

exceed mere reduction in respiratory infections, such as reduction in diarrhoea burden and improvement in nutrition indices.

There has been considerable progress in vaccination strategies for the prevention of childhood infections and pneumonia. The importance of measles and pertussis vaccine in reducing child mortality is well established. Recent public health successes with large scale introduction of *Haemophilus influenzae* type b vaccine in developing countries^{19, 20} also indicate that this vaccine must now become part of the universal expanded programme on immunisation vaccination package. Similar preliminary success with pneumococcal conjugate vaccine in Gambia²¹ and South Africa²² also raises the hope that we may soon have vaccines against the common bacterial pathogens which cause pneumonia.

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Children under pressure

Children under pressure: an underestimated burden?

Saverio Stranges, Francesco P Cappuccio

Perspective on the paper by Jackson *et al* (see page 298)

The study by Jackson *et al*¹ represents a significant contribution to our knowledge in the area of hypertension research and related clinical practice. The definition of national blood pressure references for children and young adults, aged 4–23 years, living in Great Britain provides important, complementary information to the updated US guidelines on the management of high blood pressure in children and adolescents aged 1–17 years,² as well as to earlier attempts to

define normative blood pressure values from other countries.^{3–7} In addition, these centiles will integrate existing charts in the UK regarding other important parameters (eg, body mass index), thereby allowing a more comprehensive characterisation of the health of children. Some distinctive aspects of the study by Jackson *et al*¹ should be highlighted: the representative and large sample size of the seven surveys from which blood pressure data were drawn; the consistent

method applied for blood pressure measurements; the use of a statistical technique such as the LMS method to construct blood pressure centiles, which accounts for the skewness (L), median (M), and coefficient of variation (S) of the blood pressure distribution.⁸ Indeed, this statistical tool had been previously used in a German study to derive normalised reference values for the 24-h ambulatory blood pressure in children and adolescents aged 5–20 years.⁷

In addition to the statistical value of their contribution, the study by Jackson *et al* is particularly relevant because it gives emphasis to a significant problem in the medical field: hypertension in childhood. In the past few decades, the definition of normative values for blood pressure in the paediatric age range has been increasingly recognised as an important issue in clinical practice and public health because of the changing patterns in the epidemiology and associated determinants of hypertension among children and young adults. Several reasons justify the increasing attention to

this issue. Firstly, essential hypertension, especially in school-age children and adolescents, has become a condition of clinical and epidemiological relevance at least comparable to that associated with secondary forms of childhood hypertension.⁹ Secondly, as indicated by Jackson *et al*, there is substantial evidence showing the tracking of blood pressure from childhood to adulthood at a population level.¹⁰ Thirdly, hypertension in childhood may cause end-organ damage (eg, left ventricular hypertrophy) and predispose children to the early development of atherosclerosis and the occurrence of cardiovascular sequelae in adulthood.¹¹ Therefore, greater attention to blood pressure early in life has the potential to generate long-term benefits on cardiovascular health.¹² Finally, common determinants of hypertension in adulthood have increasingly become important medical issues in children and adolescents. The most important example is obesity-related hypertension, which is a condition that is acquiring epidemic dimensions in the UK as well as worldwide.¹³ The finding of Jackson *et al* of a strong association between body weight/obesity and high blood pressure further corroborates this notion.

A further interesting result observed in this study is the high percentage (23%) of young males with systolic blood pressure levels above the British Hypertension Society cut-off for hypertension (ie, >140 mm Hg).¹⁴ This finding needs to be cautiously interpreted, however, as it is based on blood pressure measurements obtained on a single occasion, which may lead to some degrees of misclassification (overdiagnosis) because of the potential for a "white coat" effect¹⁵ and regression to the mean on subsequent measurements.¹⁶ Further considerations refer to the age range of the study participants with a large proportion consisting of older teenagers and young adults (up to 24 years), and the use of an oscillometric device that may overestimate systolic blood pressures compared with values obtained by auscultation.¹⁷ However despite these methodological issues, it should be noted that the apparently high prevalence of hypertension among young males found by Jackson *et al* is comparable to figures reported in recent studies across different populations of children and adolescents.^{18–21} For example, using a similar approach to measure resting blood pressure (ie, three consecutive measurements with an oscillometric device), a school-based survey of 3589 children and adolescents conducted in Quebec, Canada, showed prevalence percentages of high-normal or increased systolic blood pressure to be 12%, 22%, and 30% among 9, 13 and 16-year-old males, respectively,

with lower figures among females, based on the US cut-off values.¹⁸ This is consistent with the British data. Similar figures were observed in a sample of minority schools from three US locations; however, only eight-grade adolescents were included.²¹ Together, these data support the existence of an evolving epidemic of hypertension in youth, which is closely associated with a parallel epidemic of obesity.¹³ In addition, these data indicate the potential for future increases in adult blood pressure levels and in the prevalence of hypertension in the next generations, which could determine a rise in cardiovascular morbidity and mortality. Open questions in this area pertain to: the observed sex differences among children in hypertension prevalence, which tend to be magnified with increasing age; the predominance of systolic hypertension, which could be partially related to excess body weight and fat distribution; the role of other determinants in the development of high blood pressure in youth (eg, diet, decreased physical activity, social factors, ethnicity, heritability, sleep disorders)^{22–25} beyond body weight, which does not explain the overall variability in blood pressure levels and accounts only in part for the observed increase in the mean levels of blood pressure.²⁴ For example, findings on the role of ethnicity in childhood hypertension have been inconsistent, with the observed ethnic differences often explained by differences in body size and fat distribution.^{19–21, 25} However, more data are needed to understand the interaction between ethnicity and environmental stimuli over the life course, which may result in ethnic differences in blood pressure levels in adulthood.

The information provided by Jackson *et al* highlights the importance of performing routine blood pressure screenings in childhood for the early detection of high blood pressure levels, thus allowing the implementation of timely preventive and therapeutic measures. Nevertheless, some unresolved issues deserve further consideration. Firstly, there is still concern about the accuracy of blood pressure measurements in large epidemiological studies because of the aforementioned misclassification issues, which are particularly critical in the paediatric age range.²⁶ In addition, the comparability across studies is often hampered by the use of different measurement methods. Moreover, the use of oscillometric devices is still a controversial issue despite the efforts made to validate this tool. Therefore, as recommended by Jackson *et al*, the proposed centiles need to be applied with caution when blood pressures are measured by auscultation.

Secondly, the difficulty in defining normative blood pressure levels in children has been due to the paucity of data associating childhood hypertension with cardiovascular risk in adulthood. However, ongoing longitudinal investigations should provide new insights into the long-term significance of high blood pressure in childhood, and of its interaction with other cardiovascular risk factors.^{27–29} Finally, although well-documented in adults, there is still uncertainty about the role of environmental determinants of hypertension in children. Indeed, while the evidence on the importance of excess body weight in the development of high blood pressure in children is substantial, findings on the effects of other determinants such as dietary factors are less persuasive.³⁰ In particular, there is a paucity of data regarding the efficacy of dietary and other lifestyle modifications in the prevention and management of high blood pressure among children. Recent findings from small-scale studies suggest that short-term lifestyle interventions including dietary changes may produce beneficial effects on blood pressure and other components of the metabolic syndrome in overweight children.^{31–32} For instance, compelling evidence has become available for a reduction in salt intake in infants and children to reduce the rise in blood pressure with age and the ensuing risk of hypertension.³³ Long-term and larger intervention trials are needed to evaluate whether the observed benefits are sustainable and clinically relevant within the paediatric age range.

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