Pediatric Hypertension: New Guidelines



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Objectives

• Review new hypertension guidelines for children and adolescents

- Definition
- Evaluation
- Treatment

AAP HTN Guidelines 2017: Major Changes

- Replacement of the term "prehypertension" with the term "elevated blood pressure"
- New normative pediatric blood pressure (BP) tables based on normal-weight children
- A simplified screening table for identifying BPs needing further evaluation
- A simplified BP classification in adolescents ≥13 years of age that aligns with the AHA-ACC adult BP guidelines
- More limited recommendation to perform screening BP measurements only at preventive care visits

AAP HTN Guidelines 2017: Major Changes

- Streamlined recommendations on the initial evaluation and management of abnormal BPs
- An expanded role for ambulatory BP monitoring in the diagnosis and management of pediatric hypertension
- Revised recommendations on when to perform echocardiography in the evaluation of newly diagnosed hypertensive pediatric patients
- A revised definition of left ventricular hypertrophy

Prevalence

- Clinical Hypertension in Children - 3.5%
- Persistently elevated BP (formerly termed "prehypertension")
 - 90th to 94th percentiles or between 120/80 and 130/80 mm Hg (in adolescents)
 - ~2.2% to 3.5%

Significance

• 32.6% of US adults have HTN

- 50% of them (17.2%) are not aware they have HTN
- among those who are aware of their condition, only approximately half (54.1%) have controlled BP
- Autopsy and imaging studies have demonstrated BP-related CV damage in youth
- Numerous studies have shown that elevated BP in childhood increases the risk for adult HTN and metabolic syndrome



Definition

• In contrast to the adult definition of hypertension, which is based on outcome data, the definition of hypertension in children is based on normative distribution of BP in healthy children



Definition - Adults

Blood Pressure Categories



BLOOD PRESSURE CATEGORY	SYSTOLIC mm Hg (upper number)		DIASTOLIC mm Hg (lower number)
NORMAL	LESS THAN 120	and	LESS THAN 80
ELEVATED	120 – 129	and	LESS THAN 80
HIGH BLOOD PRESSURE (HYPERTENSION) STAGE 1	130 – 139	or	80 - 89
HIGH BLOOD PRESSURE (HYPERTENSION) STAGE 2	140 OR HIGHER	or	90 OR HIGHER
HYPERTENSIVE CRISIS (consult your doctor immediately)	HIGHER THAN 180	and/or	HIGHER THAN 120

Definition - Children

TABLE 3 Updated Definitions	of	BP	Categories	and	Stages
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For Children Aged 1—13 y	For Children Aged \geq 13 y
Normal BP: <90th percentile	Normal BP: <120/ < 80 mm Hg
Elevated BP: \geq 90th percentile to <95th percentile or 120/80	Elevated BP: 120/<80 to 129/<80 mm Hg
mm Hg to <95th percentile (whichever is lower)	
Stage 1 HTN: \geq 95th percentile to <95th percentile + 12 mmHg,	Stage 1 HTN: 130/80 to 139/89 mmHg
or 130/80 to 139/89 mm Hg (whichever is lower)	
Stage 2 HTN: \geq 95th percentile + 12 mmHg, or \geq 140/90 mmHg	Stage 2 HTN: ≥140/90 mm Hg
(whichever is lower)	

