

# Journal of Nephropathology



## The importance of screening for hypertension in children and adolescents

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### ARTICLE INFO

*Article type:*  
Review

*Article history:*  
Received: 16 February 2023  
Accepted: 25 April 2023  
Published online: 3 May 2023

*Keywords:*  
Hypertension  
Blood pressure  
Child  
Adolescents  
Screening

### ABSTRACT

Hypertension (HTN) is the most prevalent chronic non-infected disease and the greatest cause of adult premature mortality. Although in the past clinicians assumed that HTN in childhood and adolescents is uncommon, it is currently a significant public health issue and this narrative review aimed to assess the new finding regarding screening for HTN in Children and adolescents. Relevant English publications were extracted from Web of Science, PubMed, Scopus, and Google Scholar. As there are gaps regarding recommendations, guidelines, and screening for HTN in children and adolescents, this review tried to notice some important points.

### *Implication for health policy/practice/research/medical education:*

Hypertension is the most prevalent chronic non-infected disease and is the greatest cause of adult premature mortality and a serious long-term health issue. There is a controversy about screening hypertension in children and adolescents and needs a comprehensive assessment.

*Please cite this paper as:* Alaei M, Ghazanfari Hashemi M, Chatrnour G, Fakhre Yaseri A. The importance of screening for hypertension in children and adolescents. J Nephropathol. 2023;x(x):e21457. DOI: 10.34172/jnp.2023.21457.

### Introduction

Hypertension (HTN) is the most prevalent chronic non-infected disease, the greatest cause of adult premature mortality, and a serious long-term health issue. Moreover, it is the main factor of adult premature mortality in both developing and developed countries (1). The World Health Organization reported that only one in 5 of the estimated 1.1 billion individuals with HTN have it under control (2). Due to the inherited nature of HTN, it is reported that young people are the ones who first get the condition (3). Notably, children and adolescents also can develop high blood pressure (BP) (4), while childhood HTN can be related to adult-onset HTN (5). Due to the potential risk of cardiovascular diseases and the anatomical changes that can result from HTN, monitoring of BP is essential (6). Since early identification and proper management

of HTN can make a significant difference in preventing future health complications (7), this study aimed to assess the significance of screening for HTN in children and adolescents.

### Methods

This narrative review assessed the new findings on screening for HTN in children and adolescents. Relevant English publications from the Web of Science, PubMed, Scopus, and Google Scholar using keywords such as hypertension, high blood pressure, pre-hypertension, pediatric, children's adolescents, screening and prevention.

### Results

#### *The definition of hypertension*

High BP and HTN in children and adolescents are defined

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differently by the European Society of Hypertension (ESH) and the American Academy of Pediatrics (AAP) (7). The definition of HTN according to the AAP guideline for children aged 1-13 years and those aged  $\geq 13$  years are different. In children aged one to 13 years, a BP < 90<sup>th</sup> percentile is considered normal, a BP  $\geq 90^{\text{th}}$  to < 95<sup>th</sup> percentile is high normal or elevated BP, a  $\geq 95^{\text{th}}$  to < 95<sup>th</sup> percentile +12 mm Hg is considered stage 1 of HTN, and a BP  $\geq 95^{\text{th}}$  percentile +5 mm Hg is considered stage 2 of HTN. In children older than 13 years, BP < 120/80 mm Hg is considered normal, 120-129/80 mm Hg is high normal or elevated BP, 130/80 to 139/89 mm Hg as HTN stage 1, and BP 140/90 mm Hg is considered HTN stage 2 (8).

On the other hand, the ESH guideline defines HTN for children aged 0-15 years and aged  $\geq 16$  years. According to the ESH guideline for children aged 0 to 15 years, a BP < 90<sup>th</sup> percentile is considered normal BP, a BP  $\geq 90^{\text{th}}$  to < 95<sup>th</sup> percentile is high normal or elevated BP, a BP  $\geq 95^{\text{th}}$  to < 99<sup>th</sup> percentile +5 mm Hg as HTN stage 1, and a BP > 99<sup>th</sup> percentile +5 mm Hg is considered HTN stage 2. For children 16 years or older, BP < 130/85 mm Hg is considered normal, 130-139/85-89 mm Hg high normal or elevated BP, 140-159/90-99 mm Hg as HTN stage 1, and 160-179/100-109 mm Hg as HTN stage 2 (8). It is noteworthy that the static cutoff criteria in the AAP guideline correspond to the most recent HTN recommendations for American adults and are lower than the ESH cutoff points (9).

