JRHS
Journal of Research in Health Sciences
journal homepage: www.umsha.ac.ir/jrhs

Original article

Association of Obesity with the Prevalence of Hypertension in School Children from Central Thailand

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ARTICLE INFORMATION

Article history:
Received: *20 September 2014*
Revised: *30 November 2014*
Accepted: *16 December 2014*
Available online: *27 December 2014*

Keywords:
Child
Obesity
Overweight
Underweight
Hypertension

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ABSTRACT

Background: Obesity and underweight are both a public health concern worldwide. Being overweight and obesity are primary risk factors for the development of chronic conditions including hypertension. Data on obesity and the underweight as well as their association with hypertension in Thai children, specifically, are scant. This study was aimed to assess the relationship between obesity or underweight status and hypertension in Thai school children.

Methods: Anthropometric data were collected from 3991 students (mean age of 9.5 yr) in Ongkharak district, central Thailand. The sex as well as the age-specific BMI criteria of the WHO were used to define what is overweight, obesity, underweight and severe underweight status of children. In order to calculate the odds ratio and the association between one's nutritional status and hypertension logistic regression was used.

Results: Obese and overweight children have a higher prevalence of hypertension compared with children with an average weight (49.5% and 26.5% versus 16.2%, respectively). The risks of developing hypertension are also higher in obese children (OR 5.15; 95%CI: 4.27, 6.22), overweight children (1.87; 95% CI: 1.50, 2.32) and overweight/obese children (OR 3.30; 95% CI: 2.82, 3.86. Additionally, underweight children were not associated with an increased risk of hypertension (OR 1.04; 95% CI: 0.72, 1.42).

Conclusions: Rates of hypertension in overweight and obese children are high in central Thailand and, as a result, this increased body weight is a risk factor for hypertension. Larger, multicentric studies are required to evaluate the correlation between hypertension and obesity amongst children at the national level.

Citation: Rerksuppaphol S, Rerksuppaphol L. Association of Obesity with the Prevalence of Hypertension in School Children from Central Thailand. J Res Health Sci. 2015; 15(1): 17-21.

Introduction

Worldwide the problem of obesity has increased, and its prevalence is reached epidemic over the recent year[1-3]. Long term chronic conditions, including hypertension, type 2 diabetes mellitus, metabolic syndrome and dyslipidemia, sleep apnea, gall bladder disease, social and psychological consequences, osteoarthritis, certain forms of cancer, and additionally respiratory and skin problems are a risk for children who are obese or overweight[4-7]. An increased likelihood of adult obesity is directly related to childhood[8,9]. Obesity in school children is influenced by a number of factors such as society, economic conditions and environmental changes along with the eating habits and child rearing practices in the family[10].

According to a number of studies performed over the last 50 years, the prevalence of obese children between the ages of 6 and 11 years old has doubled since the 1960s. The 1999-2002 National Health and Nutrition Examination Survey (NHANES) indicated that of Thai children between the ages of 6 to 11 years old 15.3% of them were overweight[11]. In Thailand, a 1992-1994 nutritional survey of Bangkok primary schools with 2,885 student respondents indicated that obesity increased from 25.9% to 31.5% in its prevalence at Thailand's demonstration schools, additionally there was an increase of 2.4% seen in private schools from 25.7% to 28.1%. Moreover, there was an increase from 11.2% to 14.6% in Bangkok Metropolitan schools and 23.3% to 27.4% in government schools [12]. Obesity and increased body weight have been associated with increased rates of hypertension. However, data on obesity/overweight status and its association with hypertension in Thai children are scant.

In this study, we evaluated the relationship between the prevalence of obesity, overweight and underweight children with the risk of the development of hypertension in children from the central Thailand.

Methods

This cross-sectional study was conducted in schoolchildren studying in grades 1-6 of public elementary schools in the Ongkharak district in central Thailand during May to June

2013. Ongkharak district, with a population of 61,236 (December 2012), has 38 elemental schools. At the time of this study, Ongkharrak district had a total enrollment of 4,219 children[13]. Children with a previously known history of chronic illnesses such as chronic respiratory diseases, chronic renal diseases, chronic liver diseases, diabetes mellitus and congenital heart diseases or children with significant physical deformities were not included in the study. Data from children who were unavailable for examination on a designated date or were not available for a complete anthropometric examination and blood pressure measurements were excluded from the analysis. Written informed consent was obtained from children's guardians before enrollment to the study.