Europe vs US

Table 2 Definition of normotension and hypertension

	European guidelines		US guidelines				
	< 16 years	≥ 16 years		< 13 years	\geq 13 years		
Normotension	< 90th %ile	< 130/85	Normotension	<90th %ile*	< 120/80		
High-normal BP	≥90th %ile-<95th %ile	130-139/85-90	Elevated BP	≥90th%ile*-<95th %ile	120-130/80		
Grade I HTN	≥95th %ile–99th %ile + 5 mmHg	140-159/90-99	Stage I HTN	\geq 95th %ile-< 95th %ile + 12 mmHg [£]	130/80–13- 9/89		
Grade II HTN	>99th %ile+5 mmHg	160-179/100-109	Stage II HTN	\geq 95th%ile+12 mmHg [€]	≥140/90		
Isolated systolic HTN	SBP > 95th% ile and DBP < 90th %ile	SBP > 140 and DBP < 90	Isolated systolic HTN	Not addressed	Not addressed		
Immediate referral to ED	Severe HTN [±] associated with life threatening condition	Severe HTN [±] associated with life threatening condition	Immediate referral to ED	>95th %ile + 30 mmHg [¥]	>180/120¥		

US United States, BP blood pressure, SBP systolic blood pressure, DBP diastolic blood pressure, HTN hypertension, ED emergency department

*Or 120/80, whichever lower

[£] Or 130/80–139/89, whichever lower

 $^{\epsilon}$ Or 140/90, whichever lower

 $^{\pm}$ Defined by some as 20% above grade II limit

[¥] Or stage II with symptoms

Brady TM et. al. Pediatr Nephrol (2019) 34:405–412

Definición Chile

Tabla I. Definición de Hipertensión Arterial.

	Percentil de PAS y/o PAD
Normal	< 90
Presión arterial elevada	≥ 90 a < 95 ≥ 120/80 aún si < 90 en adolescentes
Estadio 1 Hipertensión	95 al 99 más 5 mm Hg
Estadio 2 Hipertensión	> 99 más 5 mm Hg

Tomado de: Task Force on High Blood Pressure in Children and Adolescents. Pediatrics 2004;114:555-76.

Saieh C et. al. Arch Latin Nefr Ped 2018;18(2):74-115

TABLE 5 BP Levels for Girls by Age and Height Percentile

Age (y)	BP Percentile				SBP (mm Hg)						DBP (mm Hg)		
				Height Perce	entile or Mea	sured Heigh	t				Height Perc	entile or Mea	asured Heigh	ıt	
		5%	10%	25%	50%	75%	90%	95%	5%	10%	25%	50%	75%	90%	95%
1	Height (in)	29.7	30.2	30.9	31.8	32.7	33.4	33.9	29.7	30.2	30.9	31.8	32.7	33.4	33.9
	Height (cm)	75.4	76.6	78.6	80.8	83	84.9	86.1	75.4	76.6	78.6	80.8	83	84.9	86.1
	50th	84	85	86	86	87	88	88	41	42	42	43	44	45	46
	90th	98	99	99	100	101	102	102	54	55	56	56	57	58	58
	95th	101	102	102	103	104	105	105	59	59	60	60	61	62	62
	95th + 12 mm Hg	113	114	114	115	116	117	117	71	71	72	72	73	74	74
2	Height (in)	33.4	34	34.9	35.9	36.9	37.8	38.4	33.4	34	34.9	35.9	36.9	37.8	38.4
	Height (cm)	84.9	86.3	88.6	91.1	93.7	96	97.4	84.9	86.3	88.6	91.1	93.7	96	97.4
	50th	87	87	88	89	90	91	91	45	46	47	48	49	50	51
	90th	101	101	102	103	104	105	106	58	58	59	60	61	62	62
	95th	104	105	106	106	107	108	109	62	63	63	64	65	66	66
	95th + 12 mm Hg	116	117	118	118	119	120	121	74	75	75	76	77	78	78
3	Height (in)	35.8	36.4	37.3	38.4	39.6	40.6	41.2	35.8	36.4	37.3	38.4	39.6	40.6	41.2
	Height (cm)	91	92.4	94.9	97.6	100.5	103.1	104.6	91	92.4	94.9	97.6	100.5	103.1	104.6
	50th	88	89	89	90	91	92	93	48	48	49	50	51	53	53
	90th	102	103	104	104	105	106	107	60	61	61	62	63	64	65
	95th	106	106	107	108	109	110	110	64	65	65	66	67	68	69
	95th + 12 mm Hg	118	118	119	120	121	122	122	76	77	77	78	79	80	81
4	Height (in)	38.3	38.9	39.9	41.1	42.4	43.5	44.2	38.3	38.9	39.9	41.1	42.4	43.5	44.2
	Height (cm)	97.2	98.8	101.4	104.5	107.6	110.5	112.2	97.2	98.8	101.4	104.5	107.6	110.5	112.2
	50th	89	90	91	92	93	94	94	50	51	51	53	54	55	55
	90th	103	104	105	106	107	108	108	62	63	64	65	66	67	67
	95th	107	108	109	109	110	111	112	66	67	68	69	70	70	71
	95th + 12 mmHg	119	120	121	121	122	123	124	78	79	80	81	82	82	83

