Are we measuring blood pressure correctly in children, particularly in obesity?

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Body size is recognised as the highest correlate to blood pressure in childhood, leading the US National Institutes of Health sponsored Task Forces on Blood Pressure in Children and Adolescents to base their standard blood pressure tables on age, gender and height, with the understanding that increased levels of blood pressure result primarily from increases in weight. Because of the known tracking of blood pressure through childhood and into adult life, it is generally believed that early identification of hypertension in children can lead to introduction of antihypertensive strategies to reduce blood pressure levels and prevent or reduce hypertension-related cardiovascular disease. Thus, it makes sense to regularly measure blood pressure in overweight and obese children and to ensure that the definitions for hypertension are valid.

The paper by Wirix *et al*[1] is an important reminder of two issues currently associated with blood pressure measurement in childhood. The first is whether the protocols used to diagnose hypertension are reliable, accurate and standardised across research studies and clinical practice. Most physicians follow the definitions of hypertension developed by the US Expert Task Force panels, beginning in 1977. Despite these definitions being arbitrary, that is, primarily based on expert consensus because of a lack of available evidence from long-term outcome studies, most would agree that higher levels of blood pressure suggest a higher likelihood of future cardiovascular disease. Although a much smaller issue, questions might be raised about the accuracy of the published standard blood pressure tables, which are based on single measurements made by auscultation. Many paediatric clinical sites, including those participating in the study by Wirix *et al*, now use automatic devices.

It has been known for many years that blood pressure values tend to decrease with repeated measurements, whether at the same clinic visit or at follow-up visits. The reduction is due to a combination of 'regression to the mean' (ie, when an initial blood pressure measurement is extremely high or low in a given individual, subsequent measurements tend to be closer to the mean blood pressure of that individual) and an 'accommodation effect' (ie, an individual becomes more relaxed with repeated measurements, leading to a lower value). It is not surprising, therefore, as shown by Wirix, that an initial measurement at a given clinic visit yields the highest blood pressure, the final measurement is the lowest and the average of the measurements falls someplace in between.

Thus, as the Wirix study suggests, it seems reasonable that the lowest measured blood pressure should be used to assign a blood pressure category (normal, prehypertension and hypertension). This approach seems to be followed by most clinicians and is consistent with the practice of measuring blood pressure on multiple visits before diagnosing hypertension in children. While it is true that the use of an initial versus average versus lowest of multiple measurements can affect categorisation of blood pressure at any given visit, it is less likely, if a protocol of repeated visits is followed, that differences in prevalence of hypertension among studies are solely influenced by which measurement is used. Rather, some of these differences in prevalence may have been affected by race, sex, location and so on. In addition, the interval between the repeated visits may affect prevalence. In contrast to the study by Wirix in which a second visit occurred within 6 weeks, as recommended by the US Task Force, the results from an exceptionally large US study of 200 000 children followed over 3.5 years showed a prevalence of hypertension, based on hypertensive levels at three visits, of less than 1%.[2] This suggests a more conservative approach to diagnosing mild-to-moderate childhood hypertension is warranted, since it seems reasonable to suggest that a true diagnosis of hypertension should be sustainable over longer periods of observation.

The second important issue is how to approach blood pressure measurement and interpretation in overweight and obese children. As shown by Wirix, and also by many other investigators, normal weight is rarely associated with hypertension, whereas there is a significantly increased prevalence in obese children. Moreover, as recently reported, this occurs relatively quickly in association with increases in body mass index (BMI). Over a median of only 3.1 years of follow-up, children and adolescents who became obese or maintained obesity had greater than a threefold increased risk of incident hypertension risk compared with those of similar age who maintained a healthy weight.[3] While it is good news from epidemiological studies that the prevalence of overweight and obesity appears to be levelling off in children, the prevalence remains high. Because of the strong tracking effect for BMI, this means there will continue to be considerable ongoing risk into adulthood for development of obesity-associated hypertension.

Despite the generally higher levels of blood pressure in obese children compared with normal weight children, there is a broad range of blood pressure associated with obesity. The ultimate risk to normotensive obese children is not known, but as recently reported, obesity beginning in adolescence clearly presents a long-term general risk to cardiovascular disease.[4] Moreover, it is abundantly clear that hypertension and

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other cardiovascular risk factors associated with overall cardiovascular risk increase with increasing severity of obesity.[5] Thus, accurate diagnosis of elevated blood pressure in obesity is highly relevant to evaluation of overall prospective health risk in children and adolescents.

Where does that leave us when it comes to measuring and evaluating blood pressure in paediatric populations? Most would agree there are two benefits to measuring blood pressure during childhood. The first is to identify the small number with severe hypertension due to secondary causes that can be treated surgically or medically. The second is to identify children with presumed primary hypertension in the form of mild or moderately elevated blood pressure that requires longitudinal observation and, most often, risk-free intervention strategies. The US Preventive Services Task Force concluded in 2013 that screening blood pressure was of questionable value because of a lack of evidence associating childhood blood pressure with cardiovascular outcomes. We believe this is an overly severe interpretation of the data. While there is clearly still room for improvement in current methods and definitions for hypertension, blood pressure screening is low risk, low patient burden and inexpensive; and as suggested by Wirix, it should be continued. A basic goal of Paediatrics has always been to maintain healthy growth and development on the way to adulthood. In addition to advice about diet and exercise as health promotion strategies in obese and overweight children, regular measurement of blood pressure also should be integral to that process.

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