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ORIGINAL ARTICLE

# Waist Circumference as a Predictor of Pediatric Hypertension Among Normal-Weight Taiwanese Children

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*Background:* Although the association between increased waist circumference (WC) and hypertension has been established in adults, it has not been thoroughly studied in Asian children. The present study investigates the association between WC and hypertension risk in normal-weight children and subsequently examines the ability of WC to effectively predict hypertension in 7-year-old Taiwanese children.
*Design:* The body height, weight, neck circumference, WC, and blood pressure (BP) data of 2253 of 7-year-old elementary school children ($1^{st}$ grade) were collected.
*Methods:* BP was measured twice, and prehypertension and hypertension were defined as mean systolic and/or diastolic BP greater than or equal to $90^{th}$ or $95^{th}$ percentile, respectively, according to sex, age, and height (as defined by standard U.S. BP tables).
*Results:* The prevalence of prehypertension and hypertension across all subjects was 10.47% and 18.11%, respectively. The gender-adjusted odds ratio [95% confidence interval (CI)] of hypertension associated with a 1-standard deviation higher level of WC was 2.13 (95% CI: 1.75–2.59) for normal-weight children; 1.88 (95% CI: 1.31–2.71) for overweight children; and 1.72 (95% CI: 1.15–2.57) for obese children. Regarding hypertension status, the areas under the receiver operating characteristic curve for body mass index and WC were 0.64 and 0.69, respectively.
*Conclusion:* The results of this study suggested that WC is a simple measurement that may be more efficient than body mass index in predicting the risk of pediatric hypertension among normal-weight, 7-year-old children.


## 1. Introduction

The prevalence of pediatric hypertension is increasing with the pediatric obesity epidemic. Failure to diagnose hypertension in children in clinical settings has garnered more attention recently.[1] The reported prevalence of hypertension in school-aged children has widely varied because of differences in age, gender, ethnicity, and methods of blood pressure (BP) screening. The hypertension prevalence of children in Texas (8–10 years old) was 21%, whereas in South African children (6–13 years old), it was 4.68%.[2,3] For most children in Taiwan, the measurement of BP is not included in the entrance examination in elementary school. Unlike adult patients in clinical settings, pediatric patients are not required to receive BP measurements in clinics at medical centers in Taiwan.

Recent data have documented significant increases during the past 20 years in obesity among Asian and Caucasian children, with rates increasing from 10% to 17%.[4–6] The increasing trend of obesity is of particular concern because childhood obesity is associated with a high risk of hypertension, Type 2 diabetes, abnormal lipid profiles, and early atherosclerosis. Among children and adolescents 10–19 years of age, the odds ratio (OR) of hypertension in association with obesity is 3.26.[7] The body mass index (BMI) is a common means in identifying obesity but may not reflect the body fat in all individuals. Compared with the BMI, waist circumference (WC) is a better index to investigate metabolic abnormalities.[8–13] Maffeis et al[10] suggested that WC is helpful in detecting, among overweight children, those with a higher likelihood of metabolic and cardiovascular risks. It was

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shown that abdominal obesity is more important than overall obesity for predicting metabolic abnormalities.

Increased WC is well defined in adults, although it has not been thoroughly investigated in Asian children. Previous reports that investigated relationships between WC and obesity-related diseases from epidemiological studies were mostly focused on overweight and obese children rather than normal-weight children. First-grade children are generally considered a noncooperative population, and needle phobia is a fairly common problem within these subjects.[14] A noninvasive and easy-to-perform measurement of screening for pediatric hypertension risk would be beneficial. To the best of our knowledge, no study in Taiwan investigated factors influencing hypertension in 7-year-olds. Therefore, the aims of this study were to investigate the association between WC and pediatric hypertension risk in normal-weight children and to subsequently examine the ability of WC to be used as an effective predictor of hypertension risk within this same population.

## 2. Methods

Health examinations were conducted for 7-year-old (first-grade) children in six public elementary schools in Taipei County, Taiwan. In the past, the annual basic health examination at elementary schools included height and weight measurements, an oral checkup, a vision test, and some regular internal examinations. Starting in 2007, neck circumference, WC, and BP measurements have been added to the regular examination process in those elementary schools that consented to do so. All first-grade students in the six elementary schools received these examinations. The Research Ethics Committee of Taipei Medical University Hospital approved the study. The study was consistent with the World Medical Association Declaration of Helsinki.

