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COMMENT

High blood pressure in childhood and adolescence

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High blood pressure (BP) is one of the most important modifiable risk factors for cardiovascular disease (CVD). The prevalence of high BP remains high, and the greatest absolute burden of high BP is observed especially in the East Asian and Pacific regions [1, 2]. Hypertension tracks from childhood to adulthood [3] and is associated with adverse cardiac and vascular changes that can in turn be associated with manifest CVD events in adulthood (Fig. 1) [4]. Therefore, the early identification and appropriate treatment of hypertension in children and adolescents is of paramount importance in the primordial and primary prevention of CVD, particularly for at-risk individuals, such as those with obesity, diabetes, or chronic kidney disease, among others [5].

The criteria for defining pediatric hypertension differ from those for adults. BP naturally increases with age and height, and specific cutoff points for BP in childhood and adolescence that result in higher CVD risk in adulthood are not available [6]. Therefore, the criteria for pediatric hypertension are traditionally determined based on the age-specific, sex-specific, and height-specific distribution of BP among healthy children and adolescents [5]. Figure 2 shows the criteria for pediatric hypertension as defined as the Japanese Society of Hypertension Guidelines for the Management of Hypertension (JSH 2019) [7]. These criteria were established based on almost 40,000 measurements obtained via automated BP devices using oscillometric methods at the Tokyo Health Service Association. The 95th-percentile values of the age-specific and sex-specific distributions are defined as hypertension for children and adolescents in the JSH 2019 [7]. The American Academy of Pediatrics guidelines for the screening and management of high BP in children and adolescents (AAP 2017) describe the 90th and 95th percentiles of systolic and diastolic BP in each age group according to the 5th, 10th, 25th, 50th, 75th, 90th, and 95th percentiles of height [6]. The AAP 2017 guidelines define 728 criteria for pediatric hypertension before 13 years of age by sex, age, and height, but this high number of criteria may limit the speed and ease of use for clinicians [8]. For adolescents aged 13 years or older, the AAP 2017 also include static cutoff points to define hypertension (i.e., systolic/diastolic BP of <120/ < 80 mmHg for normal BP; 120–129/ < 80 mmHg for elevated BP; 130–139/80–89 mmHg for stage 1 hypertension; and ≥140/ ≥ 90 mmHg for stage 2 hypertension). The cutoff points are the same as the cutoff points in the guidelines' respective adult guideline counterparts, and therefore promote seamless transition from care provided in adolescence to care provided in adulthood [5]. Because abnormal BP values on at least three separate occasions are required for a clinical diagnosis of pediatric hypertension [6], hypertension can be difficult to appropriately diagnose in children and adolescents, and as such is frequently under-recognized in the clinical context [5].

The variable definitions of pediatric hypertension should be considered when interpreting global prevalence data. A meta-analysis of epidemiological studies on hypertension in participants aged 3–20 years from the United States, Europe (Hungary, Switzerland, Italy, Iceland, Poland), Asia (China, Hong Kong, India), and Africa (Uganda) showed an overall prevalence of approximately 3% [9]. In a systematic review of the global prevalence of pediatric hypertension among participants aged 19 years or younger, pre-hypertension and elevated BP had a prevalence of 9.7% (95% confidence interval (CI), 7.3–12.4%), stage 1 hypertension had a prevalence of 4.0% (95% CI, 2.1–6.5%), and stage 2

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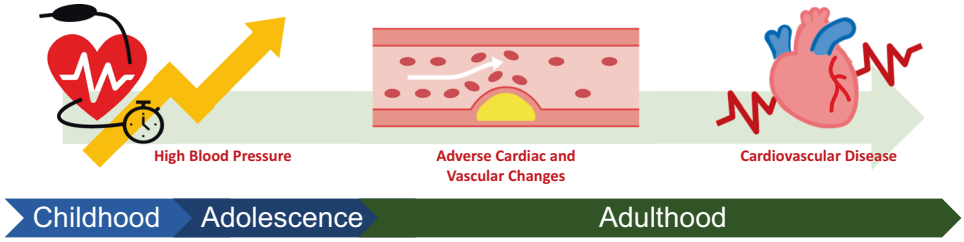

Fig. 1 High blood pressure during childhood and adolescence and cardiovascular disease risk in adulthood. Hypertension tracks from childhood to adulthood and is associated with adverse cardiac changes and higher atherosclerotic burden that in turn can manifest as CVD events in adulthood

Fig. 2 The criteria for pediatric hypertension as defined by the JSH 2019 [7]

	Systolic blood pressure (mmHg)	Diastolic blood pressure (mmHg)
Preschool	≥120	≥70
Elementary school		
1st–3rd graders	≥130	≥80
4th–6th graders	≥135	≥80
Junior high school		
Boys	≥140	≥85
Girls	≥135	≥80
Senior high school	≥140	≥85

hypertension had a prevalence of 1.0% (95% CI, 0.5%–1.6%), with higher prevalence noted in patients who were classified as overweight or obese, and increasing prevalence noted over the past two decades [10]. In Japan, a health check-up survey at elementary and junior high schools [8] reported pediatric hypertension in 0–4.4% of each grade and in 0.9% of the overall population. However, few studies have investigated how the prevalence of high BP or hypertension has been presented or is changing, especially in Japanese adolescents.

