

Pediatric Hypertension: Risk, Diagnosis, and Treatment

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Pediatric hypertension (HTN) is defined as elevated blood pressure (BP) that is persistently above the 95th percentile for a child's age, sex, and height. Diagnosing pediatric HTN is crucial, as it has important implications for health outcomes during both childhood and adulthood. The overall prevalence of HTN in children is approximately 4%, but it rises significantly to 10% to 11% among 18-year-olds.^{1,2}



Understanding the pathophysiology and risk factors associated with pediatric HTN is crucial for preventing complications. Several factors contribute to an increased risk of pediatric HTN, including certain medical conditions, geographic and demographic variables, chronic stress, and environmental exposures (Table 1).¹⁻⁶ Identifying these risk factors and high-risk populations is essential for addressing health care disparities.

Table 1. Pediatric Hypertension Risk Factors

Category	Risk Factors
Personal	- Age and puberty - Male sex² - Certain medical conditions (e.g., type 1 and type 2 diabetes, obesity, sleep apnea, history of prematurity)¹⁻³
Geographic & Demographic	- Urban areas and geographic regions with elevated obesity rates - Black race or Hispanic ethnicity² - Dietary habits (e.g., high intake of sodium, sugar-sweetened beverages) - Early-life factors (e.g., small for gestational age, prematurity)^{1,4,5}
Chronic Stress & Environmental Exposures	≥4 adverse childhood experiences (e.g., household substance abuse, parental divorce, household mental illness)⁶ - Environmental factors (e.g., tobacco exposure, air pollution)^{2,4,6}

Early Vascular Changes in Pediatric Patients

The early cardiovascular impact of HTN is profound, with subclinical changes detectable in children. These include atherosclerosis, increased carotid intima-media thickness (cIMT), and greater arterial stiffness, all of which are associated with cardiovascular disease in adulthood. Notably, 38% to 46% of adolescents with primary HTN show increased cIMT at diagnosis.^{2,4} These findings align with the concept of early vascular aging and early biological maturation, as children with HTN demonstrate a biological age advanced by 4 to 5 years compared with normotensive peers. Such changes often persist into adulthood. Children with elevated BP are 35% more likely to develop HTN in adulthood.^{6,7} However, normalization of BP is associated with decreases in body mass index (BMI) z-scores; reduced alcohol consumption; and improved dietary habits, such as increased vegetable intake. Interventions addressing HTN also reverse early vascular aging, with improvements observed as early as six weeks into dietary and lifestyle interventions and sustained benefits over one year.^{1,4-7}

Recognition and Diagnosis of Pediatric Hypertension

During childhood, BP gradually increases to support growth and development. The normal range (i.e., 5th to 95th percentile) for both systolic and diastolic BP in children is stratified based on the sex, age, and height of the child. For children and adolescents, BP assessments are recommended at every annual pediatric well child visit, routinely starting at 3 years of age.⁸ For pediatric patients at additional risk for HTN, including those with obesity, renal disease, diabetes, treatment with medication known to affect BP, or history of aortic arch obstruction or coarctation, BP should be assessed at every health encounter. Moreover, prevention measures focusing on physical activity, dietary interventions, and general obesity prevention should be emphasized regularly.⁸

As recommended by the American Academy of Pediatrics 2017 guideline, the definition for elevation of BP for females and males starts at systolic or diastolic BPs $\geq$ 90th percentile for a given age and height at three different visits, with the absolute cut-off in mmHg increasing over time in accordance with age and interval linear growth.⁸ As youth reach their adult height, the use of adult cut-offs for HTN become applicable. As such, a simplified screening recommendation using both pediatric BP percentiles and adult cut-offs can aid in recognition of elevated BP, stage 1 HTN, and stage 2 HTN in pediatric patients (Table 2).⁸

Table 2A. Pediatric Blood Pressure Categories and Stages

Categories	For Children Age 1-<13 years	For Children Age ≥13 years
Normal BP	<90th percentile	<120/<80 mmHg
Elevated BP	≥90th percentile to <95th percentile or 120/80 mmHg to <95th percentile (whichever is lower)	120/<80 to 129/<80 mmHg
Stage 1 HTN ^a	≥95th percentile to < 95th percentile + 12 mmHg, or 130/80 to 139/89 mmHg (whichever is lower)	130/80 to 139/89 mmHg
Stage 2 HTN	≥95th percentile + 12 mmHg, or ≥140/90 mmHg (whichever is lower)	≥140/90 mmHg

^aStage 1 HTN is also referred to as pre-HTN.

BP = blood pressure; HTN = hypertension.

