals with arm circumference in the 19-24.8 range was observed, with a predominance of the 12-17 year old age range. In the 6-11 year old age range, 133 (47.5%) children had an AC between 13.5 and 18.8 cm; 25 (44.6%) between 19 and 24.8 cm; 21 (7.5%) between 25 and 30.5 cm; and 1 (0.4%) between 31 and 36 cm. Among the adolescents in the 12-17 year old age range, most 223 (70.6%) had their AC between 19 and 24.8; 76 (24.1%) between 25 and 30.5 cm; 9 (2.8%) between 13.5 and 18.8; and 8 (2.5%) between 31 and 36 cm. Similar values were found in another study with children and adolescents between 6 and 18 years old, where most of the group had an arm circumference varying between 19 and 23 cm[7].

In the evaluation of the association between the AC and age range, a statistically significant association ($p = 0.000$) was found in both genders, indicating that children have shorter AC and adolescents have longer AC. However, although less frequently, children with arm circumferences between 31 and 36 cm were found, as well as adolescents with much shorter circumferences, like between 13.5 and 18.8cm.

Literature has often emphasized that age determines the width of the cuff to be used. However, from 1967 onwards, the circumference of the limb was emphasized as the determiner of the cuff width to be used, instead of age[11].

In agreement with another study[7], several circumference lengths were found in all ages, showing that there are large growth and development changes in these age ranges, which would therefore prevent the age factor to be the determiner for the choice of cuff.

The indication of the cuff was performed while seeking the closest approximation with the recommended guideline, which considers that the width and length of the rubber bag should correspond to 40% and 80-to-100% of the arm circumference, respectively[1]. In clinical practice, it is observed that the choice of cuff, when it happens, is related only to age (models for children, adolescents and adults), which could harm the correct diagnostic evaluation by over - or under-estimating the real blood pressure values.

Table 4 shows the adequate cuff width values, according to age range.

Table 4 – Distribution of the children and adolescents according to the adequate cuff and age range. Fortaleza, 2005

Age range (years)	Adequate cuff									Total
	6×12	7×14	8×16	9×18	10×20	11×22	12×24	13×26	14×28	
6 -11	25	109	83	35	17	7	4	0	0	280
Line %	8.9	38.9	29.6	12.5	6.1	2.5	1.4	0.0	0.0	100.0
Column %	100.0	92.4	52.5	23.5	19.8	17.1	33.3	0.0	0.0	47.0
12 - 17	0	9	75	114	69	34	8	2	5	316
Line %	0.0	2.8	23.7	36.1	21.8	10.8	2.5	0.6	1.6	100.0
Column %	0.0	7.6	47.5	76.5	80.2	82.9	66.7	100.0	100.0	53.0
Total	25	118	158	149	86	41	12	2	5	596
Line %	4.2	19.8	26.5	25.0	14.4	6.9	2.0	0.3	0.8	100.0
Column %	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Fisher's exact test, $p = 0.000$
Initial seed for Monte Carlo simulation: 624387341

It can be observed that the correct dimensions of the cuffs for the evaluated group were 7×14, 8×16, 9×18 and 10×20 cm, at 19.8%, 26.5%, 25% and 14.4%, respectively. It should be noted that these sizes were adequate for all ages.

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When the association between the adequate cuff and the age range in both genders is analyzed, a statistically significant association (p = 0.000) is found, indicating that the 7×14 cm (38.9%) and 8×16 cm (29.6%) cuffs were more adequate for children, whereas the 8×16 cm (23.7%), 9×18 cm (36.1%) e 10×20 cm (21.8%) cuffs were more adequate for adolescents. These findings are opposed to the indication of the 9×18 cm and 12×24 cm cuffs as standards for children and adolescents, respectively.

It is also worth noting that the 9×18 cm cuff, considered the standard width for children, was adequate for only 35 (12.5%) children. In a similar study, the most adequate cuff for 6- to 11-year old children was that of 6 cm, followed by the 8-cm wide cuff[12]. The 12×24 cm cuff did not present expressive usage, not even among adolescents, confirming its inadequacy as a standardized instrument for adults and people over 12 years old. It should be highlighted that 13×26 cm and 14×28 cm cuffs were adequate for two and five individuals, respectively.

These findings are corroborated by a study about the indirect measurement of blood pressure in function of the cuff width in school children aged 6 to 10, which found that the cuff width does not depend on the age, since the statistical analysis showed a very low correlation and the variance analysis showed values that were not significant. This was associated to the fact that both the wide cuffs and the narrower cuffs were used in all ages[13]. This result strengthens the idea that the choice of the cuff should not be based on the child's gender and age, but on the arm circumference, as stated in the 2004 Task Force[14].

Furthermore, research shows that the systolic pressure (SP) and the diastolic pressure (DP) are underestimated by the standard width cuff, when compared with the pressure levels evaluated with an adequately sized cuff[6,13,15]. In one study[15] that aimed to evaluate the pressure levels of women in the pregnancy-puerperal cycle, differences of 23 mmHg for SP and 20.7 mmHg for DP were observed. When the SP and DP were evaluated in function of the cuff width, differences in blood pressure values were found at 3, 4 and 6 mmHg, as well as 10 mmHg and even 40 mmHg.

These studies show increased blood pressure levels when evaluated with the correct cuff width. Therefore, they elucidate the importance of the width as an error factor for blood pressure measurement, as well as the need for improvement, attention and precision in blood pressure measurement, seeking to adequately determine the cuffs that will be used.

The importance of being able to depend on a broader offer of narrower cuffs than the standard widths for the evaluation of the Brazilian population is emphasized, since the need to use wider cuffs has been constantly emphasized due to increasing obesity cases in Brazil, including the Northeast[16].

Some circumferences detected in children and adolescents in this study confirm this tendency, but attention should be paid to skinny people, whose diagnosis is also impaired, in a way that is even more concerning than obese people. However, in our reality, the frequent use of the standard-width cuffs instead of adequate-width cuffs is an important error factor for the measurement of blood pressure, and still a reality observed in most healthcare institutions.

FINAL CONSIDERATIONS

The results obtained confirm that the utilization of standard cuffs as the correct ones can subject the blood pressure measurement to errors, showing the need to start verifying the blood pressure by measuring the arm circumference, so that an adequate cuff can be chosen.

The need for improvement and precision during blood pressure measurement is indispensable, aiming to contribute to the minimization of error sources and, consequently, obtaining more reliable blood pressure values, since blood pressure measurement is fundamental to support therapeutic actions.

Although recommendations about the need to have cuffs of different dimensions to measure blood pressure adequately for any age are long-standing, the inadequate use of cuffs nowadays is an important error factor for blood pressure measurement, itself one of the most important aspects of sphygmomanometry.

It is believed that more attention to the standards and recommendations about the standardization of blood pressure measurement, both in the content of the undergraduate curricula and by healthcare managers and professionals at Healthcare Units and the Hospital Units, could contribute to the necessary changes.

If routinely, careful blood pressure measurement is one of the most efficient and safe actions nowadays for the control of hypertension in adults, why not start during childhood?

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