#### *Risk factors of hypertension in children and adolescents*

Previous research showed that obesity, abdominal circumference, and an elevated body mass index are associated with higher rates of BP or HTN in children and adolescents (9). Furthermore, insulin level, body mass index, hip and waist circumferences, low high-density lipoprotein, high triglyceride, and low-density lipoprotein are the strongest predictors of high BP. It has been suggested that to track risk factors, these variables should be evaluated in high-risk children and adolescents and followed in children with high BP and HTN. Besides, HTN due to obesity is associated with higher BP in children and adolescents, since its pathophysiology may involve several pathways, including the renin-angiotensin system, hyperinsulinemia, the sympathetic nervous system, and the activation of cytokines. Additional testing for obesity-related risk factors, such as glucose and lipid profile, in children and adolescents with high BP or HTN can provide valuable information regarding the general health statement.

As sleep-disordered breathing, such as continuous positive airway pressure or obstructive sleep apnea, is frequently associated with HTN in children and

adolescents, obtaining a sleep history may be beneficial, particularly in adolescents with a body mass index (BMI) of 40 kg/m<sup>2</sup> or more (7). Moreover, HTN risk factors vary by gender, age, ethnicity, and race. Whereas, high BP is more common among black children and adolescents than among white non-Hispanics. High BP and HTN also occur more frequently in males than females and adolescents than younger children (4).

#### *Measurement of hypertension in children and adolescents*

Similarly to adults, accurate and reliable BP measurement is essential in children and adolescents (7). Currently, there are three methods for measuring BP:

1. Auscultatory; in this method, the stethoscope bell is placed in the antecubital fossa of the patient's right arm, and the BP cuff is inflated. During deflation, the first auscultated heart sound corresponds to systolic BP (SBP), and the second to diastolic BP (DBP).
2. Oscillometric; this method employs an automated device for measuring oscillometric BP. A patient's right arm is covered with the automated BP cuff, which then expands automatically until the blood flow to that arm is completely blocked. Each machine calculates the SBP and DBP using a distinct method after analyzing the oscillation of blood in the artery.
3. Invasive; this method utilizes a flow transducer connected to an artery catheter (an arterial line) to measure invasive BP. This method may only be used on patients who are critically ill, typically in an intensive care unit.

Auscultatory and oscillometric measurements have become the two most common ways to measure BP in clinical and inpatient settings. Considering the differences in BP, based on cuff size, anxiety level, and time of day, measuring BP accurately in children and adolescents may be challenging. For accurate results, the patient has to seat quietly for at least five minutes with their back supported and their feet on the floor. Measuring the arm circumference of the mid-upper arm is necessary to determine the right BP cuff size. It is recommended that the width and length of the bladder should be at least 40% and 80% of the mid-arm circumference, respectively. Small cuff sizes may result in overestimating BP, while large cuff sizes may lead to an underestimation. Multiple measurements are required to determine the true office BP if the BP is abnormally high (10). All measurements are based on auscultation, and while oscillometry can be used for screening, results should be confirmed via auscultation (11).

Additionally, the use of various measurements depends on age. Intra-arterial measurement is the gold standard for newborns. After four weeks and up to three years of age, the technique of reference is the non-invasive

measurement with an aneroid sphygmomanometer, with palpation of the radial pulse and auscultation of the antecubital fossa (12). According to the European and North American BP measurement guidelines, BP should be measured with an aneroid sphygmomanometer between the ages of 3 and 12 in clinical settings. However, the manual auscultatory technique could be utilized to confirm the results. In addition, BP should be monitored by 24-hour ambulatory BP monitoring (ABPM) or home BP monitoring (HBPM) between the ages of 13 years and 17 years, both of which use approved automated devices and cuffs customized to the size of the patient's arm (13).