The study was approved by the Ethics Committee of the Faculty of Medicine, Srinakharinwirot University, Thailand.

Anthropometric measurements

Demographic data and anthropometric measurements were conducted by trained staff. Weight of the subjects was measured in light weight clothing to the nearest 0.1kg using a digital scale (Tanita body composition analyzer, Model BF-680W, Tokyo, Japan). Height was measured without shoes to the nearest millimeter using a height rod (Seca, Model 220, Hamburg, Germany). Waist circumference (WC) was measured at the midpoint between the lower costal margin and the top of the iliac crest in a standing position using a non-stretch tape. Body mass index (BMI) was calculated as the ratio of weight (kg) to square of height (m). Waist to height ratio (WHTR) was calculated as the ratio of waist circumference (cm) to height (cm). Blood pressure (BP) was measured in a sitting position, and the children were rested for at least 5 minutes before the measurement. Systolic blood pressure (SBP) and diastolic blood pressure (DBP) were measured using an automated oscillometric measurement device (Omron, Model HEM-7211, Kyoto, Japan) with a proper cuff size on the left arm. Blood pressure was obtained twice at 1-minute interval, and the average of two readings was used to represent SBP and DBP, respectively.

Sex- and age-specific BMI criteria of WHO were used to define overweight (≥1 SD), obesity (≥2 SD), underweight (≤2 SD) and severe underweight (≤3 SD)[14]. Abdominal obesity was defined as: a) waist circumference equal to or greater than sex-and age-specific cutoffs[15] or b) WHTR >0.5[16]. Children were classified as hypertensive if the average SBP and/ or DBP was equal to or higher than 95th percentile as defined for the particular sex, age and height of the child[17]. Children were classified as pre-hypertensive if the average SBP and/ or DBP levels were equal to or greater than 90th percentile but lower than 95th percentile for sex, age, and height specific standards[17].

Statistical analysis

Demographic characteristics and anthropometric data were descriptively presented as mean, standard deviation and percent separately, depending on the gender. We used the Chi-square test in an effort to compare differences between the nutritional status and hypertension. Student's *t*-test was used to verify the differences between groups. Logistic regression was used to determine the odds ratio (OR) and 95% confidence interval (95%CI) of nutritional status for the risk of hypertension. Statistical analysis was performed using SPSS 17.0 software package (SPSS Inc., Chicago, IL, USA). A *P* value <0.05 was considered as statistically significant.

Results

All 4,219 schoolchildren from the public elementary schools of Ongkharak district were invited to participate in the study. Overall, 218 children were excluded from the study due to the following reasons: lack of informed consent (115), missing the data measurement schedule (93) or moved out from the schools (10). Of the rest 4001 schoolchildren participating in the study, data from 10 children were excluded from the analysis because of incomplete blood pressure measurements. Data from 3,991 students was used in the final analysis.

Demographic characteristics and anthropometric data are presented in Table 1. Mean age of the study population was 9.5 yr (SD. 1.9, range 4.4 to 16.6 yr), and 49.7% of children were girls. There were no significant differences in weight, age, height, WC and WHTR between sexes. However, boys had a significantly higher BMI, SBP and DBP when compared to the girls. Overall rate of severe underweight, underweight, overweight and obesity was 1.2%, 4.0%, 13.8% and 15.5%, respectively. We also saw no significant differences in the prevalence of underweight, severe underweight and overweight between sexes, however, the prevalence of obesity was significantly higher in boys than in girls (18.5% vs. 12.5%, *P*<0.001).

Abdominal obesity was diagnosed in 22.3% children (892/3991) as classified by WHTR and 22.3% of the children (891/3991), when classified according to the criteria of WC. Additionally, there were no significant differences in the prevalence of abdominal obesity between sexes when using each measure separately. However, by using either WTHR or WC criteria, the overall prevalence of abdominal obesity was 25.6% with the higher prevalence in girls than in boys (27.1% and 24.2%, respectively; *P*=0.035). Totally, 448 children (11.2%) had elevated SBP, and 712 children (17.8%) had elevated DBP. Overall, 912 children (21.4%) were classified as hypertensive of which, boys had a significantly higher prevalence of hypertension than girls did (24.3% and 21.4%, respectively; *P*=0.001).

