

Prevalence of Elevated Blood Pressure Among First Grade Students in Elementary School in Taipei

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Background/Purpose. To evaluate the prevalence of elevated blood pressure (BP) and the associated anthropometric factors among first-grade elementary school students in Taipei county.

Methods. We measured height, weight, neck circumference (NC), waist circumference (WC), and blood pressure (BP) in 2344 first-grade children who were undergoing a regular health examination at 6 elementary schools in Taipei County in 2007.

Results. The overall prevalence of elevated BP was 19.0%. The prevalence of elevated BP was significantly higher in boys (21.1%) than in girls (15.7%) ($p = 0.0002$). Compared with the reference group, children with high NC (41.9% vs 17.5%, $p < 0.0001$) or high WC (45.9% vs 17.4%, $p < 0.0001$) had a higher prevalence of elevated BP. The prevalence of elevated BP was higher in obese children than in children with normal weight (37.6% vs 15.8%, $p < 0.0001$). In the multivariate logistic regression, boys had a higher risk of elevated BP than girls (OR = 1.41, 95% CI = 1.13-1.75). The OR for elevated BP in children with high WC was higher than that in children with normal WC (OR = 1.99, 95% CI = 1.18-3.37). Obese children (OR = 1.83, 95% CI = 1.14-2.92) and overweight children (OR = 1.99, 95% CI = 1.48-2.68) had a higher risk of elevated BP than children with normal weight.

Conclusion. This study found that overweight and obesity are associated with elevated BP. We suggest that BP measurements should be included in regular health examinations among children. (Mid Taiwan J Med 2008;13:130-5)

Key words

blood pressure, overweight, school children, Taipei

INTRODUCTION

Stroke and heart disease are the second and the third leading causes of death in Taiwan, respectively. Hypertension is an important risk factor for both of them [1]. Hypertension is a common disease in middle-aged and older people

and the prevalence increases as age increases. It is estimated that 60% of US adults have prehypertension or hypertension [2,3].

Obesity is strongly associated with hypertension in all age groups [4-6]. Hypertension is rare in children and adolescents. However, with the increasing prevalence of childhood obesity, many studies have suggested that the growing obesity epidemic may be responsible for an unexpected increase in the

Received : 1 February 2008.

Revised : 14 April 2008.

Accepted : 14 July 2008.

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number of children with hypertension [7-11]. The disease frequently goes undiagnosed in the pediatric population [12]. Surprisingly, a previous study found that the effect of being overweight on blood pressure was present in childhood and could be detected even in children as young as two years of age [11]. Childhood hypertension is associated with adulthood hypertension and chronic disease. Therefore, early detection and prevention of childhood hypertension has been advocated in many studies [4,8,13-17].

The prevalence of childhood obesity was reported to be 14.8% in Taiwan in 1996. However, the current childhood hypertension situation is unknown [18]. In this study, we evaluate the prevalence of elevated blood pressure and its related anthropometric factors among school children in Taipei.

MATERIALS AND METHODS

We conducted health examinations among first-grade school children aged 7 years at 6 public elementary schools in Taipei county, Taiwan. The health examination included height, weight, neck circumference (NC), waist circumference (WC), and blood pressure (BP) measurements, oral check-up, vision test and some regular internal examinations. The number of school children in the first grade in school A, school B, school C, school D, school E, and school F was 329, 642, 300, 368, 634, and 174, respectively. The anthropometric measurements were taken by 6 physicians, 2 dentists, 9 nurses, and 3 research assistants. A total of 103 children were excluded from analysis because their values were considered to be incorrect due to data entry error and/or lack of insurance information.

We used weight (kg) divided by the square of height (m^2) to calculate the body mass index (BMI). Elevated BP was defined as an average systolic blood pressure (SBP) or diastolic blood pressure (DBP) greater than or equal to the gender, age, and height-percentile-specific 95th percentile blood pressure value according to the criteria of the National High Blood Pressure Education Program Working Group

on Hypertension Control in Children and Adolescents [19]. According to the suggestions from the Chinese Taipei Association for the Study of Obesity, the prevalence rates of high NC (≥ 95 th percentile), high WC (≥ 95 th percentile), overweight (Boys: BMI $\geq 18.6 \text{ kg/m}^2$; Girls: BMI $\geq 18.0 \text{ kg/m}^2$), and obesity (Boys: BMI $\geq 21.2 \text{ kg/m}^2$; Girls: BMI $\geq 20.3 \text{ kg/m}^2$) were also determined.

