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## **Arterial hypertension in children and adolescents**

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## Summary

Arterial hypertension is a serious clinical problem in everyday medical practice. It mainly affects adult patients, but is also increasingly common in children and adolescents. Making a diagnosis is possible thanks to systematic measurements of blood pressure during routine medical visits, while maintaining appropriate rules and referring to adequate biological norms - centile charts. Arterial hypertension in children and adolescents may be primary, but much more often than in the adult population, it occurs secondary to diseases of other organs and systems. Early diagnosis of hypertension in the developmental age gives a chance to implement adequate therapy by treating the underlying disease, lifestyle modification or pharmacological treatment. The aim of effective therapy of hypertension is to prevent the occurrence of early and long-term complications of the disease, as well as to reduce the risk of hypertensive emergencies.

**Keywords:** hypertension, cardiovascular risk, obesity, children, adolescents

## Introduction and purpose

Hypertension is one of the most common diseases in medical practice. It occurs in all age groups, reaching the highest frequency with the age of the patient. Based on the results of representative population studies, it is estimated that this disease affects 3-5% of children and adolescents aged 0 to 18 years. [1] However, the prevalence of hypertension increases with age and reaches as high as 10% after puberty. [2] In the entire developmental age population, secondary hypertension is still the dominant form of hypertension. However, at present, primary hypertension is diagnosed in younger children, and after the age of 10 it is the dominant form of hypertension [3,4]. It is suggested that this is related to the worldwide epidemic of obesity and overweight in children and adolescents. In recent years, there has been a significant increase in obesity in all age groups. This was also accompanied by an increase in mean population blood pressure values. [5] It is assumed that body weight has the greatest influence on blood pressure.

According to the recommendations of the European Society of Hypertension (ESH) and the American Academy of Pediatrics (AAP), blood pressure should be measured in children  $\geq 3$  years of age at least once a year during routine check-ups and visits related to a health problem. In children  $\leq 3$  years of age the measurement is recommended in selected cases and applies to patients with a recognized health problem, which include: positive perinatal history, congenital defects, recurrent urinary tract infections, kidney disease, cancer, organ transplantation and bone marrow transplantation, use of drugs affecting height blood pressure. [6] BP measurement in younger children is associated with a high risk of failure due to the lack of cooperation on the part of the patient: in children in the first year of life, BP measurement is unreliable in 41% of cases [7], in children in the third year of age — in 20% , and in the age group of 3-6 years, approximately 9% of children fail to measure correctly. [8]

Blood pressure is a variable hemodynamic phenomenon that is affected by many factors, including circumstances and how it is measured. The measurement result may be affected by temporary fluctuations in blood pressure related to the respiratory cycle, emotions, physical exertion, eating, smoking or drinking alcohol. Only a correctly performed and interpreted measurement can be the basis for the diagnosis of hypertension. During the first visit to the general practitioner's office, BP should be measured by an automated method on

all limbs. In the 1st year of life and until the child is in an upright position, BP values in the lower limbs are lower compared to the measurement in the upper limbs. At the age of 2 in a child able to stand independently, the values on the lower limbs become about 20 mmHg higher, and at a later age - about 30-40 mmHg higher. In a physiologically healthy child, the difference between the upper limbs can be up to 15 mmHg. If the difference in pressure between the lower and upper limbs is not maintained or if there is a difference between the two upper limbs and it is > 10 mmHg, the presence of a vascular defect, e.g. aortic coarctation or stenosis of the descending aorta, should be considered. [9] At subsequent visits, it is recommended to perform measurements on the right arm, completely uncovered, raised at the level of the heart.

Currently, one of the most popular and recommended techniques of non-invasive blood pressure measurement, due to the simplified method of measurement and low probability of error, is the oscillometric method, which is based on measuring pressure changes in the measuring cuff caused by the propagation of the pulse wave.

In order to reliably assess a child's blood pressure, attention should be not only to the method of measurement, but also to careful preparation of the child for the measurement, as well as the correct selection and application of the cuff. [10,11]

Principles of proper preparation of the child for the measurement:

1. Blood pressure should be measured at rest, preferably in the morning after a good night's sleep or after a nap during the day.
2. The child should be seated for at least 5-10 minutes immediately before the examination.
3. Measurements are not taken in children who exercised just before the visit, you should wait 30 - 40 minutes with the test.
4. Next measurements should be made in the same position – usually sitting in older children, and in the supine position in newborns and infants [10,11]

You should also remember about the correctly selected and applied measuring cuff. It must cover the entire circumference of the arm and at least 40% of its length. The air portion of the cuff should cover at least 80% of the upper arm circumference and the entire palmar side. A measurement made with too narrow a cuff may overestimate the reading by up to 30%, and too wide - underestimate.

Most of the standards used present blood pressure values at the 90th, 95th and 99th percentiles for a subpopulation distinguished on the basis of sex, age, and sometimes also height. Systolic and diastolic blood pressure values <90th percentile are considered normal, values between the 90th and 95th percentile are defined as borderline pressure or prehypertension. We have the right to diagnose arterial hypertension when the values of arterial and/or diastolic blood pressure exceed the 95th percentile in 3 independent measurements during 3 independent visits. If blood pressure is above the 99th percentile we are talking about severe hypertension. [12] Values > 90th percentile (cc) assessed by the oscillometric method require verification by auscultation - this provision is included in the guidelines but has no practical use.