In this issue of *Hypertension Research*, Azegami et al. [11] present secular trends in BP levels and prevalence of hypertension over the period 2000–2019 among Japanese adolescents aged 12–18 years, based on cross-sectional data from health check-ups in three junior high schools and four senior high schools in Tokyo. The authors found that systolic BP levels decreased in male adolescents while diastolic BP levels increased in female adolescents in the same period. The authors provide possible mechanisms for this discrepancy: decreasing trends in body mass index or salt intake may contribute to the observed decline in systolic BP especially in male adolescents, whereas greater catch-up growth, especially in female adolescents of lower birth weight, may contribute to the observed increase in diastolic BP. However, decreasing trends in body mass index, salt intake, and birth weight have been observed in both sexes in Japan, and thus the exact mechanism for the discrepancy remains unclear, warranting subsequent exploration. The authors also found that age-specific BP levels increased with age in male adolescents but were stable in female adolescents. One possible explanation for the difference between the sexes may be that female adolescents finish their physical growth earlier than male ones, which could indicate that physical growth during adolescence is a major contributor to BP increases [12].

Azegami et al. provide important evidence of recent secular trends in BP levels and the prevalence of hypertension among Japanese adolescents. However, several limitations of this study warrant consideration. First, because only Japanese junior or senior high school students living in urban areas were included in the analyses, the results cannot be generalized to other populations. Second, BP values were measured either once or twice on a single occasion, which did not follow the guideline recommendations for appropriately assessing pediatric hypertension. Finally, the analysis did not account for factors thought to affect BP levels during adolescence, such as family history of hypertension, birth status, childhood growth, socioeconomic factors, and dietary habits. In Japan, the prevalence of hypertension remains high, and of the estimated 43 million hypertensive patients, most (31 million, 72%) are considered poorly controlled, representing an increased risk of future CVD [13]. Given the progression of high BP from childhood to adulthood and its contribution to future CVD risk, it is important to continue to carefully monitor trends in BP levels and hypertension prevalence during childhood and adolescence.

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Compliance with ethical standards

Conflict of interest The authors declare no competing interests.

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References

1. NCD Risk Factor Collaboration. Worldwide trends in hypertension prevalence and progress in treatment and control from 1990 to 2019: a pooled analysis of 1201 population-representative studies with 104 million participants. Lancet. 2021;398:957–80.
2. Hisamatsu T, Miura K. Epidemiology and control of hypertension in Japan: a comparison with Western countries. J Hum Hypertens. 2021. https://doi.org/10.1038/s41371-021-00534-3.
3. Chen X, Wang Y. Tracking of blood pressure from childhood to adulthood: a systematic review and meta-regression analysis. Circulation. 2008;117:3171–80.
4. Khoury M, Urbina EM. Cardiac and vascular target organ damage in pediatric hypertension. Front Pediatr. 2018;6:148.
5. Khoury M, Urbina EM. Hypertension in adolescents: diagnosis, treatment, and implications. Lancet Child Adolesc Health. 2021;5:357–66.
6. Flynn JT, Kaelber DC, Baker-Smith CM, Blowey D, Carroll AE, Daniels SR, et al. Clinical practice guideline for screening and management of high blood pressure in children and adolescents. Pediatrics. 2017;140:e20171904.
7. Umemura S, Arima H, Arima S, Asayama K, Dohi Y, Hirooka Y, et al. The Japanese Society of Hypertension Guidelines for the Management of Hypertension (JSH 2019). Hypertens Res. 2019;42:1235–481.
8. Kikuchi T. Pediatric hypertension based on Japanese Society of Hypertension Guidelines (JSH 2019) with actual school blood pressure screening data in Japan. Clin Exp Pediatr. 2022;65:283–90.
9. Sun J, Steffen LM, Ma C, Liang Y, Xi B. Definition of pediatric hypertension: are blood pressure measurements on three separate occasions necessary? Hypertens Res. 2017;40:496–503.
10. Song P, Zhang Y, Yu J, Zha M, Zhu Y, Rahimi K, et al. Global prevalence of hypertension in children: a systematic review and meta-analysis. JAMA Pediatr. 2019;173:1154–63.
11. Azegami T, Uchida K, Sato Y, Murai-Takeda A, Inokuchi M, Hayashi K, et al. Secular trends and age-specific distribution of blood pressure in Japanese adolescents aged 12–18 years in 2000–2019. Hypertens Res. 2023. https://doi.org/10.1038/s41440-023-01432-6.
12. Kotchen JM, McKean HE, Neill M, Kotchen TA. Blood pressure trends associated with changes in height and weight from early adolescence to young adulthood. J Clin Epidemiol. 1989;42:735–41.
13. Hisamatsu T, Segawa H, Kadota A, Ohkubo T, Arima H, Miura K. Epidemiology of hypertension in Japan: beyond the new 2019 Japanese guidelines. Hypertens Res. 2020;43:1344–51.