Adapted from *Clinical practice guideline for screening and management of high blood pressure in children and adolescents*

Table 2B. Simplified Cutoffs for Normal vs. Elevated Blood Pressure in Pediatrics*

Age (years)	Males SBP	Males DBP	Females SBP	Females DBP
1	94	49	97	52
2	97	54	98	57
3	100	59	100	61
4	102	62	101	64
5	104	65	103	66
6	105	68	104	68
7	106	70	106	69
8	107	71	108	71
9	109	72	110	72
10	111	73	112	73
11	113	74	114	74
12	115	74	116	75
13	117	75	117	76
14	120	75	119	77
15	122	76	120	78
16	125	78	121	78
17	127	80	122	78

*Based on the 90th percentile blood pressure for age and sex for children at the 5th percentile of height.

DBP = diastolic blood pressure; SBP = systolic blood pressure.

Adapted from *Clinical practice guideline for screening and management of high blood pressure in children and adolescents*

In-office BP monitoring in children, as in adults, requires the use of equipment that is well maintained and calibrated per the manufacturer’s specifications, proper selection of cuff size and positioning of the patient, and careful timing of the assessment after a period of rest. Specifically, if oscillometric devices (i.e., calibrated, automated machines) are used, they should be validated in the pediatric population.

If the initial BP is $\geq$ 90th percentile, then two additional auscultatory BP measurements should be obtained at the same visit and averaged to determine the BP category. If BP is elevated and persists at follow-up visits at 6 and 12 months, additional evaluation and referral to nephrology, endocrinology, or cardiology should be considered due to much higher rates of secondary HTN in children.^{9,10} An initial workup, as recommended by the American Academy of Pediatrics, is highlighted in Table 3.⁸

Table 3. Suggested Initial Evaluation for Pediatric Hypertension

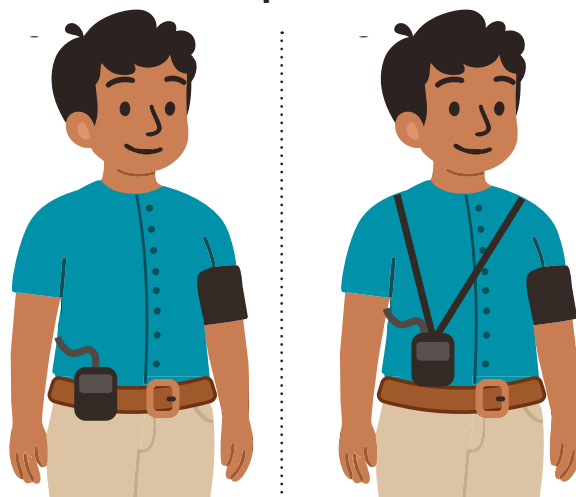
Patient Population	Screening Tests
All pediatric patients	Urinalysis
	Chemistry panel, including electrolytes, blood urea nitrogen, and creatinine
	Lipid profile (fasting or non-fasting to include high-density lipoprotein a and total cholesterol)
	Renal ultrasonography in those <6 years of age or those with abnormal urinalysis or renal function
Children or adolescents with obesity (BMI $\geq$ 95th percentile)	All tests listed above plus:
	Hemoglobin A1C (accepted screen for diabetes)
	Aspartate transaminase and alanine transaminase (screen for fatty liver)
	Fasting lipid panel (screen for dyslipidemia)
Optional tests (based on history, physical exam, or initial results)	Fasting serum glucose for those at high risk for diabetes mellitus
	Thyroid-stimulating hormone
	Drug screen
	Sleep study (if loud snoring, daytime sleepiness, or reported history of apnea)
	Complete blood count, especially in those with growth delay or abnormal renal function

Adapted from *Clinical practice guideline for screening and management of high blood pressure in children and adolescents*

Acknowledging the challenges associated with in-office BP screening, such as children experiencing anxiety, limited time for visits, missed appointments, and the higher likelihood of white coat HTN, ambulatory BP monitoring (Figure 1) is being used more often to obtain additional screening information.¹¹ When unavailable, home BP monitoring is another reliable way to assess BP outside of the health care setting, provided that the cuffs are the correct size for the child.¹²

In-office measurements of BP in children with or without obesity need special attention to ensure use of the proper cuff size, necessitating offices to be stocked with a large range of sizes, including thigh cuffs.

Figure 1. Ambulatory Blood Pressure Monitoring Device Options



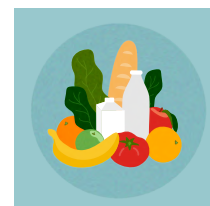
Adapted from 24 Hr BP Monitor

Treatment for Pediatric Hypertension

Lifestyle Modifications

Lifestyle modifications (i.e., non-pharmacologic treatment) are usually first-line interventions and are recommended for all youth with HTN.⁹ These include dietary changes, such as decreasing sodium intake and adopting the DASH diet; increasing physical activity; and weight management for children who are overweight or have obesity.⁸

