Paediatric blood pressure percentiles from United States of America electronic health records

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Blood pressure increases in children with growth, and appropriate reference intervals based on sex, height and age are required to interpret readings.[1] It is important to identify hypertension as the obesity pandemic leads to hypertension earlier in life. Owing to increasing height and methodology changes, the reference intervals need regular updates. The American Academy of Paediatrics (AAP) Clinical Practise Guidelines with new reference intervals were published in 2017, with values based on auscultatory measurements in 50,000 children and adolescents.[2] Older normative values have been based on sphygmomanometer readings, which became obsolete because of harm that could be inflicted by mercury leakage.[1] However, in well-resourced practices, oscillometric devices are widely used.[1] Mitsnefes's team used electronic health record (EHR) data of 292,412 children (1,085,083 blood pressure measurements) without obesity or chronic health conditions, based on oscillometric and aneroid device readings from outpatient records, generating new normative values.[3] This thoughtful contribution to the literature included a diverse population, but Hispanics were under-represented, Black/African Americans over-represented and Asian were represented compared to the levels of the USA general population. Using EHR data from eight large USA children's hospitals over a 12-year period, Mitsnefes and colleagues[3] used mixed-effects polynomial regression model with random slopes to generate Z-scores and blood pressure percentiles for sex, age, and height. They compared findings with the 2017 guidelines and reported only minimally higher systolic (1–4 mmHg) and slightly lower diastolic (1–3 mmHg) blood pressure readings, arguing that using such real-life data could be used to update paediatric reference intervals.

Mitsnefes' study percentiles reflect oscillometric-based scenarios with good agreement to published references. Oscillometric devices, widely used for blood pressure readings in well-resourced countries, determine the mean arterial pressure defined as the maximum amplitude of the pulse wave and use device-specific algorithms rarely validated in children.[1] Limitations that prevent generalization include lack of differentiation between aneroid and oscillometric readings and a single-country study.

We believe their findings may facilitate future research for the diagnosis and management of paediatric hypertension. For instance, humans are getting taller; over the past century adult height increased in South Korean women and Iranian men by 20.2 cm (95% credible interval 17.5–22.7) and 16.5 cm (13.3–19.7), respectively.[4] Reference intervals need to be regularly updated to accommodate this development but studies for the establishment of normative values are expensive. The findings by Mitsnefes and colleagues suggest that EHR data can be used for casual blood pressure measurements to monitor secular trends and identify the prevalence of paediatric hypertension.[5]

Future studies could compare aneroid and oscillometric devices in larger, diverse samples. Their study's generalizability could be improved by combining data from different countries, regions and populations, like what was done for the CKD-Epi formula for estimation of glomerular filtration rates in adults.[6] Such approaches may also be used to improve the evaluation of special populations in whom the estimation of stature is challenging, for instance, in spina bifida patients.[7]

Other limitations of the study include source blood pressure readings (aneroid or oscillometric device brands), and how data was collected (manual entry by allied healthcare professionals vs. direct transmit to the EHR from the device) as transcription errors are described.[8] It was not stated whether stadiometer scales were used for height determination. There was also no description of the EHR systems, which can be variable in their quality. Lastly, a statistical method was chosen to eliminate outliers. It is not clear if the manufacturers of EHR systems utilize artificial intelligence approaches to identify errors at the time of entry; for example, if a child is 10 years old and accidentally the input reads 173 rather than 137 cm, does the EHR flag this error?

One issue that needs further discussion is related to the 95th percentiles of adolescents >14 years as shown in Figure 4 of Mitsnefes' manuscript. The 2017 AAP guidelines have stated that blood pressure norms after

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age 14 are ≤130/80 mmHg to concur with adult guidelines, but previous guidelines have allowed for higher 95th percentiles for tall adolescents.[2] Conversely, the in European guidelines from 2023, the cut-off age for 130/80 mmHg is 16, not 14 years.[9] In Mistnefes' paper, there are higher 95th percentiles than 130/80 mmHg. In view of the acceleration of stature with every generation and the fact that blood pressure is strongly correlated with height, future research needs to address whether it is appropriate to have a unified cut-off of 130/80 mmHg.

In conclusion, new paediatric blood pressure reference ranges were generated from over one million measurements recorded in EHRs of apparently healthy children served at eight USA children's hospitals. There was good agreement with the 2017 AAP guidelines. This single-country study serves as an example for artificial intelligence methods to generate practice guidelines to monitor the longitudinal changes and dynamic growth of children and adolescents. We are pleased to see the advancement in the field of paediatric blood pressure readings.

Contributors

GF and MEDGF conceptualized the commentary. Both authors performed the literature search. GF wrote the first draft and MEDGF provided critical intellectual input. Both authors have read and approved the final version of the manuscript.

Declaration of interests

The authors declare that they have no conflict of interest.

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