# Blood pressure percentiles and systemic hypertension-associated factors among children aged between 6 and 15 years in Southern Vietnam

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## Abstract

**Background:** The present study determined blood pressure percentiles in children aged between 6 and 15 years in Southern Vietnam.

**Material and methods:** Blood pressure was measured in a random sample of 1080 students aged 6–15 years who was studying at primary and secondary high schools in My Tho city, Vietnam. A descriptive cross-sectional study was conducted from November 2019 to June 2020. To diagnose children systemic hypertension, the blood pressure must be above the 95$^{th}$ percentile. Data were analyzed by IBM SPSS statistics software version 20.0. The Chi-squared test was employed to evaluate the relationship between systemic hypertension and child demographic characteristics including gender and obesity.

**Results:** The results showed that the 95th percentiles of systolic and diastolic blood pressure of the children was 110/70 mm Hg in the 6-year-old group, 120/75 mm Hg in the 7 to12-year-old group and 125/80 mm Hg in the 13 to 15-year-old group, respectively. The rate of systemic hypertension in the children was 10% whereas boys had a 1.2 time higher risk of systemic hypertension than girls ($p > 0.05$). Obese children had an 8.6 time higher risk of systemic hypertension than non-obese ones ($p < 0.001$).

**Conclusion:** The blood pressure percentile chart of school children aged 6–15 years were reported here for the first time in Vietnam. The results provided useful information in early diagnosis and timely treatment of systemic hypertension in children.

**Key words:** blood pressure; children; hypertension; percentile chart

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## Introduction

Systemic hypertension is associated with long-term negative health effects not only in adults, but also in children and adolescents. It has been recognized as a major cause for cardiovascular morbidity and mortality [1]. Normally, high blood pressure in children was often neglected in diagnostic process. In

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a study from 1999 to 2006 of 14187 children and adolescents aged 3 to 18 years in Cleveland, the United States, 507 of the children (3.6%) had systemic hypertension but only a quarter was diagnosed [2]. The lack of information on pediatric hypertension had a direct detrimental effect on diagnosis and treatment [3, 4]. In fact, the standard blood pressure tables were essential to provide recommendations for diagnosis, evaluation, and treatment of systemic hypertension [5]. Several worldwide studies were performed to establish blood pressure reference values. The National Health and Nutrition Examination Survey 1999–2000 (NHANES) presented blood pressure tables including the 50$^{th}$, 90$^{th}$, 95$^{th}$, and 99$^{th}$ percentiles by sex, age, and height [6]. Another study performed in India in 1999 (n = 10215 children) reported children aged 5–9 years had systolic blood pressure (SBP) ranging from 70 to 140 mm Hg, diastolic blood pressure (DBP) ranging from 36 to 100 mm Hg, while BP values in children aged 10–14 years were 72–160 mm Hg and 46–120 mm Hg, respectively. The study also provided the rates of systemic hypertension which were 11.9% for boys and 11.4% for girls [7]. However, Vietnam has not reported a typical blood pressure table for children yet. So far, the blood pressure tables for foreign children have been used in diagnosis and treatment of systemic hypertension for children in Vietnam, which often led to some errors due to a great difference in characteristics between Vietnamese and foreign children. Moreover, the Vietnam National Association of Cardiology has not showed the status of systemic hypertension in children yet. The present study determined blood pressure percentiles of children aged 6–15 years old in southern Vietnam, which contributed to improved treatment for underage patients in this country.

## Material and methods

### Study population

A descriptive cross-sectional study was conducted from November 2019 to June 2020. The study was performed at 6 schools in My Tho city, southern Vietnam. My Tho has a population of 165,074 in which urban population accounts for 74.76%. The Kinh, the most predominant ethnic group, accounts for 98% of its population, followed by the Hoa ethnic group (1.89%) and the remaining ones are Khmer and Indian ethnic groups. Regarding education, My Tho has 19 primary schools with 393 classes and 13,880 students, on average 30–35 students/class. There were also 7 secondary high schools with 229 classes and 9,911 students, on average 40–45 students/class. Overall, twenty-six schools are located in 10 wards belonging to 4 communities. In terms of healthcare, there has not been any published study on systemic hypertension in children as well as in adults. In this study, 1,080 children of 10 age groups (the average age was 10.5 ± 2.87) , from grade 1 to grade 9, were enrolled. Each grade had 108 participants, except 9th grade with 216 children divided equally into two groups of ages (ages 14–15). Each age group average accounts for 10% of the total number of children enrolled in the study.

### Method of blood pressure measurement

Blood pressure in children was measured according to four steps as described below:

- step 1: chose randomly 3 primary schools and 3 secondary high schools from 26 schools;
- step 2: select all grade classes from the six randomly chosen schools;
- step 3: at each grade in any school, select randomly 36 children meeting eligibility criteria;
- step 4: collect statistics of all children who meet the following selection criteria.

