Original Article

Prevalence and Risk Factors of Hypertension in Schoolchildren from Central Thailand: A Cross-Sectional Study

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Abstract

Background: Hypertension (HTN) among children is a major health issue with mounting prevalence rates. The aim of this research is to assess the prevalence of HTN and its associated risk factors among apparently healthy schoolchildren. **Methods:** We conducted a cross-sectional study of schoolchildren in the academic year 2015 from 38 public primary schools in central Thailand for the prevalence and risk factors of HTN. Apparently healthy children aged 6-12 years were included. Informed consents were obtained before participation. Hypertension was diagnosed as per the new reference cutoff levels recommended by the American Academy of Pediatrics. **Results:** A total of 3,870 children with a median age of 9.5 years were included in the final analysis. The prevalence of obesity, overweight, and thinness among children was 15.7%, 13.6% and 5.2%, respectively. The overall prevalence of hypertension in the study population was 26.2%. HTN was significantly more prevalent in boys than girls (summary odds ratio (OR) 1.16 [95% confidence interval (CI) = 1.01-1.34]). Overweight and obesity were among the associated risk factors of HTN in the enrolled children with (OR 2.44 [95% CI 1.98-3.00]) and (OR 7.99 [95% CI 6.58-9.70]), respectively. Obese children who had central obesity were at greater risk of hypertension (OR 9.16 [95% CI 7.45-11.27]). **Conclusions:** The prevalence of HTN among Thai children is markedly high. Obesity, overweight, and male gender are considerable risk factors of HTN in children. Routine blood pressure measurement and further studies are recommended to investigate the potential risks and to lessen the associated complications.

Keywords: *Blood pressure, child, hypertension, risk*

Introduction

Hypertension (HTN) is a serious medical condition affecting both the developed and developing countries. It is considered a leading health burden causing some major mortality and morbidity rates originating from various cardiovascular diseases.[1-3] In 2013, the Global Burden of Disease deemed HTN as a major risk factor for premature deaths worldwide.[4] About one-third of the world's population has high blood pressure, and this number is increasing rapidly. By 2025, it is expected that 1.56 billion individuals will develop HTN.[5] Throughout a five-year review, a survey study in Thailand observed an increased prevalence of HTN from 21.4% to 24.7% among patients who were15 years or above.[6] HTN is a multifactorial disease and several factors are involved in its incidence including age, sex, weight, height, body mass index (BMI), positive family history, stress, and dietary habits.[7]

HTN in children is a growing health problem with an increasing prevalence rate.[8-10] Furthermore, there is a lack of disease recognition and limited solicitude owing to the lack of awareness.[11] Pediatric high blood pressure was first introduced by the National Heart Lung and Blood Institute (NHLBI) in 1977. Since then, various papers further demonstrated that adult primary hypertension originates in childhood.[12,13] Previous research studies also indicated that the unfavorable HTN complications reported in adult HTN have been also reported in children HTN. For instance, left ventricular hypertrophy and reduced cognitive function were observed as a consequence of children HTN.[14,15] In addition, a study carried out by Urbina *et al*. showed an association between pediatric elevated blood pressure and potential markers of cardiovascular diseases like thickening and stiffening of the arterial wall.[16]

Being challenging to track before six years, the recommended age for blood

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pressure assessment and screening for HTN should start at school-age children. In addition, the National Institute of Health (NIH) of the USA has recommended at least one annual assessment of blood pressure as a constituent elements of anthropometry. Furthermore, it is noteworthy that HTN screening is an essential step for appropriate condition management and early intervention reducing complication outcomes. Evidence-based information and statistics would help the policymakers and all health-care practitioners in the effective management of HTN and associated comorbidities. In view of the above, this study aimed to evaluate the prevalence of HTN and investigate its associated risk factors among apparently healthy schoolchildren in one district of central Thailand.

Methods

Study setting

We conducted a cross-sectional study among schoolchildren in the academic year 2015 from 38 public primary schools in Ongkharak district, Nakorn Nayok province, central Thailand. The study was conducted according to the Declaration of Helsinki and was approved by the ethics committee of Srinakharinwirot University. In addition, informed consents were obtained from parents or legal guardians of the involved children before participation.