Normal Weight children (Excluded BMI >85th percentile)

Screening

TARIE & Screening

	Further F	valuatio	n	noquinit
		varuatio		
Age, y		BP,	mm Hg	
	Воу	S	G	irls
	Systolic	DBP	Systolic	DBP
1	98	52	98	54
2	100	55	101	58
3	101	58	102	60
4	102	60	103	62
5	103	63	104	64
6	105	66	105	67
7	106	68	106	68
8	107	69	107	69
9	107	70	108	71
10	108	72	109	72
11	110	74	111	74
12	113	75	114	75
≥13	120	80	120	80

RD

Values

Requiring

90th percentile BP for age and sex for children at the 5th percentile of height Negative predictive value 99%

Key Action Statement 1.

 BP should be measured annually in children and adolescents ≥3 years of age (grade C, moderate recommendation).

Key Action Statement 2.

 BP should be checked in all children and adolescents ≥3 years of age at every health care encounter if they have obesity, are taking medications known to increase BP, have renal disease, a history of aortic arch obstruction or coarctation, or diabetes (grade C, moderate recommendation).

Key Action Statement 3.

 Trained health care professionals in the office setting should make a diagnosis of HTN if a child or adolescent has auscultatory- confirmed BP readings ≥95th percentile on 3 different visits (grade C, moderate recommendation).

Measurement of BP

- The examining area should be quiet and the child reassured.
- Sufficient time should be allowed for recovery from recent activity or apprehension.
- The procedure should be fully explained and stressful circumstances should be eliminated whenever possible.



Measurement of BP

- To measure BP the child should have avoided stimulant drugs or food, have been sitting quietly for 5 mins, in the seated position (infants may be supine), feet on the floor, right arm supported, cubital fossa at heart level.
- BP should be recorded at least twice on each occasion, and the average of each of the systolic and diastolic BP measurement should be used to estimate the BP level.

IS THIS POSSIBLE?

Key Action Statement 4.

• Organizations with EHRs used in an office setting should consider including flags for abnormal BP values both when the values are being entered and when they are being viewed (grade C, weak recommendation).



Key Action Statement 5.

• Oscillometric devices may be used for BP screening in children and adolescents. When doing so, providers should use a device that has been validated in the pediatric age group. If elevated BP is suspected on the basis of oscillometric readings, confirmatory measurements should be obtained by auscultation (grade B, strong recommendation).

Measurement of BP

- After choosing the right cuff, the cuff should be inflated to about 20 mmHg above the point at which the radial pulse disappears.
- The pressure is then released at a rate of about 2 3 mmHg/sec, while auscultation is performed with the bell of the stethoscope over the brachial artery.

CHOOSING THE RIGHT CUFF



Errors will be minimized by choosing the largest cuff that will fit in the child's arm (leaving sufficient room to place the bell of the stethoscope, and prevent obstruction of the axilla).

Key Action Statement 6.



• *ABPM should be performed for the* confirmation of HTN in children and adolescents with office BP measurements in the elevated BP category for 1 year or more or with stage 1 HTN over 3 clinic visits (grade C, moderate recommendation).

Key Action Statement 9.

