Short Communication

Waist circumference as an indicator of high blood pressure in preschool obese children

Bin Chen MD, Hai-fei Li MD

Department of Children Healthcare, Shenzhen Maternal and Child Healthcare Hospital, Shenzhen, China

Objective: To investigate the relationship between waist circumference and blood pressure (BP) to determine if waist circumference was an indicator of BP in preschool children. Methods: Body weight, height, waist circumference (WC), hip circumference, and blood pressure of 939 3-6-year-old preschool children were collected. Results: Systolic blood pressure (SBP) and diastolic blood pressure (DBP) in obese children were significantly higher than that in normal weight children in both sexes ($p<0.001$). Overweight children had significantly higher SBP and DBP than normal weight boys ($p<0.01$). Age- and sex-adjusted Body mass index (BMI) correlated significantly with SBP and DBP. In children aged 3-6 years, age-, sex-and BMI-adjusted waist circumference correlated significantly with SBP, but not with DBP. Receiver operating characteristic (ROC) curves showed a significant ability of BMI, WC and waist-to-height ratio (WtHr) to discriminate high blood pressure in children of both sexes. Multiple linear stepwise regression analysis using SBP as the dependent variable showed that BMI and WC were significant independent factors that influence high blood pressure adjusted for age, WtHr and waist-to-hip circumference ratio (WHr) in boys. When using DBP as the dependent variable, BMI was the only significant independent factor that influenced high blood pressure adjusted for age, WtHr and WHr, in both sexes. Conclusion: Waist circumference was independently associated with high blood pressure in boys aged 3-6 years. In addition to BMI, increased waist circumference was found to be an indicator of high blood pressure in the preschool children, especially in boys.

Key Words: preschool children, obesity, waist circumference, blood pressure, body mass index

INTRODUCTION

The prevalence of childhood and adolescents obesity has increased substantially in the developed and developing countries in the last few decades, and it is probable that this trend will continue.[1] China has joined the world epidemic of obesity.[2] Previous studies have suggested that obese children are at approximately threefold higher risk for hypertension than non-obese children.[3] Moreover, in the pediatric age group and especially in obese children, hypertension has already been associated with end-organ damage such as left ventricular hypertrophy, carotid artery intima-media thickness, endothelial dysfunction, early renal involvement or obstructive sleep apnoea.[4-6] Therefore, an early management of hypertensive children is now considered to be of major clinical importance for the effective prevention of associated morbidity.[7]

Visceral adiposity is clearly linked with cardiovascular risk both in adults and in children, and the estimation of fat distribution is considered mandatory in evaluation of obese patients.[8] Although waist circumference (WC) have been shown to be associated with hypertension in some age group in some studies,[9-12] to our knowledge, few data are available for the preschool period. The aim of the present study, therefore, was to determine the prevalence of high blood pressure in a representative sample of 3- to 6-year-old preschool normal weight, overweight and obese children; and to investigate the relationship between waist circumference and BP, to determine whether it is an indicator of high blood pressure in this population.

MATERIALS AND METHODS

A cross-sectional survey was conducted in 2006 on Chinese children aged 3-6 years. Study children were selected from kindergartens in Shenzhen, China. There are six districts in Shenzhen. All districts participated in this study. Two kindergartens with over 250 children and at least one trained child healthcare doctor or nurse were randomly recruited from every district. The reason that the children dropped-out were: missing kindergarten, taking medicine on the day when measurements were taken or not compliable for anthropometric and blood measures. Data from 271 obese children (male, 161; female, 110) and 139 overweight children (male, 56; female, 83) were collected. None of the obese children were found to have an organic cause for their obesity, and none were taking any medication that might interfere with growth and blood pressure. At the same time, 529 normal weight (male, 423; female, 106) children of the same age and similar social economical conditions as the obese and overweight group were selected, as the control group.

Corresponding Author: Dr Bin Chen, Department of Children Healthcare, Shenzhen Maternal and Child Healthcare Hospital, 3012 Fu Qiang Rd., Shenzhen 518048, Guangdong Province, China.
Tel+86 755 83570000-1306; Fax: +86 755 83570589
Email: cbin63@126.com
Manuscript received 8 September 2010. Initial review completed 25 March 2011. Revision accepted 12 May 2011.

