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Simple Formulas for Screening Abnormal Blood Pressure in Children and Adolescents

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Childhood hypertension has been extensively focused on in the past decades because of its increasing incidence, which is related to physicians' awareness and the increasing number of obese children. Age, gender, and body size are the main determinants of blood pressure in children. The revised childhood blood pressure tables of the National High Blood Pressure Education Program are a prerequisite for classification of childhood hypertension. Although these tables provide a reasonable basis, they are intricate and height percentile is needed for final diagnosis. Many attempts have been done to decrease such complexity. We present new formulas that are concise and memorable, and will help physicians to screen prehypertensive and hypertensive pediatric patients.

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BRIEF COMMUNICATION

Knowing the exact cutoff points for the prehypertensive and hypertensive blood pressure, which are dependent to gender and age, is the key point in the approach to abnormal blood pressure in children and adolescents. Although the normal limits have been defined in the accurate charts of the National High Blood Pressure Education Program (NHBPEP)[1] for abnormal blood pressure screening, in practice, there are some complications in using these tables. Problems include the intricacy of finding height percentiles, unavailability outside the pediatrician offices and in bedside visiting of patients, and the high probability of visual error in reading the numbers because of the large amounts of normal and abnormal blood pressure values based on gender, age, and height percentile. Many investigators have tried to classify, compress, or reduce the size of the NHBPEP charts to make them easy and memorable. All of these methods have positive aspects and weak points, as well. Classifying into age groups, memorability increases, but accuracy decreases significantly. Compression the size of the charts, for example with integration of the systolic and diastolic values, as we did previously,[2] results in a reduction in visual errors and the elapsed time to find desirable limits, but does not have any effects on the other complications. Reduction of the size of blood pressure charts by elimination of height percentile and normal percentile of blood pressure, as recently done by Kaelber and Pickett,[3] is a very effective idea based on considering the lowest value of abnormal blood pressure for the 5th percentile of height in each age and gender as the screening value. However, users of these reduced tables still need to always carry them, printed or in the form of a calculator. Here, we try to present a formula-based method that has the positive points of the abovementioned methods, which is in addition very concise and memorable and would solve the problem of carrying a table everywhere.

For elaborating formulas to predict the prehypertensive values, the 90th percentiles of blood pressure for the 5th percentiles of height were considered as target values (to include prehypertensive individuals). Using linear regression method, the relationship between age and prehypertensive target values by the two genders were determined. The model fitness was approved by the R^2 coefficient. The values of intercepts and β

were used for generating equations. For increasing the memorability, the primary results were rounded off (Table). The correlation between the results of the generated formulas and blood pressure cutoffs are shown in Figures 1 to 3.

Making a formula for predicting abnormal childhood blood pressure values is a priority in pediatric research. Somu and coworkers[4] extracted formulas for this purpose in 2003 from the data of the Update of 1987 Task Force report. They used values of the 95th percentile of blood pressure, corresponding to the 50th percentile for height in both genders, as screening cutoff points of hypertension. By using regression analysis, they structured 3 formulas. Although their results were practical, it seems that its publication time was late because of the publication of the new charts of the NHBPEP in 2004. In addition, their attempt to make maximum memorable results and relinquish the differences between genders led to unfavorable amount of estimation and round off errors. In order to avoid such errors, we preserved accuracy by decreasing the degree of coefficient rounding off and considering the differences of abnormal values between the two genders, especially for abnormal diastolic blood pressure cutoff values, which led to extracting two separate formulas for them.

A simplified Table of Blood Pressure Normal Cutoffs in Children

	Hypertension	
Age, y	Systolic, mm Hg	Diastolic, mm Hg
3 to 7	≥ age + 96	≥ 2 × age + 55
8 to 13	≥ 2 × age + 91	≥ age + 63
≥ 14	≥ 120	≥ 75

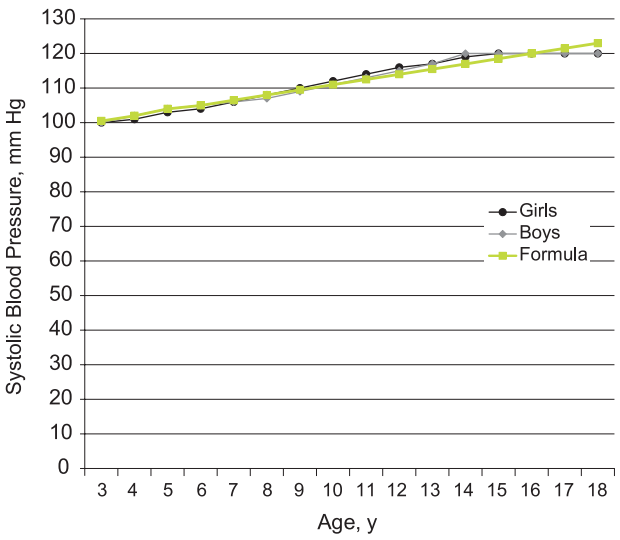

Figure 1. Systolic blood pressure in boys and girls aged 3 to 18 years old based on the National High Blood Pressure Education Program tables[1] and the introduced formula (Table).

