Measuring Children’s Blood Pressure Matters

Samuel S. Gidding, MD

In the 1970s, childhood, and particularly the part of childhood before adolescence, was considered a low–cardiovascular risk state. With the exception of specific conditions such as diabetes mellitus type 1, familial hypercholesterolemia, end stage renal disease, and secondary hypertension, assessment of cardiovascular risk in children seemed unnecessary. Childhood risk factor distributions were well below thresholds thought to be associated with risk for cardiovascular disease. Even today, it is not until adolescence that blood pressure classified as prehypertension by adult criteria is at the 90th percentile of the pediatric distribution.1

In the Korean War, the observation that significant atherosclerosis was present in young US soldiers dying in that conflict suggested that atherosclerosis had its origins in youth. This possibility has been dramatically confirmed by the Pathobiological Determinants in Youth (PDAY) study and the Bogalusa Heart Study where autopsy assessment of coronary and abdominal aortic atherosclerosis has been shown to relate directly to risk factors measured postmortem (PDAY) and those measured before accidental death (Bogalusa).2,3

The recognition that atherosclerosis is a chronic disease with possible origins early in life led several pioneering investigators in the United States and around the world, beginning in the 1970s, to measure cardiovascular risk factors in youth. In addition to determining the distribution of these risk factors at young ages, an important goal of these studies was to determine if risk in youth predicted risk later in life, a concept termed “tracking.” meaning that those with higher or lower risk at initial measurement would likely retain that position relative to the rest of the cohort in the future. The presence of tracking would allow the identification of high-risk individuals at younger ages, so that disease prevention might begin during the earliest stages of atherosclerosis.4

In the current issue of Circulation, Chen and Wang, using meta-analytic techniques, provide an elegy of sorts for these many studies by combining them to retest the hypothesis that blood pressure measured early in life predicts blood pressure many years later.4 They demonstrate that, yes, blood pressure measured in childhood predicts future blood pressure with a tracking coefficient of ≈0.4 for systolic blood pressure and ≈0.25 for diastolic blood pressure. Tracking is less precise when blood pressure is measured very early in life (before 7 or 8 years of age) and deteriorates with longer follow up (several decades). The findings are true for both boys and girls and are independent of country of origin or ethnicity. Interestingly, additional blood pressure measurements in youth do not substantially improve tracking coefficients.

Though the basic rationale for performing tracking studies is simple, that blood pressure early in life predicts blood pressure later in life, the interpretation of tracking studies is complex. Because tracking coefficients describe an individual’s persistence in rank relative to the rest of the cohort, knowledge of the prevalence of hypertension in the population being studied is critical to understanding the ability of blood pressure tracking to predict future hypertension. With a low prevalence of hypertension, a tracking coefficient of 0.4 would not suggest a high likelihood of future hypertension. Unfortunately, this is not the case in many countries around the world. Blood pressure increases with age, and by age 40 years a substantial percentage of the US population has prehypertension or hypertension.5 The childhood obesity epidemic is contributing to a further increase in the population blood pressure.6 Thus, being in the upper decile of the blood pressure distribution as a child in the current environment makes future hypertension likely.

Factors that modify tracking (ie, that lower the tracking coefficient) are also critical in interpreting the results from this meta-analysis because these factors may be targets for population-based intervention to lower blood pressure. Again, the most important of these is the acquisition of obesity.7 The simplest way to have increasing blood pressure relative to the remainder of the population is to increase one’s body-mass index (BMI) relative to the cohort. The pediatric obesity epidemic may thus be contributing in a second way to a substantial increase in the blood pressure burden of the current generation. Other factors that may modify tracking, though less well studied in children, are physical fitness, physical activity, and diet. Young adults in the upper portion of the fitness distribution are less likely to develop hypertension over the next 15 years.8 Children with higher self-reported physical activity have slightly lower blood pressure over a 3-year interval.9 Research on dietary patterns suggests that following a healthy diet pattern for a sustained period of time may have favorable effects on blood pressure both within childhood and with aging.10,11 The International Study of Salt and Blood Pressure (INTERSALT) suggests that lower sodium intake over a sustained period of time can blunt the age-related rise in blood pressure.12 However, a review of pediatric research suggests little success of dietary intervention trials to impact blood pressure.13