Data on anthropometric measure and BP of 939 3-6 years old children (male, 640; female, 299) were collected. Parents provided written consent for their children's participation before data collection. All children enrolled in this study underwent a physical examination to obtain anthropometric measures (weight, height, waist circumference, and hip circumference) according to standard guidelines. All anthropometric measures were performed by pediatrician specifically trained for this project, in the kindergarten setting. Body weight was measured in light clothes and without shoes and was approximated to the nearest 0.1 kg on a mobile lever scale (Hengxing, Wuxi, China), and height was measured to the nearest 0.1 cm using a wall-mounted stadiometer (Hengxing, Wuxi, China). Waist circumference was measured by a non-elastic flexible tape in the standing position. The tape was applied horizontally midway between the lowest rib margin and the iliac crest. Hip circumference was measured at maximal protrusion of the buttocks. The mean of two measurements to the nearest 0.1 cm were documented. BP was measured in the classroom by the same pediatrician on the same occasion as the anthropometric measurements, while children were sitting and with the cubital fossa supported at heart level, after at least 5 min of rest. BP was measured using a mercury sphygmomanometer, with the appropriate cuff for the children upper arm size. The cuffs used hand bladders long enough to circle at least half of the upper arm without overlapping, and widths that covered at least two-thirds of the upper arm. Systolic BP was defined by the onset of the first Korotkoff sound, and diastolic BP was indicated by the fifth Korotkoff sound (disappearance of Korotkoff sound).

BMI was calculated in each participant as weight (kg) over squared height (m^2). BMI was categorized by using the 2006 standard of The National Task force on childhood obesity of China (NTFCOC) for boys and girls aged 3-6 (normal weight: 5^{th}-85^{th} percentiles; overweight: 85^{th}-95^{th}percentiles; obese: $\geq 95^{th}$ percentiles).[13] WtHr was calculated as waist circumference divided by height. WHR was calculated as waist circumference divided by hip circumference. High BP was defined as either the systolic or diastolic BP values or both exceeding the 95th percentile according to sex, age and height based on the US normative BP tables published by the National High Blood Pressure Education Program Working Group.[14]

Statistical analysis

Descriptive statistics were computed by sex for age, weight, height, BMI, waist circumference, WTHR, WHR, systolic and diastolic BP, expressed as mean and standard deviation (SD). Student-t test was used to compare the average between two groups. Percentages of hypertension and weight-class distribution were compared between sexes and among weight classes by chi-square test. Partial correlation analysis was used to examine the relationship between WC, WtHr, WHr and blood pressure after controlling age, sex, and BMI. It was also used to examine the relationship between age- and sex-adjusted BMI and blood pressure. The tendency of BMI, waist circumference, WtHr and WHr as single markers to discriminate hypertensive children was assessed by receiver operating characteristic methodology. A multiple stepwise regression, adjusted for sex and age, was used to examine the influence of waist circumference, WtHr, WHr and BMI on the risk of hypertension in both sexes, respectively. Statistical analysis was conducted with software package SPSS (version 16.0, SPSS Inc, Chicago, USA). Differences were considered statistically significant with a *p*-value <0.05.

This protocol of the study was approved by the Ethical Committee of Shenzhen maternal and child healthcare hospital.

RESULTS

The characteristics of the study population are shown in Table 1 according to sex and weight. Systolic BP and diastolic BP in obese children were significantly higher than that in normal weight children in both sexes ($p<0.001$). Overweight children have significantly higher systolic and diastolic BP than normal weight children in boys ($p<0.01$). Systolic BP and diastolic BP were not significantly difference between overweight and normal children in girls (SBP, $p=0.127$; DBP, $p=0.113$).

The prevalence of high blood pressure in the overall group of 939 children was 23% (n=216) and was not significantly different between sexes, with 23.8% in boys and 21.4% in girls ($p=0.67$). A significant difference between normal weight (boys, 17.5%; girl, 14.2%) and obese children (boys, 38.5%; girl, 33.6%) was observed for both sexes ($p<0.01$). This difference was significant between overweight (14.5%) and obese (33.6%) groups in