Participants

Apparently healthy schoolchildren aged 6 to 12 years were invited to participate. Children with a history of chronic illnesses or congenital anomalies were excluded. We used the World Health Organization (WHO) references for body mass index (BMI) for age and gender for classifying the children into thinness (BMI < -2SD), normal weight (-2SD ≤ BMI ≤+1 SD), overweight (+1 SD < BMI ≤ +2 SD), and obesity (BMI > + 2SD).[17] Central obesity was defined as waist-to-height ratio (WTHR) greater than 0.5.[18] Blood pressure was classified into normal, elevated, stage 1 HTN and stage 2 HTN using gender-, age-, and height-specific reference values as recommended by the American Academy of Pediatrics.[19] Systolic (SBP) and/or diastolic (DBP) blood pressure were categorized to normal BP (<90th percentile), elevated BP (≥90th percentile to <95th percentile or 120/80 mmHg to <95th percentile, whichever lower), stage 1 HTN (≥95th percentile to <95th percentile +12 mm Hg or 130/80 mmHg to 139/89 mmHg, whichever lower) and stage 2 HTN (≥95th percentile +12 mmHg or ≥140/90 mm Hg, whichever lower). Children who had stage 1 or stage 2 systolic HTN with normal DBP were classified as isolated systolic hypertension (ISH), while children who had stage 1 or stage 2 diastolic HTN with normal SBP were defined as isolated diastolic hypertension (IDH). Children who had combined systolic and diastolic hypertension were defined as mixed HTN.

Procedure Demographic and anthropometric data including weight, height and waist circumference were collected by a trained staff. Weight was measured in lightweight clothing without shoes to the nearest 0.1 kg, using a digital scale (Tanita's Body Fat/Body Water Monitor Model BF-680W, Tokyo, Japan). Height was measured to the nearest 0.1 cm using a stadiometer (Seca, Model 220, Hamburg, Germany) in the standing position without shoes, and the head in Frankfurt horizontal plane. Waist circumference was evaluated in the standing position at the mid-point between the lower costal margin and the top of the iliac crest, using a non-stretch tape. BMI was assessed as the ratio of (weight/height) ^{2} (kg/m^{2}). Waist to height ratio (WTHR) was calculated as the ratio of waist circumference to height. SBP and DBP were measured using an automated oscillometric device (Omron, Model HEM-7211, Kyoto, Japan) with an appropriately-sized cuff on the right arm. Blood pressure was measured twice; within a five-minute interval in a sitting position and after at least five minutes of rest. The average of two readings of SBP and DBP was recorded as the blood pressure of the individual.

Statistical analysis

The sample size was calculated with the assumption of proportion for infinite populations. A minimum sample of 3,111 was required to detect a 25% prevalence of hypertension in schoolchildren,[20] with an allowable error margin of 2% and 99% confidence interval (99%CI).

Data analysis was performed using IBM SPSS Statistics 23.0 (IBM Crop., Armonk, NY, USA). A Kolmogorov-Smirnov test was used to assess the normal distribution of the continuous variables. Normally distributed variables were presented as means and standard deviations; whereas non-normally distributed variables were presented as median and interquartile ranges (IQR). Pearson's Chi-square or Fisher's exact test was used to compare between the groups. Student's t-test and Mann-Whitney U-test were used to verify the differences between groups of normally and non-normally distributed variables, respectively. Logistic regression was applied to determine the odds ratio and 95% confidence interval (95%CI) of the HTN risks. All P values <0.05 were considered statistically significant.

Results

A total of 4,320 subjects were originally screened for enrolment. After preliminary exclusion due to age limits, a total of 4,176 were invited to participate in the study, of which further 306 children were excluded for not meeting the inclusion criteria. Eventually, data from 3,870 children were included in the final analysis. PRISMA chart of participants' enrollment is provided in Figure 1. The median age of the study population was 9.5 years (interquartile ranges 8.0 to 11.2 years) and 50.3% of them were boys. Age was categorized into seven groups from six to twelve years old. Normal nutritional status was reported in 65.5% of the enrolled patients. Normal SBP was reported