Prevalence of hypertension in schoolchildren and its risk by gender, BMI classification, and abdominal obesity status are shown in Table 2. There was a higher prevalence of hypertension in children who were either obese or overweight when compared to the children with normal weight (49.5% and 26.5% versus 16.2%, respectively). Obese children were at a highest risk of having hypertension (OR 5.15; 95% CI: 4.27, 6.22) in comparison with overweight children (1.87; 95% CI: 1.50, 2.32) and overweight/obese children (OR 3.30; 95% CI: 2.82, 3.86) than in children with normal weight. Underweight children did not pose an increased risk of hypertension in comparison to the children with an average weight (OR 1.04; 95% CI: 0.72, 1.42). Children with abdominal obesity, defined by either WHTR or WC were also at a greater risk of having hypertension when compared to children with no abdominal obesity (OR 3.61; 95% CI: 3.08, 4.22). Children, who were classified both, as obese and with abdominal obesity were also at a greater risk of hypertension (OR 5.32; 95% CI: 4.40, 6.42) than children with an average weight. Overweight or obese children with abdominal obesity were at greater risk of developing hypertension (OR 4.08; 95% CI: 3.47, 4.81) in comparison with normal weight children. We did not find a statistically significant association with regards to hypertension and underweight children.

Table 1: Age, anthropometric data and blood pressure by sex of Thai school children

Variables	Boys n=2008	Girls n=1983	*P* value
Age (years), mean (SD)	9.6 (1.9)	9.5 (1.9)	0.500
Weight (kg), mean (SD)	32.4 (12.8)	32.2 (12.5)	0.605
Height (cm), mean (SD)	132.2 (12.2)	132.8 (13.7)	0.165
Body mass index (kg/m^2), mean (SD)	18.0 (4.4)	17.7 (4.4)	0.044
Waist circumference (cm), mean (SD)	61.6 (11.8)	61.7 (11.1)	0.761
Waist to height ratio, mean (SD)	0.47 (0.07)	0.46 (0.06)	0.641
Systolic blood pressure (mmHg), mean (SD)	109.7 (15.9)	107.9 (14.8)	0.001
Diastolic blood pressure (mmHg), mean (SD)	67.0 (13.1)	66.0 (12.2)	0.017
Body mass index (kg/m^2), n (%)			0.001
Severe underweight (≤-3 SD)	26 (1.3)	23 (1.2)	0.774
Underweight (≤-2 SD)	85 (4.2)	75 (3.8)	0.519
Normal (-2SD< BMI <+1SD)	1,248 (62.2)	1.363 (68.7)	0.001
Overweight (≥+1 SD)	277 (13.8)	274 (13.8)	1.000
Obesity (≥+2 SD)	372 (18.5)	248 (12.5)	0.001
Abdominal obesity, n (%)			
Waist to height ratio >0.5	446 (22.2)	446 (22.5)	0.849
Waist circumference ≥ sex-and age-specific cutoff	429 (21.4)	462 (23.3)	0.149
Waist to height ratio or waist circumference > cutoff	485 (24.2)	537 (27.1)	0.035
Systolic blood pressure;SBP (mmHg), n (%)			0.001
Normal (SBP <90th percentile)	1688 (84.1)	1744 (87.9)	0.001
Prehypertension (90th percentile≤ SBP <95th percentile)	58 (2.9)	53 (2.7)	0.701
Hypertension (SBP ≥95th percentile)	262 (13.0)	186 (9.4)	0.001
Diastolic blood pressure; DBP (mmHg), n (%)			0.466
Normal (DBP <90th percentile)	1458 (72.6)	1474 (74.3)	0.223
Prehypertension (90th percentile≤ DBP <95th percentile)	181 (9.0)	161 (8.4)	0.500
Hypertension (DBP ≥95th percentile)	369 (18.4)	343 (17.3)	0.385
Hypertension[a], n (%)	487 (24.3)	425 (21.4)	0.035

[a] Systolic and/or diastolic blood pressure ≥95th percentile for sex, age, and height specific standards

Table 2: Prevalence and odds ratio (OR) of hypertension in school children by gender, body mass index classification, and abdominal obesity status

Variables	Total	Hypertension n (%)	OR (95% CI)	*P* value
Gender				
Girls	1983	425 (21.4)	1.00	
Boys	2008	487 (24.3)	1.17 (1.01, 1.36)	0.034
BMI classification (kg/m^2)				
Normal (-2SD≤ BMI ≤+1SD)	2611	457 (16.2)	1.00	
Overweight (+1SD <BMI ≤+2SD)	551	146 (26.5)	1.87 (1.50, 2.32)	0.001
Obesity (BMI> +2SD)	620	309 (49.5)	5.15 (4.27, 6.22)	0.001
Overweight/obesity (BMI >+1SD)	1,171	445 (38.9)	3.30 (2.82, 3.86)	0.001
Underweight (BMI< -2SD)	209	35 (16.7)	1.04 (0.72, 1.52)	0.826
Waist to height ratio; WHTR				
Normal (≤0.5)	3099	534 (17.2)	1.00	
Abdominal obesity (>0.5)	892	378 (42.4)	3.53 (3.00, 4.16)	0.001
Waist circumference; WC				
Normal (WC <sex- and age-specific cutoffs)	3100	518 (16.7)	1.00	
Abdominal obesity (WC ≥sex- and age-specific cutoffs)	891	394 (44.2)	3.95 (3.36, 4.65)	0.001
Abdominal obesity				
Normal (WHTR ≤0.5 and WC <sex- and age-specific cutoffs)	2969	488 (16.4)	1.00	
Waist to height ratio or waist circumference greater than cutoff	1022	424 (41.5)	3.61 (3.08, 4.22)	0.001
Obesity with abdominal obesity				
Non obese and normal waist to height ratio	3412	613 (18.0)	1.00	
Waist to height ratio >0.5	579	299 (51.6)	5.28 (4.36, 6.39	0.001
Waist circumference ≥ sex-and age-specific cutoff	547	287 (52.5)	5.52 (4.56, 6.67)	0.001
Waist to height ratio or waist circumference greater than cutoff	559	295 (52.8)	5.32 (4.40, 6.42)	0.001
Overweight/ obesity with abdominal obesity				
Non overweight/obesity and normal waist to height ratio	3218	558 (17.3)	1.00	
Waist to height ratio >0.5	773	354 (45.8)	4.04 (3.41, 4.78)	0.001
Waist circumference ≥ sex-and age-specific cutoff	784	370 (47.2)	4.41 (3.73, 5.22)	0.001
Waist to height ratio or waist circumference greater than cutoff	852	384 (45.1)	4.08 (3.47, 4.81)	0.001

Discussion

In this cross-sectional school-based study, we found a high prevalence of overweight (13.8%) and obesity (15.5%) in schoolchildren from a single district in central Thailand as defined by the WHO standards, classified as a BMI ≥1 SD and BMI ≥2 SD respectively. More importantly, we observed that there was an increase in the number of overweight or obese children from our previous study from the year 2007, where the prevalence of overweight and obesity were 12.8% and 9.4% respectively, as defined by the IOTF standards[18].

This trend of increased prevalence of overweight and obesity in children has been reported in several other studies conducted worldwide. A study carried out among children in Greece detected that there was a higher potential, which amounted to 42.1% in boys and 39.8% of girls, for them to be either overweight or obese[19]. Higher obesity and overweight prevalence in children has been reported in Yemen[20] (12.7% and 8.0% respectively), China[21] (11.5% and 10.3% respectively), Spain[22] (18.8% and 10.3% respectively) and the United States[23] (16.0% and 18.0% respectively).

We also found an increased prevalence of obesity, ranging from 22.3% for WTHR and WC criteria taken separately to 25.6% when the cutoff values for WTHR and WC were considered together. Moreover, a high prevalence of hypertension (22.9%) in Thai children was also observed. Additionally, significant differences in gender were observed with a higher number of boys found to be obese in comparison with the number of girls (18.5% vs. 12.5% respectively). This association of male gender and obesity has been previously reported by Kovalskys et al.[24] in Argentina. The risk of hypertension was also positively correlated with being overweight (OR 1.87); obesity (OR 5.15) and overweight/obese (OR 3.30).These findings in our study are concordant with the numerous previous studies. Dong et al.[25] have reported an odds ratio for the risk of hypertension as 4.1 for obese boys and 4.0 for obese girls in a Chinese national survey. Lu et al.[26] have found an association between increased risk of hypertension and abdominal obesity/ obesity with an odds ratio of 4.66 in Chinese children from Shanghai. The findings of these studies are in line with our conclusions and a comparable odds ratio of 4.41 in overweight/obese children with abdominal obesity.