### *Screening of HTN in children and adolescents*

Significant gaps and controversies in pre-clinical recommendations, guidelines, and screening instruments have hindered the application of optimal practices for screening HTN in children and adolescents. These conditions led to an alarming underdiagnosis of pediatric HTN. According to a previous investigation, approximately 70% of clinicians and specialists only assessed pediatric BP when the children exhibited signs or symptoms of HTN, and 65% of them compared the results of measurements by various guidelines (14).

If the BP is consistently high, BP in both arms must be checked. Furthermore, aortic coarctation should be considered if there is a significant difference in BP between the right and left arms and a heart murmur. Other examinations should be conducted to identify underlying diseases associated with HTN (7). In children and adolescents with HTN, urine, and blood tests should be assessed to evaluate kidney function, serum creatinine, electrolytes, and lipid levels. In addition, renal ultrasound should be performed if renal function and urinalysis tests are abnormal. In addition, obese children and adolescents should be screened for nonalcoholic fatty liver disease and diabetes. Children older than five years who are overweight/obese or have a family history of HTN do not require extensive evaluation for secondary causes of HTN. Based on the suspected underlying etiology and availability, additional testing may be necessary for secondary HTN by a pediatric neurologist or cardiologist. Likewise, children with second-stage HTN, no modifiable underlying factor, and comorbid chronic kidney disease or diabetes should undergo echocardiography to assess cardiovascular damage (13).

In children under the age of three, BP should be checked regularly in the following situations (15):

1. 1- Previous history of low birth weight (less than 5 pounds, 8 ounces)
2. 2- Aortic coarctation, congenital heart disease
3. 3- Urological or kidney disorder/disease
4. 4- Use medications that are known to cause HTN

5. Transplantation of organs or bone marrow
6. Diagnosed with Williams-Beuren syndrome
7. Systemic diseases such as neurofibromatosis and tuberous sclerosis complex

Notably, measuring BP in children under three can be technically challenging due to cuff size restrictions and the restlessness of young children. Obtaining an accurate result may take up to 30 or 40 minutes. Since HTN is typically asymptomatic in children as young as three years old, similar to adults, it seems reasonable to measure BP annually. Accordingly height, weight, and BMI should be measured. ABPM is prioritized in guidelines for managing HTN due to the strong evidence linking ABPM to the adult outcomes. Meanwhile, BP should be monitored by 24-hour ABPM to obtain more precise results. Moreover, ABPM is highly recommended for white coat HTN, chronic kidney disease, organ damage, low birth weight, autonomic dysfunction, and monitoring drug effects (13,16).

### **Recommendations**

Every child and adolescent with HTN or high BP must adopt therapeutic lifestyle changes. If they are overweight or obese, they must obey a multimodal strategy for weight loss that reinforces dietary modifications and increased physical activity. Children and adolescents should engage in half to one hour of moderate to intense physical activity at least 3-5 days per week as the most effective way to control their BP. A study found that one hour of exercise three times a week for three months resulted in a 10% drop in systolic BP and the prevalence of HTN. According to several articles, all children and adolescents must refrain from using tobacco and alcohol because smoking and excessive alcohol consumption increase the risk of cardiovascular disease and elevated BP. Furthermore, stress should be reduced through breathing awareness meditation and yoga (7,13).

### **Authors' contribution**

Conceptualization: MA, MGH, GC, and AFY.

Methodology: MA, MGH, GC, and AFY.

Validation: MA, MGH, GC, and AFY.

Formal analysis: MA and MGH.

Investigation: MA, MGH, GC, and AFY.

Resources: MGH and GC.

Data curation: MGH and AFY.

Writing—original draft preparation: MA, MGH, GC, and AFY.

Writing—review and editing: MA, MGH, GC, and AFY.

Supervision: MA, GC, and AFY.

Project administration: GC, and AFY.

### Conflicts of interest

The authors declared no conflict of interest.

### Ethical issues

Ethical issues (including plagiarism, data fabrication, double publication) have been completely observed by the authors.

### Funding/Support

None.

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