Inclusion criteria in the study were as follows: 1 — 6–15-year-old male and female students living and studying at primary and secondary schools in My Tho city during the study period; 2 — subjects and families accepted to participate in the study. The blood pressure evaluation included sphygmomanometer technique (seated, measure blood pressure 3 times) measurement of systolic (SBP) and diastolic blood pressure (DBP) [8]. Blood pressure values were obtained with certified mercury sphygmomanometers by trained examiners following the standard protocol recommended by the AHA. In brief, after at least 5 minutes of rest, blood pressure was obtained on the right arm of the seated children with the elbow at the level of the right atrium, using an appropriately sized cuff. The feet of children were on a platform during blood pressure measurement. Systolic blood pressure was determined by the onset of the first Korotkoff sound (i.e., appearance of tones) and DBP was determined by the fifth Korotkoff sound (i.e., total disappearance of tones). Blood pressure was measured up to three times on one occasion, with intervals of several minutes [9]. Anthropometric measurements included body weight and height.

Exclusion criteria in the study were as follows: 1 — children with hand deformities whose blood pressure cannot be measured; 2 — children who drank coffee 1 h before the measurement; 3 — children who ate, drank, used alcohol or any other stimulant

**Table 1.** Distribution of systolic (SBP) and diastolic (DBP) blood pressure by age

| Years of age | SBP | | | | DBP | | | |
|---|---|---|---|---|---|---|---|---|
| | Median blood pressure [mm Hg] | Standard deviation [mm Hg] | Min [mm Hg] | Max [mm Hg] | Median blood pressure [mm Hg] | Standard deviation [mm Hg] | Min [mm Hg] | Max [mm Hg] |
| 6 | 93 | 9.03 | 80 | 120 | 55 | 7.69 | 38 | 70 |
| 7 | 99 | 9.58 | 80 | 130 | 60 | 7.55 | 45 | 80 |
| 8 | 99 | 9.12 | 80 | 120 | 62 | 7.58 | 43 | 80 |
| 9 | 101 | 9.27 | 80 | 130 | 63 | 7.27 | 45 | 80 |
| 10 | 99 | 9.71 | 78 | 130 | 62 | 7.22 | 48 | 80 |
| 11 | 101 | 10.31 | 80 | 140 | 63 | 7.48 | 50 | 90 |
| 12 | 103 | 12.78 | 80 | 142 | 63 | 8.53 | 50 | 100 |
| 13 | 109 | 9.56 | 90 | 130 | 70 | 8.32 | 42 | 90 |
| 14 | 106 | 10.63 | 80 | 130 | 67 | 7.34 | 50 | 80 |
| 15 | 109 | 12.39 | 80 | 145 | 68 | 8.24 | 50 | 88 |

30 min before the measurement; 4 — children used tobacco and medications that may affect the amount of blood pressure.

Overweight and obesity status was assessed based on age- and sex-specific BMI percentiles as recommended by the International Obesity Task Force [10].

### Data analysis

Collecting research data was based on the use of survey questionnaires, blood pressure, height, and weight measurements on each patient. IBM SPSS version 20.0 software was used to process the collected data. The relationship between systemic hypertension and demographic characteristics (gender, obesity) of children was analyzed by $\chi^2$ test. To compare quantitative variables, independent sample t test and one-way ANOVA were used.

## Results

### Study population

In this study, 1080 children met the criteria of the study. The information of the children was as follows: male students accounted for 48.8% and female students accounted for 51.2%; the average height of the children was 138.5 ± 15.7 centimeters (min 101, max 177.5); the average weight of the children was 34.7 ± 11.4 kilograms (min 13.5, max 75); average BMI was 17.6 ± 3.1 (min 10.5, max 42.3); average SBP was 101.9 ± 11.3 mm Hg (min 60, max 145); average DBP was 63.2 ± 8.8 mm Hg (min 38, max 100). When the average SBP increased by 1 mmHg, the average DBP would increase by 0.6 mm Hg. SBP explained 59.6% of the variation of the average in the research sample (DBP = 2.45 + 0.6 * SBP; F = 1587.8, p < 0.001, 95% confidence interval 35.61–41.88). The children's blood pressure index increased with age; the difference in SBP and DBP between ages was statistically significant (p < 0.001). However, when comparing each age group separately, the 6-year-old children had the lowest SBP and DBP, and children aged 7–12 years have lower SBP than children aged 13–15 years; all of these differences were statistically significant for each group (p < 0.05). The difference in SBP and DBP between children aged 7–12 years and 13–15 years was not statistically significant (p > 0.05) (Tab. 1).

### Blood pressure percentiles of children

The results showed that the 95th percentiles of SBP and DBP of children in the 6-year-old group were 110/70 mm Hg; these values were 120/75 mm Hg and 125/80 mm Hg for the 7–12-year-old group and the 13–15-year-old group, respectively (Tab. 2).

