Chapter 26

Blood pressure assessment in children and adolescents

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ABSTRACT
The elevation of blood pressure in childhood and adolescence has proven to be a worldwide public health problem, and its early identification and adequate treatment can contribute to a better quality of life in adulthood, avoiding the involvement of other chronic diseases resulting from poorly controlled arterial hypertension (AH), such as cardiovascular diseases and kidney problems. The stratification and identification of AH can help the public authorities to create public policies that are appropriate for children and teenagers. This chapter aims to discuss the theme of blood pressure assessment in children and adolescents, approaching current aspects in Brazil and worldwide.

Keywords: hypertension, systolic blood pressure, diastolic blood pressure, childhood.

1 INTRODUCTION

It is widely known that blood pressure (BP) levels are the result of complex interactions between several organs and systems: the central and peripheral nervous system, the kidney, and the endocrine system. Recently, evidence has been provided that, even at the level of the endothelium and vascular smooth muscle cells, autocrine or paracrine control mechanisms are actively involved in regulating vascular tone through a balance between substances with vasoconstrictor or vasodilator action (GENOVESI et al., 2022).

For some time now, some risk factors for cardiovascular disease, such as hypertension (AH), have been increasingly prevalent among children and adolescents and accompany the growing trend of overweight, physical inactivity and inadequate nutrition in this population (PINTO et al., 2011). AH in children and adolescents is a growing health problem, along with the worldwide epidemic of obesity and physical inactivity (HANSEN, GUNN, KAELBER, 2007; MCNIECE et al. 2007).

AH in childhood is correlated with higher BP and risk of cardiovascular disease (CVD) in adulthood, and this relationship strengthens with age (CHEN, WANG, 2008). Primary hypertension in

children is associated with other risk factors for CVD, including hyperlipidemia and insulin resistance (MARTINO et al., 2013). Children also experience target organ damage from hypertension, including left ventricular hypertrophy and pathological vascular changes (i.e., carotid mid-intimal thickening) (BRADY et al., 2008).

Early detection and appropriate intervention for high blood pressure (BP) and hypertension in childhood are therefore extremely important because these conditions are related to cardiovascular morbidity and mortality in adulthood and are commonly associated with diabetes, dyslipidemia, and obesity (VASUDEVAN et al., 2022).

2 BLOOD PRESSURE IN CHILDREN AND ADOLESCENTS

BP has a potent direct, independent, positive, and continuous relationship with cardiovascular risk, and this concept is no different in younger age groups (CHOBANIAN, 2003). Although BP is more present in adulthood, evidence suggests that its onset may be present in childhood (AGOSTINIS, 2018). Children with elevated BP levels are highly likely to become hypertensive adults. Therefore, early diagnosis and treatment can prevent long-term adverse cardiovascular problems (LI., *et al* 2003).

The growth in obesity rates in childhood has increased and is associated with the development of several chronic diseases in this phase of life, including AH and diseases such as type 2 diabetes and cardiovascular diseases (LEITE et al, 2022) Thus clinical monitoring and early cardiometabolic risk assessment are justified by changes in the lifestyles of children and adolescents and the increase in sedentary behavior especially in recreational activities such as video games, cell phones and tablets among boys, leading to decreased participation in physical activities and reduced physical fitness in addition to adopting a less healthy diet (LEITE et al., 2022). Associating obesity with sleep disorders and increased risk of cardiovascular events.

Considering that high percent fat in childhood and adolescence has early adverse effects on BP, appropriate measures of body fat may determine more accurate markers of higher adiposity predictors of childhood and hypertension in the young individual (NEVES, 2022).

However, PAE can also occur in those children who do not appear to be at anthropometric risk, overweight. This occurrence is part of the extensive malnutrition with a paradoxical co-occurrence of metabolic obesity in anthropometrically malnourished children, which has been described in a 15-year dataset of urban school surveys in Delhi, India (GARG et al., 2013), and recently confirmed in a nationally representative survey (SACHDEV et al. 2021).

Leite et al. (2022) highlights the role of the school in actions that promote health, emphasizing curricular activities. However, he points out that there is little time to work on regular physical activity in the school environment.