According to the current European (ESH 2016) and national recommendations [Polish Society of Hypertension (PTNT) 2019], due to interpretation discrepancies in adolescents aged  $\geq 16$  years, the criteria for diagnosing HT should be used as in adults. The diagnosis of hypertension should be confirmed with 24-hour ambulatory blood pressure monitoring (ABPM). This recommendation applies to children from the age of 6 (from 120 cm tall). [13]

The current hypertension classification is shown in Table 2.

<b>Tab. 2 Classification of Hypertension Based on Office BP measurement</b>		
<b>Category</b>	<b>0-16 years old (percentile SBP and/or DBP)</b>	<b>&gt;16 y.o ( SBP and/or DBP mmHg)</b>
<b>Normal</b>	< 90	< 130/85 mmHg
<b>High normal</b>	$\geq 90$ and < 95	130-139/85-89 mmHg
<b>Hypertension</b>	$\geq 95$	$\geq 140/90$ mmHg
<b>Grade 1 hypertension (mild)</b>	95-99 + 5 mmHg	140-159/90-99 mmHg
<b>Grade 2 hypertension (moderate)</b>	> 99 + 5 mmHg	160-179/100-109 mmHg
<b>Grade 3 hypertension (severe)</b>		$\geq 180/110$ mmHg
<b>Isolated systolic hypertension</b>	SBP $\geq 95$ and DBP < 90	SBP $\geq 140$ and DBP < 90 mmHg

### State of knowledge

Hypertension is classified according to the underlying cause into primary and secondary. In the first decade of life, the secondary form of hypertension dominates. The causes of secondary hypertension in the group of the youngest patients include diseases of the renal parenchyma and large vessels; as they grow up, apart from kidney diseases, endocrine diseases and pathology of renal vessels come to the fore. You should also always consider the use of stimulants or medications.

Arterial hypertension in the pediatric population rarely causes clinical symptoms and the detection of elevated blood pressure usually takes place during routine medical visits. On the other hand, very high blood pressure may be accompanied by headaches, visual disturbances and symptoms of kidney and heart failure - in the case of hypertensive emergencies requiring immediate medical intervention. Each newly diagnosed arterial

hypertension requires a diagnostic process. Young age, sudden onset, and significantly higher blood pressure suggest a secondary etiology of hypertension.

An important role in the diagnostic process is played by a detailed interview. It should include information such as the presence of obesity, metabolic syndrome, kidney disease, and hereditary diseases in first- and second-degree relatives because a negative family history of hypertension reduces the likelihood of primary disease. The medical history should provide information on past illnesses, hospitalizations and procedures. The issue of medications taken by the patient temporarily and chronically, stimulants and hormonal agents must not be omitted. It is also worth asking about the presence of additional clinical symptoms such as weight loss, drenching sweats or headaches.

During the physical examination, it is important to assess the anthropometric parameters: weight, waist size, height and BMI, and to correctly enter the results on the charts. Some physical examination abnormalities may help to identify the root cause of high blood pressure. The following laboratory tests should be ordered: complete blood count, urea, creatinine, uric acid, glucose, lipid profile, ionogram, TSH, urine test. The scope of additional tests in a patient with arterial hypertension is selected depending on the child's age, the severity of hypertension, and the results of medical history and physical examination. ECG and ultrasound of the abdominal cavity with Doppler of the renal vessels should be performed. It is necessary to refer the patient to an ophthalmology clinic for evaluation of the fundus.

The therapeutic process depends on the cause of hypertension, severity and the presence of organ complications. Non-pharmacological treatment based on lifestyle changes - maintaining a healthy body weight, increasing physical activity, using a low-sodium diet and avoiding the use of stimulants - should play an important role both in the treatment and primary prevention of essential hypertension. [14,15]

In the event of ineffectiveness of non-pharmacological treatment or in the event of organ complications, pharmacological treatment is initiated. Drugs that directly inhibit the RA system show the best profile, causing beneficial metabolic changes. They also turned out to be the drugs with the strongest effect in regressing organ damage, and this effect is independent of the reduction in blood pressure. [4] According to this assumption, the drugs of choice in the treatment of essential hypertension with concomitant metabolic disorders in adolescents are ACE-I and/or angiotensin 2 receptor 1 blockers. Second-line drugs are dihydropyridine calcium antagonists. Antihypertensive treatment (non-pharmacological and pharmacological) allows for normalization of blood pressure in about 70% of patients and significant regression of organ damage. [16]

## **Conclusion**

Carefully performed measurement of blood pressure is the basic method in diagnosing hypertension. Such a measurement can and should be performed at each visit of the child to the doctor. The reliability of the measurements allows for early detection of hypertension, additional tests and treatment. Antihypertensive treatment based on drugs and parallel non-pharmacological treatment ensures achievement of normotension in 70% of young people with essential hypertension and normalization of metabolic disorders.

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