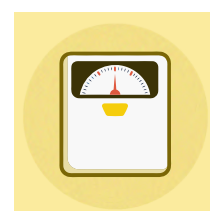
The Dietary Approaches to Stop Hypertension (DASH) diet, which prioritizes reducing sodium intake and increasing whole grains, low-fat dairy, fruits, and vegetables, has been well established for lowering BP in children.¹³⁻¹⁵ A meta-analysis of 18 observational and experimental studies showed that every gram of additional dietary sodium intake increased systolic BP by 0.8 mmHg and diastolic BP by 0.7 mmHg in children and adolescents, while sodium reduction interventions lowered systolic BP by 0.6 mmHg and diastolic BP by 1.2 mmHg.¹⁶



Increasing physical activity improves BP levels in pediatric populations, particularly when combined with dietary and behavioral interventions, such as counseling.¹⁷ A meta-analysis of 19 controlled trials demonstrated significant improvements in diastolic BP among children participating in school-based physical activity programs.¹⁸



Weight management in children who are overweight or have obesity is essential for reducing pediatric HTN. Studies consistently demonstrate a positive association between BMI and pediatric BP levels, both in children with and without obesity, as well as systolic and diastolic BP reductions associated with weight loss.¹⁹⁻²¹ A structured, family-based intervention program emphasizing nutrition, physical activity, and behavioral counseling is the standard of care.²²



Pharmacologic Treatment

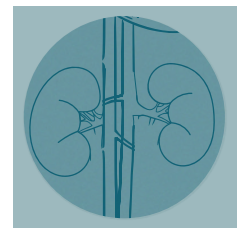
Pharmacologic treatment for pediatric HTN requires careful consideration and is initiated with low-dose monotherapy. Indications for pharmacologic treatment include:^{10,23}

- Ineffectiveness of lifestyle modifications
- Stage 2 HTN without clearly modifiable risk factors, such as obesity
- Symptomatic HTN
- Target-organ damage, such as left ventricular hypertrophy
- HTN in children with diabetes or chronic kidney disease (CKD)

First-line drug classes in pediatric HTN include angiotensin converting enzyme inhibitors (ACEi), angiotensin receptor blockers (ARBs), diuretics, and long-acting calcium channel blockers (CCBs). Beta-blockers are not recommended as first-line pharmacologic treatments in children. If monotherapy titrated to the maximal dose fails to achieve BP control, a second medication can be added.¹⁰ Caution is advised for adolescent females using ACEi or ARBs due to fetotoxicity.²³ Pediatric HTN should be treated to reduce BP to whichever is lower: < 90th percentile or < 130/80 mmHg.¹⁰



The presence of diabetes and CKD should be considered in antihypertensive treatment. The combination of HTN and diabetes substantially increases the risk of microvascular and macrovascular complications. For children and adolescents with HTN and diabetes, an ACEi or ARB is the first-line medication.¹⁰ HTN and CKD present unique challenges, as HTN accelerates renal damage. In pediatric patients with HTN and CKD, a lower BP target is recommended: the 24-hour mean arterial pressure should be reduced to < 50th percentile by ambulatory BP monitoring. ACEi or ARBs are the first-line medications in these cases.¹⁰



Treatment monitoring is essential. Pediatric HTN patients should be seen every 4 to 6 weeks until the BP treatment target is achieved, then every 3 to 4 months.¹⁰ Unlike treatment-resistant HTN in adults, it remains unclear if a truly treatment-resistant form exists in children. For pediatric HTN uncontrolled on two or more medications, the term “apparent resistant HTN of childhood” has been proposed.²⁵ There is data to support the use of aldosterone receptor antagonists (e.g. spironolactone or eplerenone) in adult patients, and these treatments could be considered in children refractory to standard treatments.⁸ Involvement of a pediatric nephrologist is highly recommended in these rare cases.



Additional Cardi-OH Resources

- **Capsule 21 – Youth Onset Type 2 Diabetes Early Treatment to Prevent Complications**
cardi-oh.org/resources/capsule-21--youth-onset-type-2-diabetes-early-treatment-to-prevent-complications
- **Capsule 33 – Adverse Childhood Events and Cardiovascular Disease Risk**
cardi-oh.org/resources/capsule-33--adverse-childhood-experiences-and-cardiovascular-disease-risk
- **CVD Risk Factors Among Adolescents**
cardi-oh.org/resources/cvd-risk-factors-among-adolescents
- **Podcast 34 – Adverse Childhood Experiences: Resources for Primary Care**
cardi-oh.org/resources/podcast-34--adverse-childhood-experiences-resources-for-primary-care
- **Podcast 43 – Obesity and Weight Loss Management: Pharmacotherapy, Part 1**
cardi-oh.org/resources/podcast-43--obesity-and-weight-loss-management-pharmacotherapy-part-1
- **Youth-Onset Type 2 Diabetes: How to Identify, Screen, and Treat**
cardi-oh.org/resources/youth-onset-type-2-diabetes-how-to-identify-screen-and-treat

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