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Assessment of risk factors associated with elevated blood pressure in children and adolescents

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Hypertension in children is associated with a higher incidence of secondary causes than in adults; however, in the last decade, studies have shown an increase in the incidence of essential hypertension in the pediatric population, especially among adolescents. The most important etiologic factor for essential hypertension in children is obesity, which has become an epidemic problem.[1,2] Other implicated factors include insulin resistance, changes in the glucose and lipid metabolism, and reduced arterial compliance.[3]

When evaluating hypertension in children, questions such as the following ones are quite common: Is the blood pressure adequate for the child?; Does the patient have white coat hypertension?; Has elevated blood pressure caused target organ damage?; What is the etiology of hypertension: is it primary or secondary?; Should hypertension be treated?

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The prevalence of hypertension in children ranges between 2% and 3%, as reported in the literature.[4] The prevalence of hypertension decreases after repeated measures; the 1996 Task Force Report[5] establishes that approximately 1% of children are hypertensive after repeated measures, using the standardized technique. Severe hypertension has a lower prevalence in the pediatric population, being estimated at 0.1%,[6] and these patients usually are the ones who need to be treated by a pediatric nephrologist.

In the Belo Horizonte study,[7] the prevalence of systolic or diastolic hypertension (percentile > 95) in elementary and high-school students was based on the values published by the 1987[8] and 1996[5] Task Forces, and by Rosner et al.,[9] and on the values generated by the study itself, considering the first and second measures and their mean. The percentage of students with systolic or diastolic hypertension, based on the studies mentioned above, ranged between 9.8% and 5.5% in the first measure and between 5.8% and 2.4% in the second measure, which was performed approximately 10 minutes after the first one.[7]

The detection of children with elevated blood pressure and with associated risk factors, such as obesity and hyperlipidemia, has added a new dimension to the preventive measures adopted in childhood, which should be included in pediatric care along with widely established measures, such as vaccination, accident prevention, etc.

The study carried out by Garcia et al.[10] assessed the blood pressure of 672 students (aged between 2 years and 10 years and 11 months) from two schools in Belo Horizonte. One of the schools was a public one located in a region with low quality of urban life (QUL) whereas the other one was a private school located in a region with high QUL. The following risk factors were associated with hypertension: age, height, gender, skin color, QUL, and body mass index (BMI). The results showed that brown or black children attended the public school, while 80% of white students attended the private one. The classification of body weight according to the BMI revealed overweight in 14% and obesity in 3.7% of children; however, when the BMI of the students attending the private school was analyzed, overweight or obesity were found in 23.5%, compared to 14% in the public school, which shows a relationship between BMI and the child's origin. Among white children 21.5% were overweight or obese against 14.5% in brown or black children. The multiple linear regression analysis showed an association with BMI, QUL

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and height for systolic blood pressure. For diastolic blood pressure, the associated variables were age and QUL. Interestingly enough, an association was observed between BMI and systolic blood pressure, but not between BMI and diastolic blood pressure. Studies with adults have demonstrated that systolic hypertension is much more common than diastolic hypertension, being correlated with mortality as a result of coronary heart disease, regardless of diastolic blood pressure levels. One of the *Bogalusa Heart Studies* assessed the echocardiographic measures of 654 patients aged between 7 and 22 years. After body weight adjustment, the left ventricle wall thickness and the relationship between left ventricle wall thickness and size of the heart chamber were correlated with systolic blood pressure.[11]

The study conducted by Moura et al.[12] assessed the prevalence of elevated blood pressure in children and adolescents in the city of Maceió. The sample included 1,253 individuals, from whom information on weight, height, and blood pressure (two measures with a two-minute interval in between) was collected. Elevated blood pressure, defined as systolic and/or diastolic blood pressure above the 95th percentile, based on the 1996 Task Force Report,[5] was noted in 9.4% of the students when measures were evaluated separately; this prevalence dropped to 7.7% when the mean of both measures was considered. The assessment of nutritional status using BMI revealed overweight and obesity in 9.3% and 4.5% of the analyzed children, respectively. In this study, the prevalence of elevated blood pressure was 28.6% in overweight children, which is significantly higher than that of normal-weight children (8.1%, $p < 0.0001$) and of children at risk for overweight (12.1%, $p = 0.016$).

The studies carried out by Garcia et al.[10] and by Moura et al.[12] assessed blood pressure levels using two measures with two-minute and five-minute intervals, respectively. However, the second 1987 Task Force Report recommends that at least three measures of abnormal blood pressure should be obtained on different occasions for the diagnosis of hypertension. In children, a separate measure of blood pressure shows the influence of several factors, and this level tends to diminish after repeated measures, probably due to the control of the stressful situation. Therefore, blood pressure levels should always be based on several measures, although some percentile curves are based on separate measures.

Nevertheless, in epidemiological studies involving a large number of patients, serial measures are difficult to obtain; in this case, it is recommendable that the child be sent to a referral center for specialized investigation after having his/her blood pressure above the 95th percentile measured separately.

Obesity is probably the major cause of health problems in adults, but it also substantially contributes to diseases in children.

Reilly et al.[13] assessed the studies published on childhood obesity, classifying them according to methodological quality; in a large number of high-quality studies obesity (defined as the percentile for BMI > 85 or >95) was associated with major cardiovascular risks: elevated blood pressure, dyslipidemia, left ventricle mass increase and/or left ventricle dysfunction, endothelial dysfunctions.

The association of overweight and/or obesity with systolic hypertension demonstrated in the studies conducted by Garcia et al.[10] and Moura et al.[12] confirms the results reported in the literature; these results are not independent and are correlated with factors related to lifestyle shown through the association of systolic blood pressure levels with QUL, which reflects an easier access to calorie-rich diets.

Hypertension in children is determined by an array of factors; for this reason, it is important to warn patients and parents about any changes in lifestyle, eating behavior, body weight, physical exercises, and about the complications that may arise from persistently elevated blood pressure.

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