Table 1. Descriptive characteristics by sex and weight status

Variables	Boys (n=640)			Girls (n=299)		
	NW (n=423)	OW (n=56)	OB (n=161)	NW (n=106)	OW (n=83)	OB (n=110)
Age (years)	4.2 (0.9)	4.2 (0.9)	4.2 (0.8)	4.1 (0.8)	4.2 (0.7)	4.2 (0.8)
Weight (kg)	18.3 (2.7)	23.1 (3.8)	26.9 (4.7)	16.5 (2.0)	19.0 (2.3)	25.7 (4.7)
Height (cm)	108 (6.8)	111 (8.0)	112 (6.5)	106 (6.7)	108 (5.6)	111 (6.5)
BMI (kg/cm^2)	15.6 (1.1)	18.5 (0.8)	21.3 (2.7)	14.6 (0.7)	16.3 (0.8)	20.8 (2.1)
WC (cm)	51.0 (3.9)	57.6 (4.6)	63.4 (5.8)	48.7 (2.8)	51.3 (4.6)	61.4 (6.1)
WHr	0.91 (0.06)	0.90 (0.04)	0.93 (0.05)	0.88 (0.06)	0.88 (0.08)	0.90 (0.05)
WtHr	0.47 (0.04)	0.51 (0.03)	0.57 (0.05)	0.46 (0.03)	0.47 (0.04)	0.55 (0.05)
SBP (mmHg)	92.9 (9.8)	99.2 (10.5)	101 (12.1)	91.7 (10)	93.9 (11.1)	99.6 (10.3)
DBP (mmHg)	60.3 (8.6)	62.9 (8.5)	66.2 (9.4)	58.7 (9.3)	60.6 (8.2)	65.5 (9.6)

Values are expressed as mean (standard deviation). NW, normal weight; OW, overweight; OB, obese; BMI, body mass index; WC, waist circumference; WHr, waist-to-hip circumference ratio ;WtHr, waist-to-height ratio; SBP, systolic blood pressure; DBP, diastolic blood pressure.

girls (p<0.01), but not in boys (overweight, 28.6%; obese, 38.5%; p=0.23). There was no significant difference between the normal weight and overweight group for both sexes (boys, p=0.07; girls, p=1).

Partial correlation coefficients between age-, sex- and BMI- adjusted WC, WtHr, WHr, and blood pressure; between age- and sex-adjusted BMI and blood pressure-correlation coefficients are shown in Table 2. In children aged 3-6years, age- and sex-adjusted BMI correlated significantly with SBP and DBP. Age-, sex- and BMI-adjusted WC correlated significantly with SBP, but not with DBP. There were no significant associations between age-, sex- and BMI-adjusted WtHr and blood pressure. No significant association was observed between age, sex- and BMI-adjusted WHr and blood pressure.

The univariate analysis by receiver operating characteristic (ROC) curves showed a significant ability of BMI [area under the curve (AUC) 0.663,95% confidence interval (CI) (0.585, 0.741), p<0.001for girls and AUC 0.62, 95% CI (0.567, 0.673), p<0.001 for boys], waist circumference [AUC 0.622, 95% CI (0.538, 0.706) , p<0.001for girls and AUC 0.580, 95% CI (0.524, 0.636) , p<0.001for boys] and WtHr [AUC 0.647, 95% CI (0.565, 0.729) , p<0.001for girls and AUC 0.631, 95% CI (0.580, 0.683) , p<0.001for boys], to discriminate high blood pressure in children of both sexes. While, WHr [area under the curve (AUC) 0.576, 95% confidence interval (CI) (0.498, 0.655), p=0.065 for girls and AUC 0.551, 95% CI (0.497, 0.605), p=0.058 for boys] did not have the ability of discriminate high blood pressure in children of both sexes.

Multiple linear stepwise regression analysis using SBP as the dependent variable showed that BMI and WC were significant independent factors that influenced high blood pressure adjusted for age, WtHr and WHr in boys; but WC was not a significant independent factor that influenced high blood pressure in girls. When using DBP as the dependent variable, only BMI was the significant independent influencing factor for high blood pressure adjusted for age, WtHr and WHr in both sexes (Table 3).

DISCUSSION

The prevalence of hypertension in the pediatric population is rising, and the increase is believed to be related to the epidemic of childhood obesity.[15] Childhood hypertension can proceed into adulthood .Since children with BMI and waist circumference values exceeding the established criterion values are at increased risk for the metabolic syndrome and the cardiovascular disease when they become adults,[16] the pediatrician must pay more attention to the evaluation of hypertension in obese children.