The numbers of school children in the first grade in schools A, B, C, D, E, and F were 595, 616, 325, 317, 139, and 261, respectively. All of the anthropometric measurements were carried out by two research assistants who were specifically trained for 6 hours in weight, height, neck circumference (NC), and WC measurements according to standard guidelines.[15] BMI was calculated as mass (kg)/[height (m)]$^2$ at each school screening, and the children were divided into one of three weight stratifications: normal weight, overweight, and obese, as defined by Cole et al.[16] Two seated BP measurements were taken at least 5 minute apart after 10 minutes of rest by using Dash 3000 Pro monitoring system (GE Healthcare Technologies, Waukesha, WI, USA). Prehypertension and hypertension were defined in students found to have an average systolic BP or diastolic BP greater than or equal to the gender-, age-, and height-matched 90$^{th}$ (prehypertension) or 95$^{th}$ (hypertension) percentile, according to the criteria of the National High Blood Pressure Education Program Working Group on Hypertension Control in Children and Adolescents.[17]

Student's *t* test was used to compare the differences in continuous variables between boys and girls. For comparing the anthropometric measurements among normal, prehypertensive, and hypertensive children, the anthropometric measurements were analyzed by analysis of variance followed by Scheffe's *post hoc* test. Person's correlation coefficient was used to assess the correlation between BP and anthropometric parameters. Logistic regression models were used to estimate the univariate and gender-adjusted OR and 95% confidence intervals (CIs). To investigate whether WC and BMI could predict the children's hypertension, the statistical analysis of receiver operating characteristic (ROC) curve was used. The Mann–Whitney test was used to compare the areas under the two ROC curves (AUCs). The level of significance considered was 5% ($\alpha = 0.05$). SAS version 8.2 (SAS Institute Inc., Cary, NC, USA) was used for all statistical analyses.

## 3. Results

There were 2253 eligible school children enrolled in this study. The characteristics of the studied population by gender are shown in Table 1. All of the anthropometric measurements and BP in boys were significantly higher than those in girls. Table 2 shows the basic characteristics of the children according to BP outcome. The overall prevalences of prehypertension and hypertension were 10.47% and 18.11%, respectively. The prevalence of hypertension was significantly higher for boys (21.38%) than that for girls (14.55%). Normal-weight children had significantly lower hypertension prevalence (14.78%) than overweight (27.33%) and obese (38.30%) children. Hypertensive children had significantly greater weight, height, BMI, NC, WC, and WC-to-hip ratio (WtH) than those children with normal BP. With the exception of height, the same results were found between prehypertensive children and those with normal BP.

The correlation coefficients between BP and anthropometric measurements were all highly significant when compared with one another ($r = 0.11–0.38$, $p < 0.001$) (Table 3). Correlation coefficients among anthropometric measurements (height, weight, BMI, WC, WtH) were significant ($r = 0.05–0.92$), except for that between height and WtH.

For prehypertension risk, the gender-adjusted ORs per standard deviation (SD) increment were 1.53-fold (95% CI: 1.33–1.77) for BMI; 1.38-fold (95% CI: 1.19–1.61) for NC; 1.55-fold (95% CI: 1.34–1.79) for WC; and 1.21-fold (95% CI: 1.02–1.43) for WtH (data not shown). One-SD increments in BMI and WC levels were associated with increased risk of hypertension by 1.62- and 1.90-fold, respectively (data not shown). Compared with normal-weight children, the risks of hypertension in overweight and obese children were 2.39- and 3.85-fold, respectively (data not shown). Table 4 shows anthropometric measurements and ORs of prehypertension or hypertension according to weight status. In gender-adjusted analyses, a 1-SD increase in