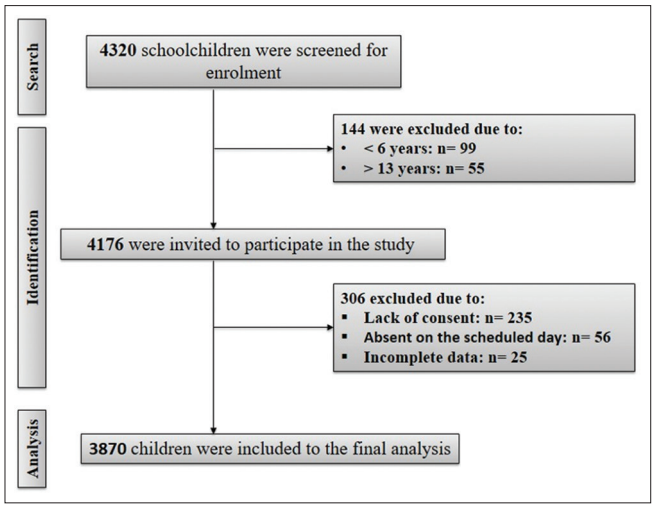

Figure 1: PRISMA flow diagram of subjects' selection and screening

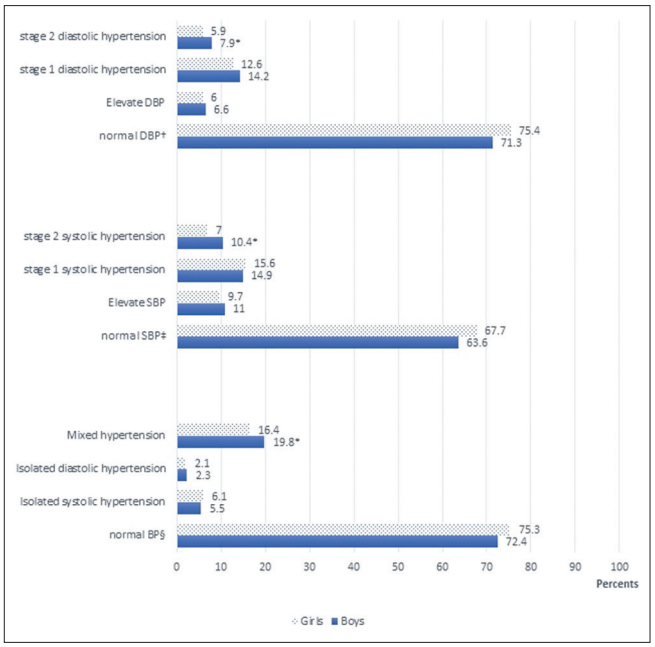

Figure 2: Comparison of blood pressure and prevalence of hypertension phenotypes between genders

in 65.7% while normal DBP was found in 73.3%. The prevalence of obesity, overweight and thinnessof the study population were 15.7%, 13.6%, and 5.2%, respectively. Overall prevalence of HTN in the study population was 26.2%. More specifically, the prevalence of ISH, IDH and mixed systolic/diastolic HTN were 5.9%, 2.2% and 18.1%, respectively. Details of SBP and DBP phenotypes were showed in Figure 2. Baseline characteristics of the study population are presented in Table 1.

HTN was significantly more prevalent in boys than those in girls (summary odds ratio (OR) 1.16 [95% confidence interval (CI) = 1.01-1.34]). Additionally, HTN was observed in 33.5% of children who were overweight and in 62.3% of obese children. Overweight and obese children had a significant greater risk of all hypertension phenotypes compared to children within normal BMI. On the other hand, underweight children tended to have a lower risk of hypertension compared to those within normal BMI, however, differences were not statistically significant. Obese children with central obesity were at greater risk of hypertension (OR 9.16 [95% CI 7.45-11.27]) than those who had no central obesity (OR 3.29 [95% CI 2.03-5.34]). The prevalence of overall hypertension, ISH and IDH according to gender, nutritional status, obesity and central obesity are presented in Table 2.

Discussion

The current study is a cross-sectional study to assess the prevalence of HTN and its associated risk factors among Thai schoolchildren. The overall prevalence of hypertension in our study reached around a quarter of the study population. The study found that male gender, overweight, obesity especially central obesity were the risk factors of HTN in Thai children, similar to the findings in children from other countries.