The association between pediatric obesity and hypertension has been reported in many studies. In one American study, 33% of obese children were hypertensive compared with 11% of lean children.[17] In a cohort of Irish overweight and obese children aged 2-18 years, 51% of the boys and 49% of the girls had initial blood pressure measurements in the hypertensive range according to the US normative BP tables published by the National High Blood Pressure Education Program Working Group.[18] The present study showed a very high prevalence of high blood pressure in overweight and obese children. The prevalence of high blood pressure in obese preschool children was higher than that in the normal weight children in both boys and girls, even in children aged 3-

Table 2. Partial correlation coefficients between WC, WtHr, WHr, BMI and blood pressure

Model		SBP	DBP	Adjusted factor
		correlation coefficients (p-value)	correlation coefficients (p-value)	
1	WC	0.073 (0.026)	0.06 (0.067)	Age, sex, BMI
	WtHr	0.011 (0.732)	-0.027 (0.403)	
	WHr	0.054 (0.099)	-0.026 (0.433)	
2	BMI	0.334 (<0.001)	0.260 (<0.001)	Age, sex

Abbreviations: BMI, body mass index; WC, waist circumference; WHr, waist-to-hip circumference ratio ;WtHr, waist-to-height ratio; SBP, systolic blood pressure; DBP, diastolic blood pressure.

Table 3. Stepwise multiple regression analysis examining the independent contribution of WC, BMI, WtHr and WHr to SBP and DBP

Sex	Dependent variable	Model	R^2	β coefficient	p-value	95% confidence interval for β
Boys	SBP	constant		69.6	0.00	63.2-75.9
		BMI	0.107	0.872	0.00	0.45-1.3
		WC	0.114	0.198	0.029	0.21-0.376
	DBP	constant		49.2	0.00	45.1-53.3
		BMI	0.058	0.743	0.00	0.51-0.976
Girls	SBP	constant		73.1	0.00	66.4-79.8
		BMI	0.127	1.28	0.00	0.894-1.66
	DBP	constant		45.1	0.00	39.1-51.0
		BMI	0.095	0.958	0.00	0.62-1.3

Abbreviations: BMI, body mass index; WC, waist circumference; WHr, waist-to-hip circumference ratio; WtHr, waist-to-height ratio; SBP, systolic blood pressure; DBP, diastolic blood pressure

6years. Obese children with hypertension often develop left ventricular hypertrophy, which also increases the risk of cardiovascular morbidity and mortality.[19] In addition, obese hypertensive patients also frequently have other components of the metabolic syndrome, including dyslipidemia, insulin resistance, and hyperinsulinemia.[20]

The impairment of hypertensive obese children lead to increasing attention on obesity related hypertension. The need for early diagnosis of hypertension of obesity has encouraged researchers to find simple but sensitive and accurate indexes of indicating hypertension in childhood. BMI is the recommended index of adiposity for epidemiological studies, as well as for clinical practice.[21] Some studies had shown that increase in BMI was associated with an increase in the blood pressure in children.[22,23] However BMI has some limitations. The age-,gender-, and ethnic-specific standards of BMI are less feasible for parents and non-professional use. Studies in adults have revealed that health risks were mainly associated with body fat distribution, more so than adiposity *per se*.[24] Therefore, it was suggested that anthropometric measures, other than BMI, were suitable as indexes of body fat distribution and morbidity, such as waist circumference. Waist circumference was proposed as a good index of intra-abdominal fat.[25] Intra-abdominal fat is strictly associated with metabolic complications of obesity and cardiovascular risks in adults.[26] In children, the relationship between waist circumference and hypertension was demonstrated in some studies.[27,28] But most of subjects previously focused on were school children. Our study found that waist circumference was associated with systolic BP in preschool children aged 3-6 years, adjusted to age, sex, and BMI. ROC curve analysis also confirmed that waist circumference has the ability of discriminating high blood pressure in preschool children aged 3-6 years in both sexes.

WHr has been widely used to evaluate body fat distribution and related health risks. Although obese and normal weight children could have different WHr values, which was confirmed in our study, we could not find any correlation between WHr and blood pressure. A multiple stepwise regression analysis of the systolic BP showed a significant influence of waist circumference on systolic BP in boys. WHr was not found to significantly influence systolic and diastolic BP in both sexes. The present study is consistent with previous descriptions in adolescents.[29] This study also shows that waist index correlate with SBP absolute values, regardless of BMI. Although using multiple stepwise regression analysis, we could not find a significant influence of waist circumference on BP in girls, we still consider the finding that waist circumference is a significant influence factor on systolic BP in boys could have important clinic significance, because waist circumference is a simple measurement which can be done by the parents at home. Especially in preschool children aged 3-6 years who have lower compliance, it would be a simple and practical indicator of high blood pressure. Further larger sample studies and examining the different influence of waist circumference on BP in boys and girls are necessary.