**Table 1** Basic characteristics of the 7-year-old children, classified by gender

| Variable | Boys ($N = 1174$) | | Girls ($N = 1079$) | | Student's *t* test |
|---|---|---|---|---|---|
| | Mean ± SD | 95% CI | Mean ± SD | 95% CI | |
| Weight (kg) | 24.48 ± 5.03 | 24.19–24.77 | 23.13 ± 4.53 | 22.86–23.40 | <0.0001 |
| Height (cm) | 120.16 ± 5.09 | 119.86–120.45 | 119.00 ± 5.11 | 118.69–119.30 | <0.0001 |
| BMI (kg/m$^2$) | 16.85 ± 2.63 | 16.70–17.00 | 16.23 ± 2.33 | 16.10–16.37 | <0.0001 |
| NC (cm) | 26.98 ± 1.88 | 26.87–27.08 | 25.88 ± 1.61 | 25.78–25.98 | <0.0001 |
| WC (cm) | 58.27 ± 6.37 | 57.91–58.64 | 56.43 ± 5.59 | 56.09–56.76 | <0.0001 |
| WtH | 0.85 ± 0.05 | 0.85–0.85 | 0.83 ± 0.05 | 0.83–0.84 | <0.0001 |
| WtHt | 0.48 ± 0.05 | 0.48–0.49 | 0.47 ± 0.04 | 0.47–0.48 | <0.0001 |
| SBP (mmHg) | 101.34 ± 13.99 | 100.54–102.14 | 97.35 ± 12.98 | 96.57–98.12 | <0.0001 |
| DBP (mmHg) | 62.57 ± 11.72 | 61.90–63.24 | 60.23 ± 10.23 | 59.62–60.85 | <0.0001 |

BMI = body mass index; CI = confidence interval; DBP = diastolic blood pressure; HC = hip circumference; NC = neck circumference; SBP = systolic blood pressure; WC = waist circumference; WtH = waist-to-hip ratio; WtHt = waist-to-height ratio.

**Table 2** Basic characteristics of the 7-year-old children, classified by blood pressure outcome

| Characteristics | Normal ($N = 1663$) | Prehypertension ($N = 182$) | Hypertension ($N = 408$) | $\chi^2$ *p* |
|---|---|---|---|---|
| | *N* (%) | | | |
| Gender | | | | |
| Boys | 817 (69.59) | 106 (9.03) | 251 (21.38) | <0.001 |
| Girls | 846 (78.41) | 76 (7.04) | 157 (14.55) | |
| Weight classes | | | | |
| Normal weight | 1394 (78.36) | 122 (6.86) | 263 (14.78) | <0.0001 |
| Overweight | 200 (60.06) | 42 (12.61) | 91 (27.33) | |
| Obesity | 69 (48.94) | 18 (12.77) | 54 (38.30) | |
| Variable | Mean ± SD | | | ANOVA *p* |
| Weight (kg) | 23.24 ± 4.34 | 25.05 ± 5.43* | 25.77 ± 5.82* | <0.001 |
| Height (cm) | 119.38 ± 5.05 | 119.75 ± 5.39 | 120.51 ± 5.24* | <0.001 |
| BMI (kg/m$^2$) | 16.22 ± 2.23 | 17.32 ± 2.69* | 17.61 ± 3.07* | <0.0001 |
| NC (cm) | 26.20 ± 1.69 | 26.82 ± 1.69* | 27.32 ± 2.15*,† | <0.0001 |
| WC (cm) | 56.37 ± 5.38 | 59.17 ± 6.81* | 60.68 ± 7.01*,† | <0.0001 |
| HC (cm) | 67.14 ± 5.27 | 69.69 ± 6.19* | 71.18 ± 6.87*,† | <0.0001 |
| WtH | 0.84 ± 0.04 | 0.85 ± 0.05* | 0.85 ± 0.05* | <0.0001 |
| WtHt | 0.47 ± 0.04 | 0.49 ± 0.05* | 0.50 ± 0.05*,† | <0.0001 |

ANOVA = analysis of variance; BMI = body mass index; HC = hip circumference; NC = neck circumference; SD = standard deviation; WC = waist circumference; WtH = waist-to-hip ratio; WtHt = waist-to-height ratio.

* Significantly different ($p < 0.05$) from children with normal blood pressure by ANOVA and Scheffe's test..

† Significantly different ($p < 0.05$) from prehypertensive children by ANOVA and Scheffe's test.