Chi-square tests were used to compare sex, NC, WC, and BMI distributions between children with normal BP and children with elevated BP. We used Pearson's correlation coefficients to investigate the correlations among blood pressure, NC, WC, and BMI. The odds ratios (ORs) and corresponding 95% confidence intervals (CIs) were calculated using univariate and multivariate logistic regression analyses. All analyses were performed with SAS software, version 8.0 (SAS Institute Inc., Carey, NC). Two-sided probability value < 0.05 was considered statistically significant.

RESULTS

Overall, there were 2344 school children who received examinations and had reliable data. The prevalence of elevated BP was 19.0% (Table 1). Boys had a higher prevalence of elevated BP than girls (22.1% vs 15.7%, $p = 0.0002$). The prevalence of elevated BP was higher among children with high NC than among children with normal NC (41.9% vs 17.5%, $p < 0.0001$). The prevalence of elevated BP was higher among children with high WC than among those with normal WC (45.9% vs 17.4%, $p < 0.0001$). The prevalence of elevated BP was higher among obese children than among children with normal weight (37.6% vs 15.8%, $p < 0.0001$).

SBP was correlated with BMI ($r = 0.285$, $p < 0.0001$), NC ($r = 0.329$, $p < 0.0001$), and WC ($r = 0.355$, $p < 0.0001$). Significant correlations were also found among DBP, BMI, NC, and WC (Table 2).

The crude and adjusted odds ratios (OR) and 95% confidence intervals (CI) for the associations between elevated BP and

anthropometrics are shown in Table 3. In the multivariate logistic regression, boys were at higher risk for elevated BP than girls (OR = 1.41, 95% CI = 1.13-1.75). Children with high WC were at higher risk for elevated BP than children with normal WC (OR = 1.99, 95% CI = 1.18-3.37). Obese children (OR = 1.83, 95% CI = 1.14-

2.92) and overweight children (OR = 1.99, 95% CI = 1.48-2.68) were at higher risk for elevated BP than children with normal weight.

DISCUSSION

The prevalence of elevated BP varies with age, sex, ethnicity and the blood pressure criteria

Table 1. Relationship between elevated blood pressure and anthropometrics

	Normal BP N = 1898 (81%)	Elevated BP N = 446 (19%)	<i>p</i>
Sex	n (%)	n (%)	0.0002
Girl	948 (84.3)	176 (15.7)	
Boy	950 (77.9)	270 (22.1)	
Neck circumference			< 0.0001
< 95 percentile	1812 (82.5)	384 (17.5)	
≥ 95 percentile	86 (58.1)	62 (41.9)	
Waist circumference			< 0.0001
< 95 percentile	1825 (82.6)	384 (17.4)	
≥ 95 percentile	73 (54.1)	62 (45.9)	
Body mass index			< 0.0001
Normal weight	1592 (84.2)	298 (15.8)	
Overweight	203 (70.2)	86 (29.8)	
Obesity	103 (62.4)	62 (37.6)	

BP = blood pressure.

Table 2. Pearson's correlation coefficient between blood pressure and anthropometrics

	SBP	DBP	BMI	NC	WC
SBP	1				
DBP	0.686*	1			
BMI	0.285*	0.197*	1		
NC	0.329*	0.245*	0.748*	1	
WC	0.355*	0.286*	0.799*	0.759*	1

**p* < 0.0001. SBP = systolic blood pressure; DBP = diastolic blood pressure; BMI = body mass index; NC = neck circumference; WC = waist circumference.

Table 3. Risk of elevated blood pressure and associated factors in logistic regressions

	Univariate OR (95% CI)	Multivariate OR (95% CI)
Sex		
Girl	Reference	Reference
Boy	1.53 (1.24-1.89)*	1.41 (1.13-1.75)*
Neck circumference		
< 95 percentile	Reference	Reference
≥ 95 percentile	3.40 (2.41-4.80)*	1.27 (0.79-2.06)
Waist circumference		
< 95 percentile	Reference	Reference
≥ 95 percentile	4.04 (2.83-5.76)*	1.99 (1.18-3.37)*
Body mass index		
Normal weight	Reference	Reference
Overweight	2.26 (1.71-3.00)*	1.99 (1.48-2.68)*
Obesity	3.22 (2.29-4.51)*	1.83 (1.14-2.92)*

**p* < 0.001.

[3-5,12,19,25]. In this study, the prevalence of elevated BP among children aged 7 years was 19%, which was relatively high compared with the reported prevalence of 9.4% among children in Brazil aged 7-17 years [20]. However, it was relatively low compared with the reported prevalence of 21% among children aged 8-13 years in the US state of Texas [6].

It is well known that men are at higher risk for hypertension than women [3]. A gender difference in elevated BP has also been found in children and adolescents. Among children aged 6-11 years in Italy, the overall prevalence of elevated BP was significantly higher in girls than in boys (5.4% vs 3.1%, $p = 0.005$) [17]. Among children aged 10-19 years in the US state of Houston, the risk for hypertension was significantly higher in boys than in girls (OR = 1.50, 95% CI = 1.15-1.95) [5]. In the US state of Delaware, the mean SBP and the mean DBP were slightly lower in girls than in boys [11]. In this study, we found that boys had a higher risk for elevated BP than girls (OR = 1.41, 95% CI = 1.13-1.75). These inconsistent findings may be due to the diverse sample sizes and sampling methods in the various studies.

The severity of childhood obesity and its effects on elevated BP have attracted much attention, particularly in North America and in Europe [4-6,11,14-18,20-22]. Among children aged 6-11 years in Italy, the prevalence of elevated BP was higher in overweight children than in normal-weight children (10.8% vs 2.6%, $p < 0.0001$) [17]. Among children aged 5-19 years in Canada, obese and overweight children had higher blood pressure values than children of normal weight [15]. Among sixth-grade elementary school students in Switzerland, the odds ratio of obesity associated with elevated BP was 16.2 (95% CI = 9.1-28.9) [4]. Among children aged 5-17 years in India, the prevalence of elevated BP in obese children and normal-weight children was 3.5% and 0.23%, respectively [22]. Elevated BP was significantly more frequent among overweight students than among normal-weight students [20]. These studies indicate that overweight and obesity may

be associated with elevated blood pressure in children [15,21].

Although it has been suggested that longitudinal change in BMI is a better predictor of BP than change in WC in childhood, the cross-sectional measurement of BMI and WC are very similar predictors of BP [14]. In this study, we found that children with high WC values had a higher risk for elevated BP than children with normal WC. Therefore, we recommend that children who are overweight or obese be enrolled in a weight-reduction program.

In this study, we failed to find an association between high NC values and elevated BP. It has been suggested that measuring NC is a simple and time-saving screening method of identifying overweight and obese adults [23]. Among Finnish adults, the prevalence of hypertension increased as the NC quintiles increased. Among Israeli adults it was found that higher NC values positively correlated with the factors of metabolic syndrome and that higher values were associated with increased risk for coronary heart disease [24].

Ethnicity, socio-economic status, eating and lifestyle habits, and blood profiles have been reported to be factors associated with elevated BP [13,25]. However, due to the limited time to conduct each physical examination, we were unable to gather information such as sociodemographic factors, lifestyle, and blood profiles. It has been reported that at least 3 occasional screenings for hypertension are necessary to identify hypertensive status in children [5]. We believe that if three screenings had been carried out in this study, we would have found a stronger association between overweight and elevated BP. A diagnosis of hypertension should be based on at least 3 blood pressure measurements [5,19]. In this study, blood pressure was measured only one time; therefore, the prevalence of childhood hypertension might be over-estimated.

Studies have suggested that intervention is needed to prevent excessive weight gain and obesity in children and adolescents. Weight control is necessary to curb the global

hypertension burden [4,15]. The association between overweight and elevated BP in this study was significant. We emphasize the need for prevention of elevated BP in children. Furthermore, regular blood pressure measurements should be included in health examinations among school children in Taiwan.

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台北國小一年級學童高血壓盛行率

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背景/目的 本文報導台北國小一年級學童高血壓盛行率及其人體測量學的相關因子。

方法 在2007年，我們利用台北縣五所國小一年級學生入學例行性身體檢查時，量測身高、體重、頸圍、腰圍及血壓。

結果 總共有2,344位合適的學童參與了這項研究，高血壓的盛行率高達19.0%。與女孩相較，男孩有較高的高血壓盛行率(22.1% *vs* 15.7%， $p = 0.0002$)。相較於參考組，頸圍過大(41.9% *vs* 17.5%， $p < 0.0001$)或腰圍過大(45.9% *vs* 17.4%， $p < 0.0001$)的兒童，他們的高血壓盛行率較高。肥胖小孩高血壓盛行率較體重正常小孩高(37.6% *vs* 15.8%， $p < 0.0001$)。在多變項羅吉斯迴歸中，男孩較女孩有較高的高血壓危險(OR = 1.41，95% CI = 1.13-1.75)。腰圍過大兒童的高血壓危險較腰圍正常兒童高(OR = 1.99，95% CI = 1.18-3.37)。相較於體重正常的小孩，肥胖小孩(OR = 1.83，95% CI = 1.14-2.92)及體重過重小孩(OR = 1.99，95% CI = 1.48-2.68)的高血壓危險較高。

結論 本研究發現體重過重或肥胖與兒童高血壓有關。建議應將血壓量測納入兒童例行性的身體檢查。(中台灣醫誌 2008;13:130-5)

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收文日期：2008年2月1日

修改日期：2008年4月14日

接受日期：2008年7月14日