Another relevant factor to work these health actions in school is that, according to the National Continuous Household Sample Survey (PNAD) (2021), its report showed that the national school attendance rate among children and adolescents aged 6 to 10 years was 98.8%, 11 to 14 years was 99.3%, and 15 to 17 years was 91.3%, an evaluation conducted from the 3rd quarter of 2017 to the 3rd quarter of 2021. Thus, the school stands out as an appropriate place for the application of public policies with emphasis on health for these age groups, because the vast majority of children and adolescents are attending schools in our country.

In Latin America, there are some programs focused on encouraging healthy habits with an emphasis on school health, with receipt of attendance by public policies developed by states and municipalities and actions aimed at preventing diseases caused by dietary, social, and environmental factors, with health promotion in schools as a basic strategy (FAIAL et al., 2019).

BP is considered one of the most important health indicators, and there are two ways to measure it, and these are used at different times: the first is the direct way, which is much more invasive, uses a catheter, and is used in more specific cases, such as patients in the ICU, presenting, for example, large-scale hemodynamic changes (FILHO, 2021; NORA; GROBOCOPATEL, 1996).

The indirect method, which is more used in clinical practice, is through the Korotkof auscultatory method, which can be manual, automatic or continuous (NORA; GROBOCOPATEL, 1996). The blood pressure measures take into account millimeters of mercury (mmHg), is analyzed by the frequency of systole and diastole cardiac movements, and circulating blood in the heart, cardiac output, as well as the resistance of the walls of blood vessels, peripheral muscle resistance (MONTEIRO; FILHO, 2004).

Children should have their blood pressure measured annually from the age of three (FLYNN et al., 2017). BP should be measured preferably in the right arm in patients up to 3 years of age and the measurement should be performed with the child lying down; in older children, in a sitting position with the arm supported at the level of the heart, using the correct cuff. The cuff length should be 80% to 100% of the arm circumference (AC) and the width of at least 40% of the AC (BARROSO et al., 2021). In the systematic review and meta-analysis by Song et al. (2019), the most widely used equipment worldwide for blood pressure assessment in children and adolescents was the mercury sphygmomanometer 40.4 %, followed by oscillometric sphygmomanometer 34.0% of the studies evaluated.

In case of risk conditions such as obesity, kidney disease, aortic coarctation, diabetes *mellitus* or chronic use of medications BP measurement should be performed in every visit, because these factors are associated with BP elevation (BARROSO et al., 2021). When available, ambulatory blood pressure monitoring (ABPM) should be used to confirm hypertension in children and adolescents (SALICE et al., 2010).

For BP classification, normal and high blood pressure values for children aged 1 to 12 years are based on the normative distribution of blood pressure in healthy children with normal weight and should

be interpreted based on age, height, and sex using percentile-based diagnostic tables. Absolute blood pressure values are used from the age of 13 years. For these adolescents, BP is defined as a systolic blood pressure of 120 to 129 mmHg and less than 80 mmHg diastolic, and AH is defined as blood pressure above 130/80 mmHg (FLYNN et al., 2017).

According to the Brazilian Guidelines on Hypertension, the prevalence of EAP and AH in children and adolescents has been increasing in recent years; AH in the pediatric age group is 3% to 5%, while that of EAP is estimated at 10-15%. In the age group of 7 to 12 years, obese people show higher prevalence, with PAE and AH of 4.7% and 1.9% respectively (BARROSO et al., 2020).

In the ERICA study: prevalences of hypertension and obesity in Brazilian adolescents, conducted by Bloch et al. (2016), revealed that the prevalences of prehypertension (PH) and AH were more significant in male adolescents in all regions of Brazil, being more frequent in adolescents aged 15 to 17 years than in those aged 12 to 14 years.

Increased body mass index, abdominal circumference, and obesity are correlated with increased rates of AH in children and adolescents (FALKNER et al., 2006). Other chronic conditions are also correlated with childhood AH and include sleep disorders (primary snoring disorder, obstructive sleep apnea, sleep fragmentation), and chronic kidney disease (ARCHBOLD et al., 2012; FLYNN et al., 2008).

In children and adolescents, the definitions of EAP and AH are related to the normal distribution curves of BP and its distribution by percentiles. For this, the auscultatory method is used, taking into consideration sex, age and height percentile of the child (MALACHIAS., et al, 2016).

