Hypertension is a potent independent risk factor for stroke, myocardial infarction, heart failure, renal failure, and mortality in adults.1 Although most of these adverse outcomes occur in adulthood, it has become clear that hypertension is a life course problem that can become evident in childhood and can be progressive throughout childhood into adolescence and adulthood.2 It has also become clear that elevated blood pressure in childhood is associated with early markers of cardiovascular abnormalities, including left ventricular hypertrophy3 and atherosclerosis.4 For these reasons, there has been an increasing focus on the identification and treatment of children and adolescents with hypertension and the prevention of the occurrence of hypertension in the first place.5

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There is still much to be learned about the mechanisms involved in the development of hypertension. In general, it is thought that both genetic and environmental forces are important. It is clear that there is a familial clustering of high blood pressure, which probably reflects both shared genes and a shared environment. Some specific genetic abnormalities have been discovered that result in blood pressure elevation.6 However, these genetic abnormalities do not explain a very large proportion of the primary hypertension observed in the population. Studies are underway to determine the multiple other genetic influences that probably interact with environmental factors and underpin the development of primary hypertension.7

Environmental factors involved in the pathogenesis of primary hypertension include lifestyle factors, such as diet and physical activity, and other factors, such as intrauterine growth retardation, as well. The most common lifestyle factor associated with hypertension is the development of obesity. Obesity has a number of adverse health effects, but it is clearly associated with blood pressure elevation in both adults and children.8 So, although some clinically useful approaches to the prevention and treatment of hypertension are known, others probably remain to be determined.

Two epidemiological approaches to studying risk factors for cardiovascular disease have proven to be quite helpful in better understanding disease processes and in generating important hypotheses for future studies. These approaches include the examination of secular trends and the use of international comparisons. Secular trends are the changes in risk factor level and prevalence that occur in a population over time. These temporal trends can be instructive, because they usually occur in a time frame where it is unlikely that the genetic background has changed, indicating that they are most likely due to changes in environmental factors. Analysis of secular trends has been useful in understanding the relative impact of the improvement of cardiovascular disease risk factors and the improvement in intensive care interventions on the declining mortality from myocardial infarction.9

International comparisons have also led to a better understanding of the development of cardiovascular disease. An important example of this is the groundbreaking work of Ancel Keys in the Seven Countries Study.10 In this study, differences in diet were correlated with differences in serum lipid and lipoprotein levels and cardiovascular disease outcomes. It is also likely that, in the future, the international differences in disease frequency will be used to evaluate the underlying genetic differences and gene–environment interactions.

A frequent concern regarding both studies of secular trends and international comparisons is the issue of the methods of measurement. When measurements are not standardized over time or across countries, this can lead to confusion regarding whether the observed differences are real or are an artifact of measurement, leading to a false conclusion.

In the current issue of Circulation, Khang and Lynch11 present the results of an analysis of secular trends in the level of childhood blood pressure and the prevalence of hypertension in children in South Korea. They found dramatic decreases in the level of systolic blood pressure (8.7 mm Hg in boys and 10.0 mm Hg in girls) from 1998 to 2008 on the basis of 4 waves of the Korean National Health and Nutrition Examination Survey. They also found a reduction of the prevalence of prehypertension (51.5% reduction in boys and 69.3% reduction in girls) and the prevalence of hypertension (64.8% reduction in boys and 86% reduction in girls). These results may be particularly important for the country of South Korea, where stroke is the leading cause of death.12 It is interesting that the observed decline in the prevalence of elevated blood pressure was observed during a time when the
prevalence of overweight was increasing—at least in boys. On the other hand, the combined prevalence of overweight and obesity remains somewhat lower in South Korea (28%) than in other countries, including the United States, where the prevalence is approximately 33%. It is also important to note that the major increase in the prevalence of overweight and obesity in South Korea occurred between 1998 and 2001; the trend has been relatively flat since then. This again is different than the trend observed in the United States, with steady increases in the prevalence of overweight and obesity since the early 1980s.

Differences also exist in the trends for blood pressure in South Korea in comparison with the United States. Trends in adult hypertension in the US National Health and Nutrition Examination Survey demonstrated an upward slope from 1988 to 1994, after a previous long period of a downward slope. For children in the United States, the trends for prehypertension and high blood pressure were downward from 1963 to 1988. Prehypertension and high blood pressure increased 2.3% and 1%, respectively, between 1988 and 1999. These increases in the prevalence of high blood pressure were explained in part by increased obesity, and especially increased central obesity in the population. It is noteworthy that the trend of increased blood pressure appeared 10 years after the onset of the increase in the prevalence of obesity in the United States. Whereas there appear to be important differences in the secular trends in blood pressure between South Korea and the United States, other countries, such as Scotland, Northern Ireland, and the Seychelles, have shown a decline in childhood blood pressure similar to that seen in South Korea.

To put these results in clinical perspective, it is important to note that the study by Khang and Lynch was not a study of hypertension. To make a clinical diagnosis of hypertension, one must have persistent elevation of blood pressure over multiple measurements repeated over a period of weeks or months. For example, McNiece et al found a prevalence of 9.4% of blood pressure in the hypertensive range on an initial screen that was reduced to 3.2% after 3 screenings in a study of school children. So, it is likely that the prevalence of established hypertension was lower than the 12.4% prevalence of a single elevated blood pressure reading observed in 1998 and the 4.4% observed in 2007/2008 in South Korea. Unfortunately, the true prevalence of established hypertension cannot be determined from the design of the Korean National Health and Nutrition Examination Survey.

Khang and Lynch also found no other trends in diet, physical activity, cigarette smoking, sleep duration, or sociodemographic factors that would be a likely explanation for the observed decline in blood pressure. Although the approaches to measurement were generally consistent across the survey years, it is quite possible that the methods used, such as the 24-hour dietary recall, were not precise enough to determine changes in important variables, such as dietary sodium, potassium, or a Dietary Approaches to Stop Hypertension diet eating pattern. In addition, they may not have considered other dietary factors, such as the change in caffeine consumption.

Important strengths of the study of Khang and Lynch are the relatively large number of participants and the rigorous approach to the measurement of blood pressure in the Korean National Health and Nutrition Examination Survey. However, the results leave us without a complete explanation of the observed trends in blood pressure. It is possible that, if children and adolescents in South Korea experience an ongoing rise in body mass index, we will see a rise in blood pressure and a reversal of the trends in blood pressure as has been seen in the United States. This argues strongly for the implementation of programs in South Korea to prevent increases in childhood obesity. Nevertheless, the results of the study by Khang and Lynch, and those from the United States and other countries, as well, suggest that there may well be other important factors influencing the secular trends in blood pressure. It is possible that these factors are known (diet and activity), but our measurement tools are too imprecise to detect them. It is also possible that there are important factors, which could be genetic or environmental, that remain unknown. Future research should be directed at achieving a better understanding of these secular trends and international differences, so that appropriate new strategies for the prevention and treatment of hypertension can be developed.

Disclosures

None.

References


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International Differences in Secular Trends in Childhood Blood Pressure: A Puzzle to be Solved

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