Hypertension is an important risk factor for myocardial infarction and for cerebrovascular disease in adults. In adults, there is evidence linking specific levels of blood pressure with adverse cardiovascular outcomes leading to the definition of 140/90 mm Hg as the almost universally accepted cut point to determine blood pressure elevation. Using that definition, >70 million adults in the United States and >1 billion adults worldwide have hypertension. It has also been clearly demonstrated that lowering blood pressure leads to reduction in the incidence of myocardial infarction and cerebrovascular disease, as well as heart failure and chronic renal disease, and although the goal blood pressure for those adults who are treated has been controversial, the most recent Systolic Blood Pressure Intervention Trial (SPRINT) results suggest that reduction of systolic blood pressure to <120 mm Hg is associated with a lower incidence of cardiovascular disease and cardiovascular mortality compared with a systolic blood pressure goal of 140 mm Hg.

It appears that the level of blood pressure is also important for children and adolescents. It has been shown that blood pressure levels tend to track over time, meaning that a child or adolescent who has high blood pressure relative to their peers at one age is likely to also have higher blood pressure compared with peers at older ages. It has also been shown that adolescents with high blood pressure already have evidence of early target organ disease, including left ventricular hypertrophy and increased carotid intima-media thickness. Target organ disease in adolescents includes levels of left ventricular mass index that would be associated with a 4-fold increased risk of cardiovascular disease in adults with hypertension.

Although evidence suggests the importance of blood pressure elevation in young individuals, it has been more difficult to define high blood pressure in children and adolescents for use in the clinical setting. Because there are no data linking specific levels of blood pressure elevation in children with cardiovascular outcomes in adulthood, the approach to defining high blood pressure has been to use percentile rank and define blood pressure elevation as ≥95th percentile. The use of percentiles rather than the absolute blood pressure measurement is necessary for children because blood pressure changes substantially during normal growth and development during childhood and during pubertal development in adolescents.

There is a long history of developing blood pressure percentiles and attempting to present them in a way that is useful for primary care physicians. The first set of blood pressure percentiles was published in 1977. In this report, blood pressure percentiles were presented by age and sex, based on a number of epidemiological studies. However, there was immediate concern about the published levels because the childhood levels of blood pressure appeared too high compared with what would be expected when these children and adolescents became adults. This led to subsequent task force reports, each of which incorporated new data from subsequent epidemiological studies and from the National Health and Nutrition Examination Survey (NHANES). In addition, it was recognized that blood pressure was strongly influenced by height in addition to age and sex. This led to the inclusion of height percentiles in the determination of the blood pressure percentiles. Although this made the blood pressure percentiles more precise, it also made it more difficult for clinicians to measure and interpret measured blood pressures in children. Subsequent studies showed that much high blood pressure was missed in practice. Nevertheless, the approach developed in the 4th report was reaffirmed in the National Heart, Lung, and Blood Institute (NHLBI) Integrated Guidelines for Cardiovascular Health and Risk Reduction in Children and Adolescents published in 2011. The 4th report also established the category of prehypertension with blood pressure between the 90th and the 95th percentile. However, it was noted that for many teenagers the 90th percentile was >120/80 mm Hg, which was the cut point used for prehypertension in adults at that time. Categories of stage 1 and stage 2 blood pressure elevation were also defined using the 99th percentile plus 5 mm Hg to define stage 2 hypertension. This level is an average ≥12 mm Hg above the 95th percentile. It is also important to note that for a diagnosis of hypertension to be made in young individuals, the blood pressure must be persistently elevated above the 95th percentile on 3 or more occasions.

In this issue of Circulation, Xi et al, on behalf of the International Child Blood Pressure References Establishment Consortium, present data to develop blood pressure benchmarks that could be used internationally. They combined blood pressure data from epidemiological studies from China, India, Iran, Korea, Poland, Tunisia, and the USA. They also improved on previous approaches to develop blood pressure percentiles in several ways. First, they used the average of 2 measurements rather than the first measurement, as had been done in previous reports. This provides a more stable estimate of the actual blood pressure; however, it will also require...
clinicians to take multiple readings in the clinical setting to use these standards. Second, perhaps most important, they excluded individuals who were overweight or obese from the analysis. Because obesity is associated with a pathological increase in blood pressure and previous efforts to create blood pressure percentiles included overweight and obese children and adolescents, this probably led to previous percentiles being too high as opposed to representing percentiles for a healthy blood pressure.

There are, however, some potential limitations to the approach used by Xi et al. First, their approach still uses a statistical, percentile-based approach to define hypertension. This begs the question of how to get to an approach to childhood blood pressure elevation that is based on outcomes. Second, although they combine data sets and present the resultant percentiles as international reference standards, it is not clear that this is the best approach to these data. It appears that there are meaningful differences from country to country in the prevalence of overweight and obesity and the percentile-based blood pressure values. This raises the question regarding the factors underlying these differences, such as diet, physical activity, and, perhaps, genetic predisposition for blood pressure elevation. It is not clear that uniform international standards for blood pressure will be appropriate. It is also possible that evaluation of international differences in the distribution of blood pressure could provide important clues to a better understanding of the development of blood pressure elevation in children. There is also the technical limitation that the youngest age in their studies was 6 years old, when it is currently recommended that blood pressure should be measured routinely in children starting at age 3 years.

The analysis of Xi et al. points out that hypertension knows no international boundaries and continues to be an important disease process worldwide. This is as true for children and adolescents as it is for adults. In fact, early recognition and treatment of high blood pressure may be the best approach to preventing the cardiac and vascular changes that lead to adverse cardiovascular outcomes. Xi et al. also remind us that we must do better to appropriately define hypertension in children and adolescents so that we can provide useful guidance to clinicians and to families to start early to prevent cardiovascular disease.

Disclosures

None.

References


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How to Define Hypertension in Children and Adolescents

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