With the increase in overweight/obesity, all age groups including children and adolescents have been affected by overweight/obesity, highlighting the growth in the 6-19 age group. This problem reaches a growing relevance with the relationship between obesity and heart attack, juvenile and the elevation of BP (GUIMARÃES et al., 2008).

AH in children and adolescents is characterized as primary (essential) or secondary. Secondary AH has an underlying cause that is identifiable and can be treated, whereas primary AH is a diagnosis of exclusion when an underlying disorder cannot be found (LURBE et al., 2016; VOGT, 2001).

All children and adolescents with AH should be clinically evaluated for hyperlipidemia and underlying kidney disease by urinalysis and electrolytes, blood urea nitrogen and creatinine testing (LURBE et al., 2016). As well, obese children and adolescents with AH should be evaluated for diabetes *mellitus* and hepatic steatosis (FLYNN et al., 2017).

For the diagnosis of AH in children and adolescents, a medical history, including birth history; growth and development; and screening for previous urological, renal, cardiac, endocrine, or neurological disease should be performed. Because several medications can elevate BP, physicians should review any prescription and over-the-counter medications and supplements, performance-enhancing drugs, and illicit substances the patient may be using. Sleep disturbances are associated with hypertension and therefore

sleep history should be evaluated. Patients should be evaluated for family history of AH, other CVD risk factors, and familial renal or endocrine syndromes. Physical activity, diet, smoking, and alcohol intake should also be investigated. Older children and adolescents should be asked about abuse, body perception, bullying, depression and anxiety, which have been found to be risk factors for PAE (STEIN et al., 2010).

In the study by Sun et al. (2017), they demonstrated that the prevalence of elevated BP in children, defined as systolic BP (SBP) or diastolic BP (DBP) greater than or equal to the 95th percentile by sex, age, and height, sustainably decreased by 53.7 % at the second visit and 77.7 % at the third visit compared to the first visit.

All children and adolescents with EAP or AH should make changes in their lifestyles and eating habits such as losing weight if overweight or obese; getting regular physical activity; eating a healthy low-salt diet; avoiding smoking and alcohol intake; as well as, reducing stress (FARPOUR-LAMBERT et al. 2009; YANG et al, 2012; DAMASCENO et al., 2012).

For children with symptomatic hypertension, stage 2 hypertension without a modifiable factor such as obesity, any stage of hypertension associated with chronic kidney disease or diabetes or persistent hypertension, evidence of left ventricular hypertrophy on echocardiography despite an attempt at lifestyle modifications require antihypertensive medications (FLYNN et al., 2017).

Regular, sustained physical activity is effective in reducing BP, and children and adolescents should engage in 30 to 60 minutes of moderate to vigorous physical activity at least three to five days per week (FARPOUR-LAMBERT et al., 2009; FLYNN et al. 2017).

The study by Farpour-Lambert et al. (2010), demonstrated that exercising for 60 minutes three times a week for three months leads to an average seven point reduction in systolic blood pressure and a 12% reduction in the rate of AH among obese prepubertal children. Children with EAP, stage 1 AH without target organ damage, or controlled stage 2 AH are cleared for participation in competitive sports (MCCAMBRIDGE et al., 2010).

Diet can also interfere with BP, thus a diet that emphasizes increased fresh fruits and vegetables, fiber, and low-fat dairy products and decreased sodium intake may be a modifiable factor and contribute to the reduction of AH (DAMASCENO et al., 2011).

From a public health perspective, reliable estimates of the prevalence of childhood AH serve as a basis for appropriate prevention and treatment, as well as for health resource allocation and evidence-based policy formulation (SONG et al., 2019).

Therefore, given the relevance and complexity of the development of AH in children and adolescents, its early identification and treatment can provide a better quality of life and a lower risk of developing other chronic diseases in adulthood. Lifestyle modifications to mitigate the involvement of chronic diseases such as AH should be inserted and encouraged in childhood and adolescence.

The development of public policies aimed at children and adolescents, besides providing better health, can also reduce future public spending on health, generating well-being for the population and savings for the public coffers.

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