Previous studies have reported various rates of the prevalence of hypertension in children, ranging from 1% to 25% while in many areas the prevalence exceeding 30%.[20-24] Regarding a similar study from North India, Das *et al*. reported that the prevalence of HTN among enrolled children aged 5-10 years in was 19.7%,[22] while in a multi-center study carried out by Narang *et al*., the prevalence of HTN in Indian schoolchildren was 23%.[24] In addition, a study among Greek children reported that the prevalence HTN in obese, overweight and normal weight children were 48.3%, 29.5% and 14%, respectively; which is similar to our statistics. Kumar *et al*. hypothesized that the significant variation in prevalence rates in different reports may have been due to the assessment of blood pressure on the basis of mean and standard deviation rather than the 95th percentile of age and height.[25] In addition, the different age groups along with different methodology may have influenced the results. For instance, the multicenter study by Narang *et al*. revealed that the age, gender, socioeconomic status, and geographical location had influences on the prevalence of HTN.[24]

In our study, overweight and obese children had a significant risk of all hypertension phenotypes versus children with normal nutritional status. Several studies have reported an association between blood pressure and body weight in children. In 2017, Das *et al*. deduced that the prevalence of HTN proportionally increases with increased BMI and age. For instance, the prevalence of HTN among underweight was 14.6% while it was 20.6% among normal weight subjects.[22] In another Turkish study, the prevalence of hypertension in adolescents had a positive association with overweight (BMI between ≥85th and <95th percentile) and obesity (BMI ≥95th percentile).[26] In addition, a study conducted among preschool children showed that 19% of obese children had high blood pressure compared to

Table 1: Baseline characteristics of study population

Item	*n*=3,870 Median (IQR)
Age, years	9.5 (8.0-11.2)
Gender, *n* (%)	
Boys	1947 (50.3)
Girls	1923 (49.7)
Age group in years*, *n* (%)	
6	256 (6.6)
7	669 (17.3)
8	628 (16.2)
9	606 (15.7)
10	586 (15.1)
11	648 (16.7)
12	477 (12.3)
Weight, kg	29.3 (23.3-38.5)
Height, cm	132 (123-142)
Body mass index, kg/m^2	16.47 (14.91-19.55)
Waist circumference, cm	58.9 (54.0-67.3)
Waist to height ratio	0.45 (0.42-0.49)
Central obesity, *n* (%)	865 (22.4)
Nutritional status, *n* (%)	
Normal (-2SD ≤BMI† ≤+1 SD)	2534 (65.5)
Thinness (BMI < -2SD)	201 (5.2)
Oveweight (+1 SD<BMI ≤ +2 SD)	528 (13.6)
Obesity (BMI > +2 SD)	607 (15.7)
Systolic blood pressure, mmHg	106 (98-115)
Normal SBP‡	2541 (65.7)
Elevated SBP	402 (10.4)
Stage 1 systolic hypertension	591 (15.3)
Stage 2 systolic hypertension	336 (8.7)
Diastolic blood pressure, mmHg	65 (58-73)
Normal DBP§	2838 (73.3)
Elevated DBP	244 (6.3)
Stage 1 diastolic hypertension	520 (13.4)
Stage 2 diastolic hypertension	268 (6.9)
Hypertension, *n* (%)	
Normotension	2857 (73.8)
Isolated systolic hypertension	225 (5.9)
Isolated diastolic hypertension	86 (2.2)
Mixed systolic and diastolic hypertension	702 (18.1)

*Age: a whole of year age, e.g., 6 years=6.0-6.99 years;
†BMI=body mass index; ‡SBP=systolic blood pressure;
§DBP=diastolic blood pressure

only 7.0% of the non-obese children.[27] Furthermore, a meta-analysis study also showed that the prevalence of elevated blood pressure in obese children was six time higher than in normal weight children.[20] All of these findings indicate that obesity is a considerable risk factor of elevated blood pressure in children. Thus, obese children should receive regular screening programs of blood pressure and assessment and interventions to overcome its associated complications. Further, policymakers and educators in schools should try to promote lifestyle and dietary modifications.[28]

