

Children's Arterial Blood Pressure Percentile Curves

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Abstract

Background-One of the most important tools for the evaluation of children's health is determining the systemic arterial blood pressure (SABP), which is affected by weight, gender, stature, and environmental conditions. The variation of children's SABP is between the 5th and 95th percentile curves. Due to environmental conditions, some criteria may be different in other countries.

Methods- We measured the SABP of 1000 7-12-year-old students who were selected randomly. The SABP percentile curves are plotted on the basis of weight, stature, and sex; and they will of course be affected by environmental conditions.

Results-The results show that the most abundant systolic SABP was 100 mmHg (27%) and the least abundant was 75 mmHg (1%). For diastolic SABP, the highest and lowest prevalences were 65 mmHg (28.2%) and 45 mmHg (0.1%), respectively. The correlation between age ($p<0.01$), weight, stature, and sex ($p<0.005$) and the SABP of the children was determined: SABP increased with an increase in age, weight, and stature. In addition, SABP in girls was higher than that in boys in the same situation.

Conclusion-In light of our results, it is necessary that children be protected against cardiovascular diseases by laying emphasis on suitable nutrition and exercise in school curriculum (*Iranian Heart Journal 2006; 7 (4): 52-56*).

Key words: blood pressure ■ children ■ percentile curve ■ weight ■ age ■ gender

The normal range of arterial blood pressure in children is affected by several factors like age, gender, weight, stature, geographic conditions, and race. Even for children of the same age and gender, the range of natural arterial blood pressure is quite wide. In other words, even in equal situations such as having the same weight, gender, and stature, the natural range of arterial blood pressure varies between the 5th and 95th percentile curves. If the systolic and diastolic arterial blood pressure of a child remains under the 90th percentile curve of his or her age and gender, it is expressed as normal arterial blood pressure.

Those children who have continuous systolic and diastolic arterial blood pressure between the 90th and 95th percentile curves of age and gender are involved in slight arterial pressure increase, and they are expressed as persons exposed to the risk of being affected by high blood pressure disease.³ Children who have systolic or diastolic arterial blood pressure equal to or more than the 95th percentile curve are affected by a significant increase in arterial blood pressure, and those who have systemic arterial blood pressure equal to or greater than the 99th or 99.9th percentile curves are expressed to have severe or malignant arterial blood pressure.^{3,4}

Therefore, determining the arterial blood pressure is one of the important tools for the evaluation of children's health.

However, due to the effect of environmental conditions on arterial blood pressure, it is probable to face different situations in various geographical areas. This research was conducted on an area which was not already reviewed so as to plot the percentile curves of blood pressure for children between 7-12 years old. The results should be treated as basic information, based on which research should be continued periodically to determine national and local criteria in the future. Indubitably, determining the local arterial blood pressure and plotting the percentile curves can facilitate the diagnosis of children's abnormalities and prevent probable consequences in the future. In contrast to adults, in children such a disease is mostly a secondary result in significant to severe cases and we can often find a cause for it.^{10,11}

Methods

This cross-sectional research was done during a three-month period. The subjects were students aged 7-12 years from 25 schools, and they were divided into 5 categories based on age. In total, 1000 students were randomly selected and studied (500 girls and 500 boys) with the stratified sampling method. In order to plot more precise curves, we divided the subjects into 5 groups based on age, each group consisting of 200 children. The visual information was collected in cooperation with the children. The stature and weight of the children were measured, and then the right hand arterial blood pressure was taken with a mercury sphygmo-manometer three times each time after 30 minutes while the children were in sitting position. The result of the third time was registered in the samples' table (blood pressure was measured three times because children can become accustomed to it without fear or anxiety affecting the result). Systolic blood pressure was read facing the 1st Korotkoff sound, and diastolic blood pressure

was read facing the 4th Korotkoff sound; they were subsequently noted in the table. After having been registered, the data were analyzed with Minitab and Epi5 software and the abundance table was derived according to age and gender. After that, the relative curves were plotted. For particular interpretation of the results, the χ^2 test was used.

Results

Research results show that children weighing between 21-25 kg had the most abundance (40.5%), followed by children weighing 26-30kg (25.4%), 16-20kg (13.8%), and 31-35kg (13.6%). The least abundant was 0.3% for the children weighing equal to or more than 51kg and 0.5% for those who were less than 16kg. Our findings show that children with a stature between 121 and 125cm had the most abundance (18.9%), followed by 126-130cm (17.4%). The least prevalence was for the children who had stature equal to 160cm (0.1%). The results show that systolic blood pressure of 100mmHg (27.7%) was the most abundant, followed by systolic blood pressure of 90 (19.2%), 95(16.4%), and 105mmHg (14.7%), respectively. The least abundance of systolic blood pressure was 75 (0.1%) and 135mmHg (0.2%). Moreover, the diastolic pressure of 65mmHg had the most abundance (28.2%) among the children under study. Diastolic pressures of 60 (26.5%) and 70mmHg (26%) came next with a minimum abundance of 45 (0.1%) and 85 mmHg (0.6%). Our results show that when age increases, the arterial blood pressure will rise; accordingly, there is a positive correlation between age and arterial blood pressure. Nomograms 1 and 2 show the increase of blood pressure with increasing age. Comparing these two nomograms reveals that the rise of diastolic blood pressure (compared to systolic) was sharper while age increased. We can also see that the arterial blood pressure of the girls was higher than that of the boys. On the whole, for the 95th percentile curve, the minimum systolic arterial pressure

of the boys was 112 mmHg and the maximum was 120 mmHg. The χ^2 test shows a meaningful correlation between age, gender, and systolic blood pressure ($p < 0.005$). The minimum diastolic arterial blood pressure for the boys was 73mmHg and the maximum was 81mmHg for the 95th percentile curve.

For the girls under study, the minimum systolic pressure was 109mmHg and the maximum was 127mmHg for the 95th percentile curve, and the minimum diastolic pressure was 74mmHg and the maximum was 82mmHg. The χ^2 test shows a meaningful correlation in this case, too ($p < 0.01$).

As the systolic blood pressure abundance distribution shows, the most abundant systolic blood pressure for the girls and boys was 100 mmHg. Nomograms 3 and 4 show this diffusion based on gender and different curves (50%, 75%, 90%, 95%).

The abundance distribution of diastolic pressure for the girls shows that except for the 8-year-old girls, for all other ages of girls, the diastolic pressure 65 had the highest abundance, whereas for the boys under study at the ages of 7, 8 and 9 years old the diastolic pressure was 60 and for the ages 10 and 11 it was 65 mmHg. The nomograms 5 and 6 show the diffusion of diastolic pressure according to the age.

What we obtained from this research about the correlation between increase in diastolic blood pressure and weight of children shows that a rise in blood pressure has a positive correlation with weight, except in children weighing 41-45kg (i.e. those who had a decrease in pressure in comparison with the former and latter groups). These results indicate that at all ages, systolic pressure rises when weight increases except for male children between 34-40kg who had a decrease in systolic blood pressure. The χ^2 test shows a meaningful correlation between weight and diastolic blood pressure ($p < 0.005$) and also between weight and systolic blood pressure ($p < 0.005$). Nomograms 7 and 8 show the diffusion of systolic and diastolic blood pressure according to weight.

In terms of the effect of stature on systolic and diastolic blood pressure, our findings reveal that we will have increase in systolic and diastolic blood pressure when stature rises. This rise is more pronounced for girls in comparison to boys. The χ^2 test shows a meaningful correlation between stature parameter of children and their systolic and diastolic blood pressure ($p < 0.005$). Nomograms 9 and 10 show the diffusion of systolic and diastolic blood pressure of children according to their stature. The results show a significant difference between first and third time measurements in children, which seems to be due to their anxiety and should be studied more.

Discussion

The aim of this research was to study the correlation between the blood pressure of 7-12-year-old children and their stature, age, and weight in order to plot nomograms of systolic and diastolic blood pressure. The results show that when age increases, both systolic and diastolic arterial pressures rise. This situation is more pronounced for girls. A research carried out in Zambian villages² also shows the same results for children of 7-16 years of age. Another research done by Gupta and his colleagues in India emphasizes that an increase in age, weight, and stature leads to a rise in the blood pressure.⁶ It also shows the same severity for girls in comparison to boys. The Zambia study also shows that for ages 7-16 years, the average blood pressure of girls is equal or slightly more than boys of the same age.⁶

Wang and his colleagues in China emphasize that blood pressure (both systolic and diastolic) has correlation with age, but they explain that up to the age of 10, boys and girls have similar blood pressure, while after this age the blood pressure of boys overtakes that of girls. Wang et al. also stress that there is a clear relation between blood pressure and three basic factors: age, weight, and stature.⁶ Another research made by Rabinowitz and his

colleagues among 3349 urban teenagers shows that high blood pressure was more prevalent in girls' national Negroid schools.⁷ It follows from the above-mentioned results that blood pressure in boys and girls may be affected by race and geographic conditions. This must be studied in more detail and can be the title of a new research, especially important in the countries with different varieties of geographic situations.

Our research was also able to conclude a meaningful correlation ($p < 0.005$) between weight and blood pressure. Our findings show that blood pressure increases with weight, except in those weighing 41-45kg. This correlation is valid in all researches, such as those by Gupta,⁶ Von Vigier and his colleagues,⁸ Yiu and his colleagues,¹⁰ and also the one in Zambia.² All these researches explain in their results that increase in weight in tandem with age leads to a rise in blood pressure and that there is a meaningful correlation between these two parameters.^{12,13}

Our results also show that the blood pressure of boys and girls has a meaningful correlation with their stature ($p < 0.005$), i.e. the blood pressure rises with an increase in stature.

In the Gupta research, made in 1990 in India, the existence of a correlation between stature and blood pressure is also emphasized.⁶ In the research made among village children of Zambia² and also in the Von Vigier research,⁸ this correlation is clearly explained. It is obvious and undeniable that variation of these parameters (i.e. weight, stature, and age increase) is a necessity for life and growth and these parameters cannot be controlled. Therefore, it is necessary to provide suitable education and trainings in the field of health and treatment for children and teenagers based on the geographic conditions that may affect such factors. Iran, albeit not considered as an industrial country, has high statistics of cardiac and vessel diseases. Teaching the methods of preventing these diseases is the most important and simplest step for decreasing cardiovascular diseases, especially high blood pressure. There should also be

more emphasis on proper nutrition and physical education in educational curricula.¹ Parents should also be encouraged to follow suit so that there can be a positive change in nutritional patterns and behaviors, paving the way for the prevention of cardiac and vessel diseases such as high blood pressure.¹⁴⁻¹⁷

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