What Exactly Do the Trends Mean?

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Although the adverse public health and economic consequences of obesity have been reported for some time, little success has been achieved in controlling the progressive increase in population prevalence and severity of obesity. The obesity epidemic in children is especially sobering. More than 17% of children are obese, and these rates have increased with each new survey. A consequence of childhood obesity has been the premature onset of diseases associated with obesity. The chronic disorders of hypertension, type 2 diabetes mellitus, and sleep apnea, which had been considered conditions of middle to late adulthood, now appear in childhood. When the cardiovascular morbidity associated with these conditions is considered, the health impact of childhood-onset hypertension or diabetes mellitus is likely to be enormous.

The extent to which childhood obesity could contribute to an increase in the prevalence of hypertension was studied in a report in this issue of Circulation. Din-Dzietham et al conducted a study in which they examined the secular trend in the prevalence of high blood pressure (BP) among children and adolescents to determine if the rise in childhood obesity contributes to an increase in the prevalence of high BP. Data were drawn from serial health surveys conducted by the National Center for Health Statistics between 1963 and 2002 on a representative sample of the noninstitutionalized civilian US population. Data on children between the ages of 8 to 17 years, which included measurement of BP, were the focus of their analysis. The investigators applied the current BP criteria for hypertension and prehypertension in childhood to the data from the participants in each of the 6 survey periods between 1963 and 2002 to determine the prevalence of high BP in each survey period. The representations of non-Hispanic white, non-Hispanic black, and Mexican-American children were sufficient to compare rates and trends across the 3 race/ethnic groups. Childhood obesity markedly increased, from ≈7% in 1976–1980 to >11% in the 1988–1994 examination period, followed by a further increase to 17% in the 1999–2002 examination period. The prevalence of high BP increased between the 1988–1994 and the 1999–2002 examination periods, and the increase appeared to be attributable to the increase in obesity. The analysis by Din-Dzietham and colleagues also demonstrates racial disparities in that the recent unfavorable trends in both obesity and high BP have a substantially greater effect on non-Hispanic blacks and Mexican-Americans.

The most pertinent aspect of the report by Din-Dzietham et al is the current upward trend in the prevalence of high BP among children that is concurrent with an increase in childhood obesity. The present report is consistent with a recent report by Munter et al, who examined BP level as a continuous variable in adolescents from the same 2 recent National Health Surveys (1988–1994 and 1999–2002). Munter et al found a significant population increase in both systolic and diastolic BP, and they verified that the BP increase was most striking among minority groups. They also demonstrated that the population increase in BP among adolescents was largely, although not entirely, a result of the increase in body mass index. These reports provide evidence for the concept that secular trends in childhood obesity are setting the stage for increasing and premature cardiovascular disease within the US population.

The other intriguing aspect of the Din-Dzietham report is the extremely high rates of high childhood BP detected in the early surveys. As stated in the methods, the authors defined high BP according to the guidelines published in 2004 by the most recent Working Group on Hypertension in Children and Adolescents. Accordingly, high BP was defined as systolic and/or diastolic BP ≥95th percentile according to sex, age, and height. Prehypertension was defined as systolic and/or diastolic BP ≥90th percentile and <95th percentile; beginning at age 12 years the criteria for prehypertension included BP >120/80 mm Hg if the 90th percentile was >120 mm Hg systolic or >80 mm Hg diastolic. Clinical criteria for diagnosis of hypertension in childhood require the average BP to remain ≥95th percentile in repeat measurement on at least 3 separate visits.

As shown in the Din-Dzietham report, the overall estimated prevalence of high BP among children in the 1963–1970 survey is 37.2%. In the 1971–1975 survey it decreases to 16.9%. The high childhood BP prevalence decreases further to 11.1% in the 1976–1980 survey, then to 4.7% in the 1982–1984 survey, and to the lowest level of 2.7% in the 1988–1994 survey, followed by an increase to 3.7% in the 1999–2002 survey period. On the basis of these results the authors state that a secular trend of decreasing rates of high BP existed among children from 1963–1994, after which...
the prevalence increased. However, it must be noted that the definition of high BP has not changed during that period. What has changed is the body of normative BP data from which the BP percentiles were derived.