In our study, all the HTN phenotypes were considerably associated with obese children; however, ISH was more commonly reported. In a recently published article, ISH was the most prevalent phenotype in obese children (24.3%)[23] which was the same as finding in the present study. In addition, different studies reported that BMI is significantly associated with elevated SBP rather than elevated DBP.[29,30] In a study carried out in Canada among overweight adolescents, the prevalence of high SBP ranged from 12 to 30%, while the prevalence of high DBP was less than 1% of enrolled subjects. Moreover, in a regression analysis model, BMI was consistently associated with SBP and DBP in all age groups in both genders.[30] A recent study by Manios *et al*. reported that the prevalence of ISH was 24.3% in obese children and was 6.3% in normal weight children; whereas, the prevalence of IDH in obese and normal weight children were 4.6% and 4.3%, respectively. Moreover, they showed that children who had central obesity had greater risk of having abnormal blood pressure than normal children which is consistent with our findings in the present study.[23] However, a recent report among schoolchildren in four states in India found higher prevalence of IDH (9.4%) than ISH (7.7%) which is contrary to the present findings.[24] This conflict may be explained by the influences of socioeconomic status, geographic location and nutritional status which were found to be the associated risks of hypertension in these study.

The significance of the present study is that it represent all schools in the Ongkharak district with 38 enrolled primary schools included. In addition, the recent standard cutoff levels of HTN and HTN phenotypes were applied. However, our study also had some limitations: (1) our study has not examined multiple reported risk factors in the literature such as socioeconomic status, family history, and stress, and (2) the investigations performed were not sufficient to evaluate and investigate the complications of hypertension. Follow-up extended studies along with complication screening are highly recommended in pediatric HTN. Also, studies with a larger sample and multi-centers approach are recommended.

Conclusions

The prevalence of HTN among Thai children is higher than other nations' reports. Obesity, central obesity, overweight, and male gender are significant risk factors of high blood pressure in children. These findings further advocate the importance of earlier detection of pediatric HTN and the appropriate management protocol through surveillance programs and routine measurements.

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Nil.

Conflicts of interest

There are no conflicts of interest.

Table 2: Prevalence and risk of hypertension, isolated systolic and isolated diastolic hypertension with regard to gender and nutritional status

Variables	Normotension *n* (%)	Hypertension *n* (%)	OR (95%CI)	Isolated systolic hypertension *n* (%)	OR (95%CI)	Isolated diastolic hypertension *n* (%)	OR (95%CI)
Gender							
Girls	1,448 (75.3)	475 (24.7)	1.0	118 (7.5)	1.0	41 (2.8)	1.0
Boys	1,409 (72.4)	538 (27.6)	1.16 (1.01-1.34)	107 (7.1)	0.93 (0.71-1.22)	45 (3.1)	1.13 (0.73-1.73)
Nutritional status							
Normal	2,100 (90.2)	434 (17.1)	1.0	111 (5.0)	1.0	44 (2.1)	1.0
Thinness	177 (88.1)	24 (11.9)	0.66 (0.42-1.02)	3 (1.7)	0.32 (0.10-1.02)	2 (1.1)	0.54 (0.13-2.24)
Overweight	351 (66.5)	177 (33.5)	2.44 (1.98-3.00)	38 (9.8)	2.05 (1.39-3.01)	12 (3.3)	1.63 (0.85-3.12)
Obesity	229 (37.7)	378 (62.3)	7.99 (6.58-9.70)	73 (24.2)	6.03 (4.36-8.35)	28 (10.9)	5.83 (3.56-9.56)
Central obesity							
Absent	2,442 (81.3)	563 (18.7)	1.0	139 (5.4)	1.0	53 (2.1)	1.0
Present	415 (48.0)	450 (52.0)	4.70 (4.00-5.53)	86 (87.2)	3.64 (2.73-4.86)	33 (7.4)	3.66 (2.34-5.73)
Obesity and central obesity							
Normal	2,012 (83.0)	412 (17.0)	1.0	109 (5.1)	1.0	42 (2.0)	1.0
Obesity with central obesity	186 (34.8)	349 (65.2)	9.16 (7.45-11.27)	66 (26.2)	6.55 (4.66-9.21)	27 (12.7)	6.95 (4.19-11.54)
Obesity without central obesity	43 (59.7)	29 (40.3)	3.29 (2.03-5.34)	7 (14.0)	3.01 (1.32-6.84)	1 (2.3)	1.11 (0.15-8.28)

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