### The rate of systemic hypertension in children

The rate of systemic hypertension in children was 108 (10%). This rate was concentrated mainly in children of secondary schools. The difference in the threshold rate and actually between ages was statistically significant (p < 0.001). Secondary school students had a 2.6-time higher systemic hypertension rate than primary school ones (p < 0.001) (Tab. 3).

### Risk factors for systemic hypertension in children

Boys had a 1.2-time higher risk of systemic hypertension than girls, which was not statistically significant (p > 0.05). the difference between obese and non-obese children was also statistically signifi-

**Table 2.** The 90th and 95th percentiles for blood pressure by age group

| Years of age | Number | Blood pressure [mm Hg] | Male | | Female | |
|---|---|---|---|---|---|---|
| | | | 90th | 95th | 90th | 95th |
| 6 | 108 | SBP | 107 | 112 | 104 | 108 |
| | | DBP | 67 | 72 | 63 | 68 |
| 7–12 | 648 | SBP | 112 | 122 | 109 | 117 |
| | | DBP | 72 | 77 | 69 | 74 |
| 13–15 | 324 | SBP | 122 | 127 | 118 | 123 |
| | | DBP | 81 | 80 | 80 | 79 |

SBP — systolic blood pressure; DBP — diastolic blood pressure

**Table 3.** Comparison of systemic hypertension between secondary and primary school students

| | Systemic hypertension | | Normal blood pressure | | OR (95% CI) | $\chi^2$ p |
|---|---|---|---|---|---|---|
| | Number | % | Number | % | | |
| Secondary school | 76 | 14.1 | 464 | 85.9 | 2.6 (1.69–4.00) | 19.91 p < 0.001 |
| Primary school | 32 | 5.9 | 508 | 94.1 | | |

OR — odds ratio; CI — confidence interval

**Table 4.** The relationship between the prevalence of systemic hypertension and sex or obesity

| | | Systemic hypertension | | Normal blood pressure | | OR (95% CI) | $\chi^2$ p |
|---|---|---|---|---|---|---|---|
| | | Number | Percentage | Number | Percentage | | |
| Sex | Male | 20 | 3.8 | 507 | 96.2 | 1.2 (0.65–2.44) | 0.42 0.515 |
| | Female | 17 | 3.1 | 536 | 96.9 | | |
| Obese | Yes | 23 | 12.1 | 167 | 87.9 | 8.6 (4.3–17.1) | 52.5 < 0.001 |
| | No | 14 | 1.6 | 876 | 98.4 | | |

OR — odds ratio; CI — confidence interval

cant (p < 0.001); namely, the former group had an 8.6-time higher risk of systemic hypertension than the latter (Tab. 4).

## Discussion

The SBP of boys was 2.6 mm Hg higher than that of girls (p < 0.001). According to the previous study conducted at 6 countries in Europe on 28,043 children, the SBP of boys was also higher 6 mm Hg than that of girls [6, 11]. The 90th and 95th percentiles for SBP and DBP in children aged 6–15 years in this study were lower than that of children and adolescents in seven countries: China, India, Iran, Korea, Poland, Tunisia, and USA [5]. The cause could be the differences in race, habitat and between Vietnamese children and foreign children. It confirmed the necessary to establish a blood pressure index for children in Vietnam which would be helpful for doctors in diagnostic and treatment [12]. Besides, the rate of systemic hypertension in children (10%) in our study absolutely agreed with that in the study of Salvador Fonseca-Reyes et al. (10.4%) [8]. When compared to Vietnamese adults with the prevalence of hypertension of 28.7%, this rate was lower in Vietnamese children [13]. In fact, the prevalence of hypertension increased with age. We found that the prevalence of hypertension is rising and tends to develop at an increasingly younger age. Yet further research is still needed for improving overall care for children and adolescents with hypertension. The results also showed that the sex had not statistical significant effect on pediatric hypertension. This observation was also consistent with the study performed on children of 5–14 year of age in New Delhi, India [7].Obesity was another risk factor for pediatric hypertension; the increase in systemic hypertension of obese children was also reported on several previous studies [14–17]. Despite some strengths of the present analysis, the limitation was also recorded. The study was only performed on one city located in the

southern region and the sample size was small; the blood pressure measurements didn't fully covered the representative sample of the population of Vietnamese children. For further research, a larger survey should be carried out on the pediatric hypertension situation for whole country. This should include regular health check-ups on the children with systemic hypertension to find the cause of systemic hypertension and evaluation of the relationship between obesity and systemic hypertension in children for the purpose of recommendation and prevention.

## Conclusion

The present study provided for the first time the blood pressure percentile chart of school children aged 6–15 years in Vietnam. The rate of systemic hypertension in children was 10%. The relationship between systemic hypertension and demographic characteristics of children, such as gender and obesity, were also observed. Further studies are in progress.

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### Conflict of interest

No conflict of interest was declared regarding the present article.

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