BMI level was observed to be associated with a risk of hypertension among normal-weight and obese children. The gender-adjusted OR (95% CI) of hypertension associated with a 1-SD increase of WC was 2.13 (95% CI: 1.75–2.59) for normal-weight children; 1.88 (95% CI: 1.31–2.71) for overweight children; and 1.72 (95% CI: 1.15–2.57) for obese children. Both BMI and WC were associated with increased risk of prehypertension among normal-weight children, showing significant ORs of 1.69 and 1.57, respectively.

The ROC curve was used to investigate whether BMI and WC could predict prehypertension or hypertension within children. Regarding prehypertension, the AUCs of BMI (0.60 for boys and 0.66 for girls; Figure 1A) and WC (0.64 for boys and 0.62 for girls; Figure 1C) were relatively similar in predicting prehypertension (0.63). Regarding hypertension status, the AUCs of BMI (0.65 for boys and 0.62 for girls; Figure 1B) and WC (0.69 for boys and 0.68 for girls; Figure 1D) were 0.64 and 0.69, respectively. Regarding the hypertension status of normal-weight children, the AUCs of BMI and WC were 0.57 and 0.65, respectively; the two compared areas were significantly different ($p < 0.0001$). The difference in AUCs of BMI and WC in overweight and obese children was not significantly different ($p = 0.08$ and 0.60, respectively), with regard to the hypertension status. Therefore, AUC analysis suggested that the area of the curve for WC was greater than that of BMI for predicting risk of hypertension among first-grade children, especially for normal-weight children.

## 4. Discussion

This study successfully investigated the relationship between WC and prehypertension and hypertension among first-grade children. Higher (per 1-SD increment) WC or BMI was shown in our study to be a risk factor for hypertension, especially in 7-year-old normal-weight children. However, childhood WC is often neglected both in clinical and school examinations. In addition, hypertension in children frequently goes undiagnosed in pediatric clinics.[1]

In agreement with earlier studies, boys with either an elevated or normal BP had a higher average WC than girls.[18–24] In addition, the current study demonstrated that hypertensive children had higher WC than children with normal BP, which was consistent with previously published studies.[13,20] WC has been shown to positively correlate with systolic and diastolic BPs among children in many studies.[10,21,22,25–28] In a study on Greek children, WC correlated with systolic BP ($r = 0.491$, $p < 0.0001$) and diastolic BP ($r = 0.479$, $p < 0.0001$).[21] A positive correlation between WC and BP was also shown in Mexican children ($r = 0.538$ for systolic BP and $r = 0.313$ for diastolic BP)[28]; Japanese children (systolic BP: $r = 0.30$, $p < 0.001$; diastolic BP: $r = 0.20$, $p < 0.001$)[25]; Finnish children ($r = 0.40$ for systolic BP and $r = 0.29$ for diastolic BP)[10]; and Portuguese children (systolic BP: $r = 0.31$ for boys and $r = 0.15$ for girls; diastolic BP: $r = 0.21$ for boys and $r = 0.13$ for girls).[22] This study not only showed significant correlation between BP and WC but also demonstrated that this relationship yielded a greater correlation coefficient between BP and WC as compared with BP and BMI.

An increased risk of hypertension was reported in Mexican children with a WC greater than or equal to 90$^{th}$ percentile (OR = 3.66).[28] Compared with children in the lowest quartile of WC, children in the highest quartile had the highest risk of elevated BP in Greece (OR = 7.09 for boys and 2.75 for girls).[13] In the United Sates, the OR of elevated BP was 1.61 with a 1-SD increase in WC (95% CI = 1.48–1.75).[29] In this study, 1-SD increments in BMI and WC were associated with increased 1.51- and 2.13-fold risks of hypertension among normal-weight children, respectively. Moreover, significantly increased gender-adjusted risk of hypertension was also observed among obese children with a 1-SD increase of BMI and WC.