Children and adolescents with suspected WCH should undergo ABPM. Diagnosis is based on the presence of mean SBP and *DBP* <95th percentile and SBP and DBP load <25% (grade B, strong recommendation).



Key Action Statement 10.

 Home BP monitoring should not be used to diagnose HTN, MH, or WCH but may be a useful adjunct to office and ambulatory BP measurement after HTN has been diagnosed (grade C, moderate recommendation).



Key Action Statement 11.

 Children and adolescents ≥ 6 years of age do not require an extensive evaluation for secondary causes of HTN if they have a positive family history of HTN, are overweight or obese, and/or do not have history or physical examination findings suggestive of a secondary cause of HTN (grade C, moderate recommendation).

Key Action Statement 14.

Clinicians should not perform
 electrocardiography in hypertensive children
 and adolescents being evaluated for LVH
 (grade B, strong recommendation).



Key Action Statement 15.

• It is recommended that echocardiography be performed to assess for cardiac target organ damage (LV mass, geometry, and *function) at the time of* consideration of pharmacologic treatment of HTN;



PSAX: Left Ventricular Hypertrophy

Echocardiogram

 LVH should be defined as LV mass >51 g/m2.7 (boys and girls) for children and adolescents older than 8 years and defined by LV mass >115 g/BSA for boys and LV mass >95 g/BSA for girls

Echocardiogram

 Repeat echocardiography may be performed to monitor improvement or progression of target organ damage at 6- to 12-month intervals. Indications to repeat echocardiography include persistent HTN despite treatment, concentric LV hypertrophy, or reduced LV ejection fraction

Key Action Statement 16.

Doppler renal ultrasonography may be used as a noninvasive screening study for the evaluation of possible RAS in normal-weight children and adolescents ≥8 years of age who are suspected of having renovascular HTN and who will cooperate with the procedure (grade C, moderate recommendation).

Key Action Statement 19.

 In children and adolescents diagnosed with HTN, the treatment goal with nonpharmacologic and pharmacologic therapy should be a reduction in SBP and DBP to <90th percentile and <130/80 mm Hg in adolescents ≥ 13 years old (grade C, moderate recommendation).



Key Action Statement 20.

• At the time of diagnosis of elevated BP or HTN in a child or adolescent, clinicians should provide advice on the DASH diet and recommend moderate to vigorous physical activity at least 3 to 5 days per week (30–60 minutes per session) to help reduce BP (grade C, weak recommendation).





Key Action Statement 21.

• In hypertensive children and adolescents who have failed lifestyle modifications (particularly those who have LV hypertrophy on echocardiography, symptomatic HTN, or stage 2 HTN without a clearly modifiable factor [eg, obesity]), clinicians should initiate pharmacologic treatment with an ACE inhibitor, ARB, long-acting calcium channel blocker, or thiazide diuretic (grade B, moderate recommendation).

Key Action Statement 23.

- Children and adolescents with CKD should be evaluated for HTN at each medical encounter;
- Children or adolescents with both CKD and HTN should be treated to lower 24-hour MAP to <50th percentile by ABPM
- Regardless of apparent control of BP with office measures, children and adolescents with CKD and a history of HTN should have BP assessed by ABPM at least yearly to screen for MH (grade B; strong recommendation).

Treatment Goals: Europe vs US

Table 5Hypertension treatmentgoals		European guid	lelines	US guidelines			
		BP goal < 16 years	BP goal ≥16 years	BP goal < 13 years	BP goal \geq 13 years		
	HTN without comorbidities	<95th %ile	< 140/90	<90th %ile*	< 130/80		
	HTN + diabetes mellitus type 1 or 2 HTN + CKD	<90th %ile	<130/80	<90th %ile*	< 130/80		
	-Without proteinuria	<75th %ile	< 130/80	< 50th %ile MAP by ABPM	< 50th %ile MAP by ABPM		
	-With proteinuria	< 50th %ile	< 125/75	< 50th %ile MAP by ABPM	< 50th %ile MAP by ABPM		

US United States, BP blood pressure, CKD chronic kidney disease, MAP mean arterial pressure, ABPM ambulatory blood pressure monitoring, HTN hypertension

*Or < 130/80, whichever lower

Brady TM et. al. Pediatr Nephrol (2019) 34:405–412

Key Action Statement 24.

 Children and adolescents with CKD and HTN should be evaluated for proteinuria (grade B, strong recommendation).



Key Action Statement 25.

Children and adolescents with CKD, HTN, and proteinuria should be treated with an ACE inhibitor or ARB (grade B, strong recommendation).



Key Action Statement 26.

Children and adolescents with TIDM or T2DM should be evaluated for HTN at each medical encounter and *treated if BP is* \geq 95*th* percentile or >130/80 mm Hg in adolescents ≥ 13 years of age (grade C, moderate recommendation).



Key Action Statement 27.

• In children and adolescents with acute severe HTN and life-threatening symptoms, immediate treatment with short-acting antihypertensive medication should be initiated, and BP should be reduced by no more than 25% of the planned reduction over the first 8 hours (grade expert opinion D, weak recommendation).

Key Action Statement 28.

• Children and adolescents with HTN may participate in competitive sports once hypertensive target organ effects and risk have been assessed (grade C, moderate recommendation).



Key Action Statement 29.

Children and adolescents with HTN should receive treatment to lower BP below stage 2 thresholds before participating in competitive sports (grade C, weak recommendation).

Table 2. Blood Pressure Categories as Defined by the 2017 Clinical Practice Guideline^a

Stage 2 hypertension

≥95th Percentile + 12 mm Hg

≥140/90 mm Hg

Resistance Training



Figure 3 Forest plot of the changes in diastolic blood pressure after resistance training *vs.* control group.

0

%

Weight

14.62

15.87

16.82

35.39

17.30

100.00

WMD (95% CI)

-2.10(-6.89, 2.69)

-2.26(-6.77, 2.25)

-8.40 (-12.70, -4.10)

-5.00 (-6.71, -3.29)

-1.40(-5.61, 2.81)

-4.09 (-6.32, -1.86)

12.7

Corrêa de Sousa E et. al Hypertension Research (2017) 40, 927-931

HYPERTENSION AND OBESITY

4X increase in BP severe obesity

BMI >99th percentile

2X increase in those with obesity

BMI 95th–98th percentiles



HYPERTENSION AND OBESITY





Holm JC et al. J Hypertens 30: 368, 2012



SLEEP DISORDERS and HYPERTENSION

- 7 hours or less per night are at increased risk for HTN
- The more severe the OSAS, the more likely a child is to have HTN
- Even inadequate duration of sleep and poor-quality sleep have been associated with elevated BP

TABLE 10 Screening Tests and Relevant Populations

Patient Population	Screening Tests
All patients	Urinalysis
	Chemistry panel, including electrolytes, blood urea nitrogen, and creatinine
	Lipid profile (fasting or nonfasting to include high-density lipoproteina and total cholesterol)
	Renal ultrasonography in those <6 y of age or those with abnormal urinalysis or renal function
In the obese (BMI >95th	Hemoglobin A1c (accepted screen for diabetes)
percentile) child or adolescent, in addition to	Aspartate transaminase and alanine transaminase (screen for fatty liver)
the above	Fasting lipid panel (screen for dyslipidemia)
Optional tests to be obtained on the basis of history.	Fasting serum glucose for those at high risk for diabetes mellitus Thyroid-stimulating hormone
physical examination, and	Drug screen
initial studies	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 Wiesen J, Adkins M, Fortune S, et al. Evaluation of pediatric patients with mild-to-moderate hypertension: yield of diagnostic testing. *Pediatrics*. 2008;122(5). Available at: www.pediatrics.org/cgi/content/full/122/5/e988.







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