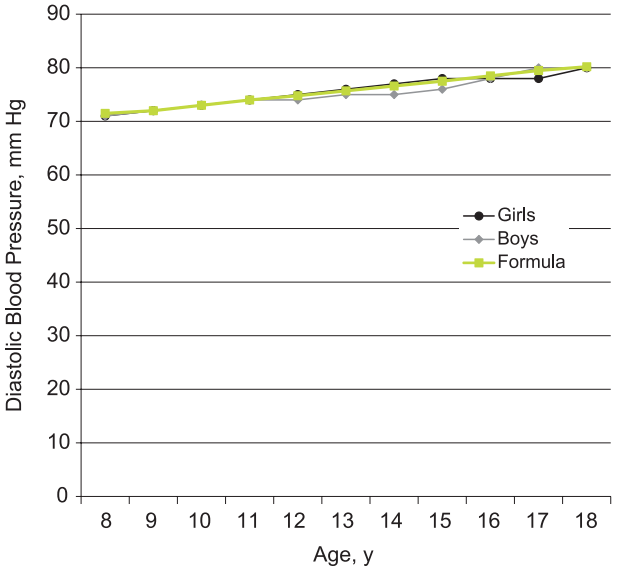

Figure 2. Diastolic blood pressure in boys and girls aged 8 to 18 years old based on the National High Blood Pressure Education Program tables[1] and the introduced formula (Table).

In medical centers that have high loads of inpatients and outpatients, physicians are forced to take the maximum possible precision in patient evaluation in a minimum time. In such conditions, all evaluations that necessitate precision and time would be done with complications and errors or would not be done at all. We suppose that using our table of formulas in the form of little labels on the cuff of pediatric sphygmomanometers would decrease the amount of errors in screening the patients who need to be evaluated by exact, complete, and detailed charts and would increase the level of accuracy.

CONFLICT OF INTEREST

None declared.

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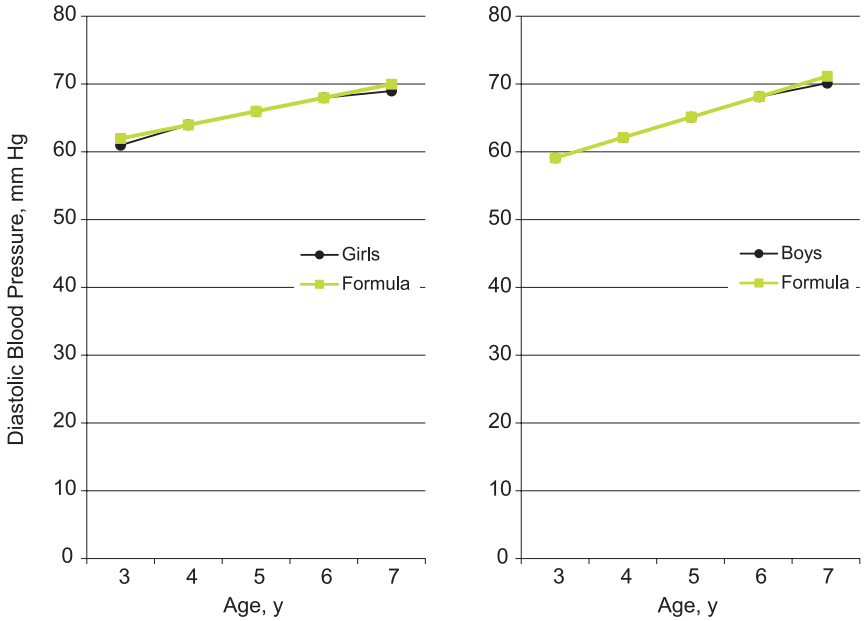

Figure 3. Diastolic blood pressure in boys (Right) and girls (Left) aged 3 to 7 years old based on the National High Blood Pressure Education Program tables[1] and the introduced formula (Table).

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