Among U.S. children and adolescents, the average WC and the prevalence of abdominal obesity greatly increased between 1988–1994 and 1999–2004.[30] The study of the impact of increased WC is crucial for the prevention of cardiovascular disease and metabolic syndrome. Fredriks et al[31] suggested that WC can be used for screening increased abdominal fat mass in Dutch children. Hirschler et al[8] reported that WC could be used as a predictor of insulin resistance in children and adolescents. Janssen et al[29] suggested that BMI and WC should be used in

**Table 3** Correlation coefficients for blood pressure and anthropometric measurements

| Variable | SBP | DBP | Height | Weight | BMI | NC | WC | HC | WtH | WtHt |
|---|---|---|---|---|---|---|---|---|---|---|
| SBP | 1.0 | 0.66* | 0.20* | 0.30* | 0.28* | 0.33* | 0.37* | 0.38* | 0.11* | 0.33* |
| DBP | | 1.0 | 0.17* | 0.22* | 0.19* | 0.25* | 0.31* | 0.31* | 0.12* | 0.28* |
| Height | | | 1.0 | 0.69* | 0.35* | 0.47* | 0.46* | 0.57* | −0.02 | 0.06† |
| Weight | | | | 1.0 | 0.92* | 0.76* | 0.81* | 0.86* | 0.18* | 0.59* |
| BMI | | | | | 1.0 | 0.73* | 0.79* | 0.81* | 0.24* | 0.73* |
| NC | | | | | | 1.0 | 0.76* | 0.75* | 0.25* | 0.63* |
| WC | | | | | | | 1.0 | 0.86* | 0.55* | 0.91* |
| HC | | | | | | | | 1.0 | 0.05‡ | 0.70* |
| WtH | | | | | | | | | 1.0 | 0.63* |
| WtHt | | | | | | | | | | 1.0 |

BMI = body mass index; DBP = diastolic blood pressure; HC = hip circumference; NC = neck circumference; SBP = systolic blood pressure; WC = waist circumference; WtH = waist-to-hip ratio; WtHt = waist-to-height ratio.

*$p < 0.001$; †$p < 0.01$; ‡$p < 0.05$.

**Table 4** Anthropometric measurements and odds ratios of prehypertension or hypertension, classified by weight status

| Variable | Normal weight | | Overweight | | Obesity | |
|---|---|---|---|---|---|---|
| | Prehypertension | Hypertension | Prehypertension | Hypertension | Prehypertension | Hypertension |
| | OR (95% CI) | OR (95% CI) | OR (95% CI) | OR (95% CI) | OR (95% CI) | OR (95% CI) |
| BMI (per 1-SD increase, kg/m$^2$) | | | | | | |
| Crude | 1.23 (0.91–1.65) | 1.13 (0.92–1.40) | 0.89 (0.49–1.59) | 0.80 (0.51–1.24) | 0.92 (0.46–1.82) | 1.28 (0.84–1.94) |
| Gender adjusted | 1.69 (1.17–2.44)* | 1.51 (1.17–1.95)* | 0.62 (0.22–1.72) | 1.58 (0.76–3.32) | 1.92 (0.79–4.66) | 2.11 (1.17–3.81)† |
| NC (per 1-SD increase, cm) | | | | | | |
| Crude | 0.98 (0.84–1.15) | 1.06 (0.94–1.18) | 1.00 (0.76–1.32) | 0.95 (0.78–1.17) | 0.62 (0.39–0.98)† | 1.10 (0.87–1.40) |
| Gender adjusted | 1.30 (1.02–1.67)* | 1.56 (1.31–1.86)‡ | 0.96 (0.62–1.48) | 1.37 (0.98–1.90)§ | 0.72 (0.40–1.27) | 1.51 (1.05–2.16)† |
| WC (per 1-SD increase, cm) | | | | | | |
| Crude | 1.16 (0.93–1.44) | 1.39 (1.19–1.62)‡ | 1.10 (0.79–1.54) | 1.18 (0.91–1.53) | 0.96 (0.60–1.54) | 1.29 (0.94–1.76) |
| Gender adjusted | 1.57 (1.19–2.06)‡ | 2.13 (1.75–2.59)‡ | 1.14 (0.74–1.76) | 1.88 (1.31–2.71)‡ | 1.24 (0.72–2.12) | 1.72 (1.15–2.57)* |
| HC (per 1-SD increase, cm) | | | | | | |
| Crude | 1.08 (0.89–1.30) | 1.21 (1.06–1.39)* | 1.05 (0.75–1.46) | 1.13 (0.88–1.45) | 0.91 (0.55–1.49) | 1.30 (0.96–1.77)§ |
| Gender adjusted | 1.51 (1.15–1.98)‡ | 1.96 (1.61–2.38)* | 1.06 (0.64–1.77) | 2.23 (1.46–3.40)‡ | 1.56 (0.76–3.22) | 2.31 (1.39–3.84)* |
| WtH (per 1-SD increase) | | | | | | |
| Crude | 1.14 (0.92–1.40) | 1.26 (1.08–1.46)* | 1.12 (0.76–1.63) | 1.16 (0.87–1.55) | 1.13 (0.63–2.04) | 1.09 (0.72–1.66) |
| Gender adjusted | 1.11 (0.89–1.37) | 1.22 (1.05–1.42)† | 1.12 (0.77–1.64) | 1.14 (0.85–1.52) | 0.98 (0.53–1.82) | 1.04 (0.68–1.60) |
| WtHt (per 1-SD increase) | | | | | | |
| Crude | 1.51 (0.95–1.38) | 1.27 (1.11–1.45)* | 1.17 (0.86–1.58) | 1.06 (0.84–1.32) | 0.85 (0.55–1.31) | 1.91 (0.98–1.75) |
| Gender adjusted | 1.66 (1.28–2.21)‡ | 2.01 (1.67–2.42)‡ | 1.31 (0.85–2.00) | 1.63 (1.16–2.31)* | 1.05 (0.63–1.72) | 1.80 (1.22–2.67)* |