In addition to the fact that blood pressure in childhood predicts blood pressure later in life, research on cardiovascu-
lar end organ injury suggests that elevated blood pressure in youth initiates chronic changes in the cardiovascular system. Left ventricular mass and change in left ventricular mass are directly related to blood pressure in childhood, as is carotid intima-media thickness.\(^ {14,15}\) Left ventricular hypertrophy is present in hypertensive children.\(^ {16}\) Most important, blood pressure in youth is associated with premature atherosclerosis later in life as assessed by carotid intima-media thickness, coronary calcium, and direct measurement of atherosclerosis on autopsies of young adults dying accidentally.\(^ {2,3,17–19}\)

These considerations underlie the recommendations of the Fourth Report on Blood Pressure in Children and Adolescents.\(^ 1\) Blood pressure should be measured beginning at 3 years of age during health maintenance visits. The distribution of blood pressure by age, gender, and height is provided in that document so that clinicians can recognize those in the upper range of the distribution and provide appropriate management.

In practice, and as highlighted by the meta-analysis, clinicians must be aware of the intrinsic variability of blood pressure. The studies cited in this meta-analysis paid scrupulous attention to blood pressure measurement methodology, with most studies performing multiple measures (up to as many as 9) in a quiet setting and averaging several resting measurements as the reported finding. This degree of precision is difficult to achieve in the office setting, particularly when automated devices are often used for blood pressure measurement. Making blood pressure measurements is sometimes difficult in children because of “white coat” anxiety, widely varying arm size, and occasional poor cooperation.

For this reason, the diagnosis of hypertension in children depends on multiple blood pressure measurements made over several office visits.\(^ 1\) Clinicians should be comfortable measuring blood pressure multiple times to confirm elevated readings or ordering ambulatory blood pressure recordings to confirm diagnosis. Earlier in this essay, I used the word “elegy” to describe the work of Chen and Wang.\(^ 4\) This term refers to the fact that despite the important knowledge about cardiovascular risk factors that emerged and continues to emerge from the population-based longitudinal studies included in this meta-analysis, very few new similar studies have been initiated, in part because of the substantial cost of these efforts. This situation is unfortunate because much still needs to be learned about modifying risk factors in populations, particularly those health behaviors that either modify blood pressure tracking in a way to minimize cardiovascular risk or lower the prevalence of hypertension in the entire population. Current research, emphasizing disease mechanisms and biomarkers, too often in cross-sectional study designs, does not address the fundamental preventive medicine question profiled and raised in this meta-analysis, a question that can only be answered by longitudinal research. How can the low–cardiovascular risk status of children be maintained to prevent cardiovascular disease in adults?

### Disclosures

None.

### References


**Key Words:** Editorials, blood pressure, hypertension, pediatrics, population
Measuring Children's Blood Pressure Matters
Samuel S. Gidding

Circulation. 2008;117:3163-3164
doi: 10.1161/CIRCULATIONAHA.108.787168
Circulation is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231
Copyright © 2008 American Heart Association, Inc. All rights reserved.
Print ISSN: 0009-7322. Online ISSN: 1524-4539

The online version of this article, along with updated information and services, is located on the
World Wide Web at:
http://circ.ahajournals.org/content/117/25/3163

Permissions: Requests for permissions to reproduce figures, tables, or portions of articles originally published
in Circulation can be obtained via RightsLink, a service of the Copyright Clearance Center, not the Editorial
Office. Once the online version of the published article for which permission is being requested is located,
click Request Permissions in the middle column of the Web page under Services. Further information about
this process is available in the Permissions and Rights Question and Answer document.

Reprints: Information about reprints can be found online at:
http://www.lww.com/reprints

Subscriptions: Information about subscribing to Circulation is online at:
http://circ.ahajournals.org//subscriptions/