The National Health Surveys between 1963 and 1975 were conducted at a time when BP was rarely measured in healthy children. It was considered difficult to obtain reliable BP measurements, especially in young children, and it was generally believed that hypertension was uncommon in children and adolescents. Because clinicians had little notion of what constituted normal BP in children, when BP was measured, the adult criteria of 140/90 mm Hg were usually applied to define high BP.4,5 Sol Londe was the first clinician who attempted to define high BP in children according to some reference of normal child BP.6 He measured BP in healthy children in his own pediatric practice and observed an increase in BP level with age that was concurrent with growth and development. He then analyzed the BP data to determine the range of systolic and diastolic BP stratified by age and sex. To define high BP, he selected the systolic and diastolic BP at the 90th percentile for each year of age. He reported rates of hypertension that were slightly above 10%, which was consistent with his definition. He also noted that, on repeated measurement among those with high BP, regression toward the mean took place and that the prevalence of persistent systolic or diastolic BP >95th percentile was 1.9%. Moreover, on repeated measurement the children with high BP were often overweight and had a family history of hypertension.6 These observations are remarkably similar to the contemporary characteristics of childhood hypertension established by a larger body of data. What is different is the level of BP used to define hypertension in children.

Early reports on the normal BP range according to age throughout childhood described markedly different results.7 For example, the Londe report in 1966 computed the mean systolic BP for a 13-year-old boy at 120 mm Hg.6 The National Health Survey (1963–1970) described a mean systolic BP for a 13-year-old boy at 132 mm Hg.7 To reconcile the differing data on childhood BP and develop a uniform method to measure BP in the young, the National High Blood Pressure Education Program appointed a Task Force on Blood Pressure Control in Children. The purpose of this Task Force was to examine the available data on BP in children, describe a standard methodology for BP measurement, and define high BP in childhood. The Task Force published its first report in 1977.8 With the use of a statistical definition, the 95th percentile for age and sex was the recommended BP level for ascertainment of hypertension, if verified on repeated measurement. However, on the basis of the data provided in the 1977 report, by 13 years of age in boys the 95th percentile was 140 mm Hg systolic and 90 mm Hg diastolic, and by 18 years of age the 95th percentile was >150 mm Hg systolic and >95 mm Hg diastolic. These numbers seemed to be too high, particularly when considerably lower BP levels were reported from other sources.8 The National Heart, Lung, and Blood Institute recognized the need to obtain a larger body of data on BP in the young within the context of childhood growth and subsequently supported several epidemiological studies that prospectively investigated BP and growth in children and adolescents. These projects were conducted at several sites, applied rigorous detail to the methodology of BP measurement, and examined the anthropometric determinants of BP level relative to physiological development.

As these data emerged, a second Task Force on Blood Pressure in Children and Adolescents was convened to reexamine the data on BP distribution throughout childhood.10 With a substantially larger sample, the normal increase in BP with age remained, but the overall distribution of BP was lower, and the 95th percentile, which defined high BP, was substantially lower than that described in the previous report. In the second report, the 95th percentile for a 13-year-old boy was a systolic BP at 128 mm Hg and diastolic BP at 82 mm Hg. Subsequent to the second Task Force report, additional childhood BP data were developed from the National Health and Nutrition Examination Surveys (1988–1994 and 1999–2002). These data were added to the cumulative childhood BP data and reexamined in the next 2 Task Force Reports.2,11 With the additional data, the BP distribution curves and the BP levels for the 95th percentiles according to age did not change. However, the BP percentiles were further adjusted for height to define the 95th percentile by age, sex, and height percentile. The Table compares the BP level at the 95th percentile for a 13-year-old boy derived from data in the 1966 study by Londe to the BP level for the 95th percentile for a 13-year-old boy in the 4 Task Force Reports published between 1977 and 2004. As can be seen, the available data that were used to define the 95th percentile in the early surveys resulted in much higher BP levels. The 1987 Task Force Report had the advantage of a large body of data obtained with a uniform methodology and was thus able to create childhood BP distribution curves that have remained stable. Therefore, the downward trend in prehypertension and high blood pressure from 1963 to 1988, described by Din-Dzietham et al,1 does not reflect a decrease in prevalence of high BP in children and adolescents. Rather, the downward trend reflects a progression toward a more accurate description of the normal BP distribution in childhood, which appears to have been achieved in the 1987 Task Force Report10 and further refined with height adjustments in the 1996 and 2004 reports.2,11 Therefore, the recent upward trend in prevalence of high BP in childhood, which appears to be related to the childhood obesity epidemic, is clearly indicative of a significant emerging public health problem.

**BP Levels That Define High BP (95th Percentile) in a 13-Year-Old Boy From 1966 to 2004**

<table>
<thead>
<tr>
<th>Year</th>
<th>Systolic BP</th>
<th>Diastolic BP</th>
</tr>
</thead>
<tbody>
<tr>
<td>1966</td>
<td>144/80</td>
<td>140/90</td>
</tr>
<tr>
<td>1987</td>
<td>128/82</td>
<td>126/82*</td>
</tr>
<tr>
<td>2004</td>
<td>126/81*</td>
<td></td>
</tr>
</tbody>
</table>

*95th Percentile for height at median height. Range, 121/79 to 130/84.

Disclosures

None.
References


Key Words: Editorials blood pressure children hypertension obesity