BMI = body mass index; CI = confidence interval; HC = hip circumference; NC = neck circumference; OR = odds ratio; SD = standard deviation; WC = waist circumference; WtH = waist-to-hip ratio; WtHt = waist-to-height ratio.
*$p < 0.001$; †$p < 0.05$; ‡$p < 0.001$; §$0.05 < p < 0.1$.

clinical settings to evaluate the presence of elevated health risks among children and adolescents. In Italy, obese children with a WC greater than 90th percentile had a higher risk of metabolic syndrome (OR = 13.1).[11] Furthermore, it was shown that the measurement of the WC may help identify those children who are at high risk of developing a metabolic syndrome.[23] Moreover, WC seems to be the best predictor of children with metabolic syndrome in pediatric clinical settings.[12] In this study, the AUC of WC was significantly larger than the AUC of BMI. The phenomenon could be seen only in normal-weight children. Other studies

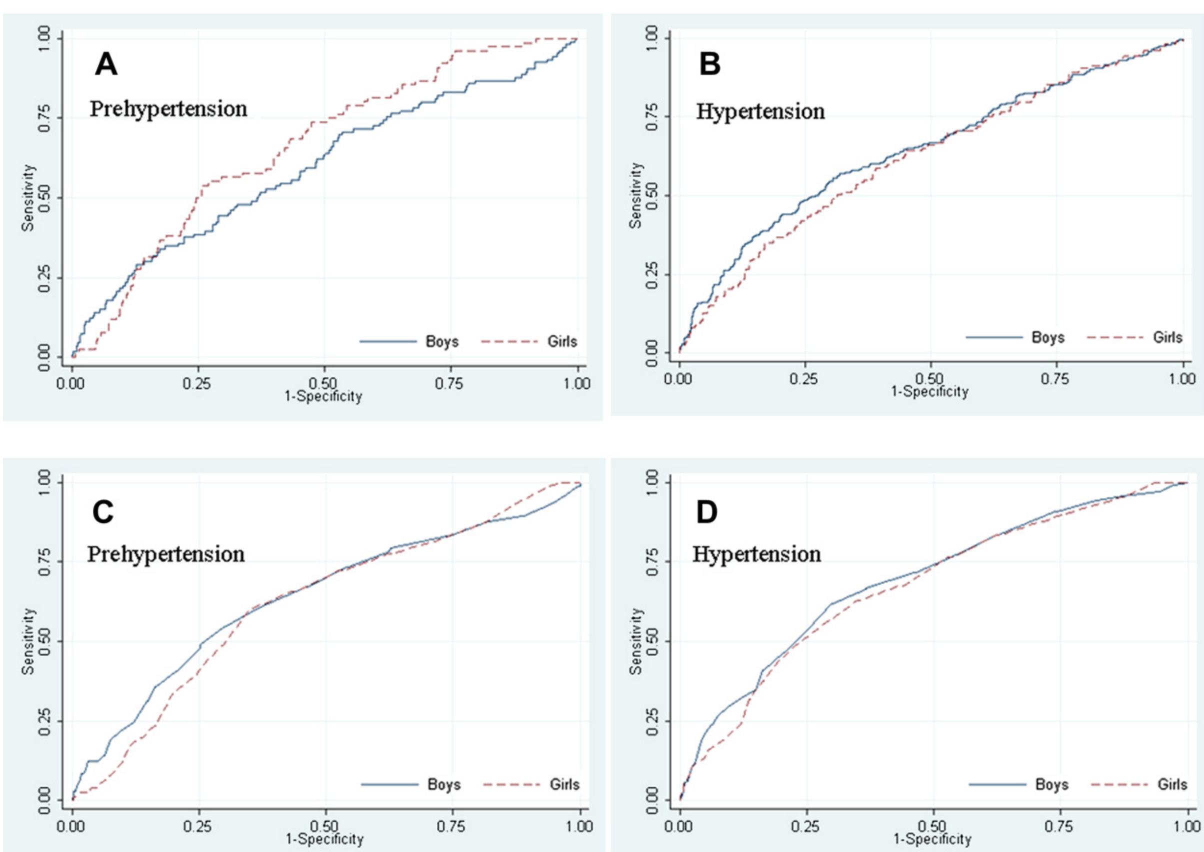


**Figure 1** Receiver operating characteristic curves of BMI (panels A and B) and waist circumference (panels C and D) as a single marker in the identification of prehypertension or hypertension in boys (solid line) and girls (dashed line).

should further explore if WC is a predictive factor for hypertension in normal-weight children of different ages.

Simple anthropometric measurements are the most commonly used tools for assessing body composition.[32] WC is a simple measure of abdominal obesity at the present time.[30] One previous report suggested that WC was an efficient predictor of total fat content in children.[32] Compared with BMI, abdominal obesity may be a better predictor for the risk of hypertension and metabolic abnormalities.[8–10,13,18,30,33,34] The results of this study suggested that WC is easy to perform and that WC was more sensitive than BMI in predicting hypertension in normal-weight first-grade children. Childhood WC is influenced by many factors, such as a family history of diabetes[19] and a high intake of sugar-based beverages.[35] African children with malnutrition have a high WC as compared with children with normal nutrition.