Because the BP reading was recorded on one occasion, high blood pressure category in the analysis can only represent a general idea of the extent of elevated BP in the studied children, rather than diagnose the presence of hypertension among them. The cross-sectional design of our study allows us to demonstrate the associations between waist circumference and high blood pressure in children aged 3-6 years. Only a prospective long-term study could assess whether the factor can predict the occurrence of hypertension in this population. Further studies with larger samples to determine a cut-off value of waist circumference should be conducted.

In conclusion, our study demonstrates that, in addition to BMI, increased waist circumference is an indicator of high blood pressure in the preschool age group. This seems particularly useful in obese boys aged 3-6years.

ACKNOWLEDGMENTS

We are grateful to the children, their parents and the teaching staff for their agreement and participation in the study. We thank the child healthcare doctor and nurse of Futian maternal and child healthcare hospital, Lohu maternal and child healthcare hospital, Nanshan maternal and child healthcare hospital, Yantian maternal and child healthcare hospital, Bauan maternal and child healthcare hospital, and Longung maternal and child healthcare hospital and all of the kindergartens that participated in this study.

AUTHOR DISCLOSURES

Bin Chen and Hai-fei Li declare no conflicts of interest.

REFERENCES

1. World Health Organization. Obesity: Preventing and Managing the Global Epidemic: Report of a WHO Consultation on Obesity. Geneva, Switzerland: World Health Organization; 1998.
2. Jiang J, Rosenqvist U, Wang H, Greiner T, Ma Y, Toschke AM. Risk factors for overweight in 2-to-6-year-old children in Beijing, China. Int J Pediatr Obes. 2006;1:103-8.
3. Scorof J, Daniels S. Obesity hypertension in children: a problem of epidemic proportions. Hypertension. 2002;40: 441-7.
4. Lande MB, Carson NL, Roy J, Meagher CC. Effects of childhood primary hypertension on carotid intima media thickness: a matched control study. Hypertension. 2006;48: 40-4.
5. Meyer AA, Kundt G, Steiner M, Schuff-Werner P, Kienast W. Impaired flow-mediated vasodilation, carotid artery intima-media thickening, and elevated endothelial plasma markers in obese children: the impact of cardiovascular risk factors. Pediatrics. 2006;117:1560-7.
6. Reinehr T, Kiess W, de Sousa G, Stoffel-Wagner B, Wunsch R. Intima-media thickness in childhood obesity: relations to inflammatory marker, glucose metabolism, and blood pressure. Metabolism. 2006;55:113-8.
7. Bowman SA. Pediatrician's office: a solution in the prevention of childhood obesity. Acta Paediatr. 2005;94:652-4.
8. Larsson B, Svardsudd K, Welin L, Wilhelmsen L, Bjorntorp P, Tibblin G. Abdominal adipose tissue distribution, obesity and risk for cardiovascular disease and death: 13 year follow up of participants in the study of men born in 1913. Br Med J (Clin Res Ed). 1984;288:1401-4.
9. Caprio S, Hyman LD, McCarthy S, Lange R, Bronson M, Tamborlane WV. Fat distribution and cardiovascular risk factors in obese adolescent girls: importance of the intraabdominal fat depot. Am J Clin Nutr. 1996;64:12-7.
10. Katzmarzyk PT, Srinivasan SR, Chen W, Malina RM, Bouchard C, Berenson GS. Body mass index, waist circumfer-

ence and clustering of cardiovascular disease risk factors in a biracial sample of children and adolescents. Pediatrics. 2004;114:198-205.
11. He Q, Horlick M, Fedun B, Wang J, Pierson RN Jr, Heshka S, Gallagher D.Trunk fat and blood pressure in children through puberty. Circulation. 2002;105:1093-8.
12. Maffeis C, Pietrobelli A, Grezzani A, Provera S, Tato L. Waist circumference and cardiovascular risk factors in prepubertal children. Obes Res. 2001;9:179-87.
13. The National Task force on childhood obesity of China (NTFCOC). National epidemiological survey on childhood obesity, 2006. Chin J Pediatr. 2008,46:179-84.
14. National High Blood Pressure Education Program Working Group on High Blood Pressure in Children and Adolescents. The fourth report on the diagnosis, evaluation, and treatment of high blood pressure in children and adolescents. Pediatrics. 2004;114:555-76.
15. Nguyen M, Mitsnefes M. Evaluation of hypertension by the general pediatrician. Curr Opin Pediatr. 2007;19:165-9.
16. Sun SS, Liang R, Huang TT, Daniels SR, Arslanian S, Liu K, Grave GD, