PREVALENCE OF HYPERTENSION IN CHILDREN AND ADOLESCENTS IN EUROPE

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Debrecen, HUNGARY
• The normal values of BP in childhood and adolescence must be determined according to age, sex and height.

• Repeated measurements are needed.
What is new?

Increasing prevalence of HTN in children and adolescents has become a significant public health issue driving a considerable amount of research. Aspects discussed in this document include advances in the definition of HTN in 16 year or older, clinical significance of isolated systolic HTN (ISH) in youth, the importance of out of office and central BP measurement, new risk factors for HTN, methods to
### 2016 European Society of Hypertension guidelines for the management of high blood pressure in children and adolescents

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<tr>
<th>Category</th>
<th>0-15 year</th>
<th>16 year and older</th>
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<tr>
<td>Normal</td>
<td>&lt;90&lt;sup&gt;th&lt;/sup&gt;</td>
<td>&lt;130/85 mmHg</td>
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<td>High-Normal</td>
<td>≥90&lt;sup&gt;th&lt;/sup&gt; to &lt;95&lt;sup&gt;th&lt;/sup&gt; percentile</td>
<td>130-139/85-89 mmHg</td>
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<td>Hypertension</td>
<td>≥95&lt;sup&gt;th&lt;/sup&gt; percentile</td>
<td>≥140/90 mmHg</td>
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<td>Stage 1 Hypertension</td>
<td>95&lt;sup&gt;th&lt;/sup&gt; percentile to the 99&lt;sup&gt;th&lt;/sup&gt; percentile plus 5 mmHg</td>
<td>140-159/90-99 mmHg</td>
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<td>Stage 2 Hypertension</td>
<td>&gt;99&lt;sup&gt;th&lt;/sup&gt; percentile plus 5 mmHg</td>
<td>160-179/100-109 mmHg</td>
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<td>Isolated Systolic Hypertension</td>
<td>SBP ≥95&lt;sup&gt;th&lt;/sup&gt; percentile and DBP&lt;90&lt;sup&gt;th&lt;/sup&gt; percentile</td>
<td>≥140/&lt;90 mmHg</td>
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NHBPEP
Working Group on Hypertension Control in Children and Adolescents

- Studies during 1970s and 1980s
- 63,000 American children and adolescents
- Ethnically inhomogeneous population (55% caucasian)
- Sphygmomanometer was used
- Methodologically inhomogenous studies
- Included overweight individuals
- Results were based on the first measurement (in previous studies only one measurement was done)

To develop a national standard level of BP for Italian children and adolescents.

BP was measured in 11,519 healthy individuals (6,258 boys and 5,261 girls), aged 5-17 years. Data from 21 Italian studies.

Mercury sphygmomanometer was used, 3 measurements, mean of the 3 values.

With respect to the American standards, the levels in Italy were 3-8 mmHg higher for systolic and diastolic BP in both sexes between 5-12 years and 2-3 mmHg higher in older males.

With respect to Northern Europe, in the lower ages, levels in Italy were a slightly higher. In late adolescents, in males the Northern levels were much higher.
120 girls and 80 boys

After 5 min rest, 3 measurements by sphygmomanometer

Mean age 17.4 ± 0.8 years

3% of girls and 4% of boys had hypertension.

Nawrot TS. Am J Hypertens, 14(4), Pt2(244A); 2001.
PREVALENCE OF HYPERTENSION IN CHILDREN AND ADOLESCENTS IN POLAND

25,309 children and adolescents (12,669 girls, 12,640 boys), aged 7-18 years
Auscultatory method, 3 independent BP reading.

Prevalence of hypertension was 4.9%.

PREVALENCE OF HYPERTENSION IN NORTHERN GREECE AGED 7-15 YEARS

308 males and 298 females, aged 7-18 years
Sphygmomanometers, 3 readings, mean of the last 2.

12.3% of boys 15.1% of girls were diagnosed with hypertension.


TRENDS IN HIGH BP PREVALENCE IN GREEK ADOLESCENTS

446 12-17 years old adolescents in 2004, 558 (different) in 2007
BP increase 4.1/10.6 mmHg.

Prevalence of high BP was 16.1% and 22.9%.

PREVALENCE OF HYPERTENSION IN TURKISH SCHOOL-CHILDREN

1.963, 7-16 years old children were included. BP were measured at least 3 times. Average was calculated.

The prevalence of hypertension was 9%. (systolic HTN 7%, diastolic HTN 2%)

PREVALENCE OF HYPERTENSION IN PORTUGUESE CHILDREN AND ADOLESCENTS

5,381 children and adolescents
Mean age: 12.5 ± 3.2 years (4-18)
Three measurements after 10 min resting period
Validated automatic BP monitor (OMRON 705IT)

Prevalence of hypertension was 12.8%.
Prevalence of pediatric hypertension

5,102 children (49% male, 51% female)
Mean age: 13.5 ± 1.7 (10-19) years

3 measurements

If BP was elevated, 2 further screening, in 1-2 weeks intervals

Oscillometric method (SpaceLabs)

• Cross-sectional, population-based survey in a Hungarian city (Debrecen, population 230000).

• After a 10-minute resting period, 3 consecutive BP measurements were taken using validated OMRON M4 automatic devices.

• Participants in the main study: n=10359
  - 5262 boys (50.8 %), 5097 girls (49.2 %)
  - average age: 16.55 ± 0.99 years
  - refused participation: n=22
RESULTS OF THE DEBRECEN HYPERTENSION STUDY

1 occasion - 3 measurements
DO WE EXCLUDE HYPERTENSION?
by age, gender and height
syst. and diast. BP <90th percentile

n=10359

YES (n=8708)
NO (n=1641)

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1 occasion - 3 measurements
DO WE EXCLUDE HYPERTENSION?
by age, gender and height
syst. and diast. BP <90th percentile

n=10359

Further measurements are needed

YES (n=8708)
NO (n=1641)

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1 occasion - 3 measurements
DO WE EXCLUDE HYPERTENSION?
by age, gender and height
syst. and diast. BP <90th percentile

n=10359

YES (n=8708)
NO (n=1641)

3 occasions - 3x3 measurements
DO WE CONFIRM HYPERTENSION?
by age, gender and height
syst. and/or diast. BP >95th percentile

n=1461

HYPTERTENSIVE (n=216)
NO (n=1245)

Further measurements are needed

RESULTS OF THE DEBRECEN HYPERTENSION STUDY

1 occasion - 3 measurements
DO WE EXCLUDE HYPERTENSION?
by age, gender and height
syst. and diast. BP <90th percentile

n=10359

YES (n=8708)
NO (n=1641)

PREVALENCE 2.53%

3 occasions - 3x3 measurements
DO WE CONFIRM HYPERTENSION?
by age, gender and height
syst. and/or diast. BP >95th percentile

n=1461

HYPERTENSIVE (n=216)
NO (n=1245)

Further measurements are needed

To produce representative BP data for children and adolescents in Great Britain.

22.901 participants, (11.364 males and 11.537 females) aged 4-23 years were included.

BP was measured using oscillometric device (Dinamap 8100). After 10 min rest triplicate measurements. The mean of 2nd and 3rd readings.

BP was similar in the two sexes in childhood, rising progressively with age and more rapidly during puberty. Systolic pressure rose faster and was higher in young men than in young women.

Hypertension defined: BP>98 pc, high-normal BP: between 91-98 pc.
5.207 school-children (mean age: 12.3 ± 0.5 years) in Switzerland
Measured 3 times, average of the 2nd and 3rd readings
Oscillometric method was used (OMRON M5)
2 additional visits, if age-, sex- and height specific BP was > 95 pc

Prevalence of hypertension in pediatric populations based on three visits.

The prevalence of elevated BP was 11.4, 3.8 and 2.2% on first, second and thirds visits, respectively; hence 2.2% had hypertension. 81% had ISH.
PREVALENCE OF HYPERTENSION IN SCHOOL-CHILDREN BASED ON REPEATED MEASUREMENTS
Elevated BP was defined according to sex-age- and height specific US reference data. Hypertension was as ‘elevated BP’ on all three visits. (81% had ISH.)
4177, 5–11-year-old school children, 48% girls.

The prevalence of hypertension was 4.1%.

- 1.4% in normal weight
- 7.1% in overweight
- 25% in obese

p<0.001

J Hypertens, 26:1563-70, 2008
BP REFERENCE VALUES IN ADOLESCENTS FOR NORTHERN EUROPE

- Norway, Northern Europe reference tables
- 7,682 adolescents, aged 13-18 years

- Oscillometric device (Criticare 507N), average of the last 2 readings

BMI had the highest influence on SBP

- Secular weight increases poses problems
- 1221 overweight and obese participants were excluded
- otherwise mean and 95 pc values would have been 2-5 mmHg higher

BP was differed not only by age, sex and height but also pubertal status.

Munkhaugen J. J Hypertens, 26:1912-1918; 2009.
The US values were measured with a manual sphygmomanometer, whereas an oscillometric device was used in other studies.
Objective: To present oscillometric BP references from German non-overweight children and compare them with US references.

Methods: validated, oscillometric devices (Datascope Accutorr Plus).
Mean of 2 measurements.

Total samples: 14.349 (3-17 years), non-overweight: 12.199.
# BP Percentiles by Age and Height from Nonoverweight Children and Adolescents in Germany

## Table 1
Baseline Characteristics of the Reference Population of Nonoverweight Children and Adolescents (5989 Girls and 6210 Boys Aged 3–17 Years)

<table>
<thead>
<tr>
<th>Age, y</th>
<th>3–6</th>
<th>7–10</th>
<th>11–13</th>
<th>14–17</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boys</td>
<td>169 (8.9)</td>
<td>340 (15.8)</td>
<td>276 (18.2)</td>
<td>316 (16.9)</td>
</tr>
<tr>
<td>Girls</td>
<td>184 (9.4)</td>
<td>300 (14.7)</td>
<td>277 (18.6)</td>
<td>288 (16.5)</td>
</tr>
<tr>
<td>Children included, n</td>
<td>1719</td>
<td>1716</td>
<td>1240</td>
<td>1535</td>
</tr>
<tr>
<td></td>
<td>1652</td>
<td>1676</td>
<td>1177</td>
<td>1484</td>
</tr>
</tbody>
</table>

Excluded only because of overweight, n (weighted % of 7038 girls/7311 boys)

<table>
<thead>
<tr>
<th></th>
<th>Boys</th>
<th>Girls</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean of first and second SBP, mean (SD), mm Hg</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boys</td>
<td>97.8 (7.6)</td>
<td>102.0 (7.7)</td>
</tr>
<tr>
<td>Girls</td>
<td>98.0 (7.6)</td>
<td>102.5 (8.0)</td>
</tr>
</tbody>
</table>

| Mean of first and second DBP, mean (SD), mm Hg |      |       |       |       |
| Boys     | 59.5 (6.8) | 62.4 (6.7) | 65.5 (7.3) | 69.8 (7.6) |
| Girls    | 60.1 (6.7) | 62.8 (6.6) | 65.7 (6.7) | 69.0 (7.1) |

BP PERCENTILES BY AGE AND HEIGHT FROM NONOVERWEIGHT CHILDREN AND ADOLESCENTS IN GERMANY

Non-overweight children’s BP were lower by up to 3/2 mmHg compared to total sample.

Non-overweight German children’s BP was lower than in the US reference sample, but higher for SBP in 14 years or older.

The German reference values are not influenced by the prevalence of overweight children in the reference population.

The prevalence of hypertension is higher in England than in the US at young ages.

ESSENTIAL HYPERTENSION VS. SECONDARY HYPERTENSION AMONG CHILDREN

423 consecutive children (median: 12 years; range: 3–17 years)

Table 4. Most common causes of hypertension in a tertiary pediatric hypertension clinic by age

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<thead>
<tr>
<th>Age groups</th>
<th>Most common etiology of hypertension</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infancy, &lt;1 y</td>
<td>Respiratory (61%)</td>
</tr>
<tr>
<td></td>
<td>Renal (13%)</td>
</tr>
<tr>
<td></td>
<td>Medication (9%)</td>
</tr>
<tr>
<td>Preschool, 1–5 y</td>
<td>Respiratory (29%)</td>
</tr>
<tr>
<td></td>
<td>Renal (27%)</td>
</tr>
<tr>
<td></td>
<td>Essential (19%)</td>
</tr>
<tr>
<td>Preteen, 6–12 y</td>
<td>Essential (57%)</td>
</tr>
<tr>
<td></td>
<td>Renal (27%)</td>
</tr>
<tr>
<td></td>
<td>Neurological (7%)</td>
</tr>
<tr>
<td>Teen, 13–19 y</td>
<td>Essential (49%)</td>
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<td>Renal (20%)</td>
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<td>Medication (11%)</td>
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Gupta-Malhotra M. Am J Hypertens, 28(1) 73-80; 2015.
Blood Pressure in 57,915 Pediatric Patients Who Are Overweight or Obese Based on Five Reference Systems

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188 centers from Germany, Austria, and Switzerland

Data from 57,915 children aged 6 to 18 years who are overweight or obese

Blood Pressure in 57,915 Pediatric Patients Who Are Overweight or Obese Based on Five Reference Systems

Marion Flechtner-Mors, PhD\textsuperscript{a}, Hannelore Neuhauser, MD, MPH, PhD\textsuperscript{b}, Thomas Reinehr, MD, PhD\textsuperscript{c}, Hans-Peter Roost, PhD\textsuperscript{d}, Susanna Wiegand, MD, PhD\textsuperscript{e}, Wolfgang Siegfried, MD\textsuperscript{f}, Karl Zwiauer, MD, PhD\textsuperscript{g}, Esther Molz\textsuperscript{g}, and Reinhard W. Holl, MD, PhD\textsuperscript{h}, for the APV initiative and the BMBF Competence Network Obesity

![Graph showing blood pressure categories and prevalence](graph.png)
21,062 adolescents aged 10 to 19 years (mean, 13.8 years).

The final prevalence of sustained hypertension in all subjects was 2.7%.

The highest rate of hypertension was seen in Hispanic (3.1%), followed by African American (2.7%), white (2.6%), and Asian (1.7%) adolescents ($P = .019$).
2016 European Society of Hypertension guidelines for the management of high blood pressure in children and adolescents

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<th>Origin</th>
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