[36] Physical activity, lifestyle, nutritional status, and parental history of cardiovascular disease were not taken into consideration in this study, and, this may be a study limitation. However, the significant findings of our study still suggest that WC is a good predictor of hypertension in 7-year-old children, especially those of normal weight. The fact that only one BP screening was performed may be another limitation of this study. The prevalence of hypertension in this study was 18.11%, which was quite similar to the prevalence reported in a previous study (19.4%) that used one measurement screening for elevated BP.[7] However, the possibility that a small number of false positives of hypertension was identified cannot be ruled out in this study.

Certain limitations of this study should be noted. First, we could not get information of the 7-year-old school children in study schools. On the other hand, we were not sure whether the children in this study could be representative of the general children population in Taiwan. Thus, the results of this study may not be generalized to other populations. Second, we used the international BP curves[17] to define the outcome (prehypertension and hypertension) in Taiwanese children. According to 2000 Centers for Disease Control and Prevention (CDC) Growth Charts for the United States, methods and development, the $10^{th}$, $50^{th}$, and $90^{th}$ percentiles of height in U.S. 7-year-old children were 107 cm, 113 cm, and 120 cm, respectively. The $10^{th}$, $50^{th}$, and $90^{th}$ percentiles of height in 7-year-old children of this study were 113, 120, and 126 cm, respectively. The BP is highly correlated with height in the children. The hypertension prevalence of this study was underestimated with the U.S. BP curves.

In conclusion, the result of this study suggested that WC is easy to perform and more sensitive than BMI for predicting hypertension in first-grade children, especially in normal-weight subjects. WC is a noninvasive measurement predictor, which could potentially be applied as a mass screening tool for pediatric hypertension. An increasing number of studies are showing that pediatric hypertension could be a major risk factor for adult chronic disease, including cardiovascular diseases. Our study provides evidence that WC may be a good predictor of pediatric hypertension among normal-weight first-grade children in Taiwan.

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