Apart from a clear increase in risk of developing hypertension in obese and overweight children as defined by the BMI, we also found that increased abdominal circumference in combination with being overweight or obese further increased the odds of developing hypertension. Waist circumference and WTHR are valuable tools for determining the obesity in children and should be routinely included in the physical examination of children during health checkups. Hypertension in children has become an emerging epidemic problem worldwide, including Asian children[27]. It is responsible for cardiovascular disease, a leading cause of morbidity and mortality among non-communicable diseases, which can start early in childhood. Numerous potential pathogenesis of hypertension in obese patients had been proposed previously[28,29]. Imbalance of adipokines, immune-modulatory proteins secreted from adipose tissue, is recently thought to be a key in the pathogenesis[29]. Visceral adipose tissue, directly associated with waist circumference and WHTR is a primary source of several adipokines including pro-inflammatory adipokines[30,31]. Obese patients especially with signs of abdominal (truncal) obesity have imbalances in the expression of adipokines and increased levels of pro-inflammatory adipokines but decreased anti-inflammatory adipokines. This can result in the development of chronic, low-grade inflammatory state, which can lead to metabolic dysfunction and cardiovascular diseases[28-31].

We did not find any increased risk of hypertension amongst children associated with underweight, in comparison to the children with a normal weight. Although there have not been many studies on the association of hypertension with underweight, two available studies have contradictory findings. Zhang et al.[32] found no additional risk of hypertension associated with underweight in a study amongst children and adolescents in South China, as in our study. However, Genovesi and colleagues[33] found a higher prevalence of hypertension in Indian children with normal and underweight children aged between 5-12 years, although the numbers of hypertensive children were significantly higher for overweight children.

Although the exact etiology of hypertension in obesity has yet to be unraveled in this study, an increased heart rate and blood pressure variability in obese children with isolated systolic hypertension suggested an increased activity of the sympathetic nervous system. This study also confirms a greater prevalence of systolic hypertension than prevalence of diastolic hypertension in overweight and obese children. This association of systolic blood pressure with the body weight has been previously described by Song in a Korean survey[34]. We also observed that the male gender displayed significantly higher rates of systolic hypertension than the female sex (13% vs. 9.4%) and the rates of hypertension in boys was significantly greater than in girls (24.3% vs. 21.4%) and boys were at a higher risk of hypertension than the girls (OR 1,17; *P*=0.034).

A key advantage of our study is that it is a follow-up cross-sectional study in the same Thai district and shows a trend in obesity in the same socioeconomic region of Thailand. Since Thailand has a relatively homogeneous Thai or Thai-Chinese ethnicity, the study excludes differences in results associated with a heterogeneous population sample. Moreover, one of the main limitations of this study is due the data being limited to cross-sectional samples of schoolchildren from a single district of Thailand. Apart from that, the measurements of blood pressure were performed on a single visit, and an average of two measurements was reported. A failure to measure the blood pressure in the children with elevated blood pressure on at least three separate occasions before diagnosing hypertension may not represent the real numbers of hypertensive children. Measuring blood pressure at multiple time points is known to cause a reduction in anxiety, thereby avoiding false positives. In this study, we aimed at the detection of hypertension and not a diagnosis, and this was at best achieved by measuring blood pressure twice on a single occasion.

Conclusions

This study indicates a high prevalence of obesity and hypertension among school-aged children in the central Thailand district of Ongkharak. Thai obese children are at an increased risk of developing hypertension, as has been reported from studies in other countries. Our data from this study serves as an extension of the results of a previous study in the same district in the year 2007 and could serve as a basis for examining the trends in the future. This study also calls for an urgent need to design preventive interventions for a middle-income country like Thailand, which is within a realm of a nutritional transition.

Acknowledgements

The authors would like to thank Ms. Kulwadee Roblou for her support of the study.

Conflict of interest statement

The authors have declared that no conflict of interest has occurred.

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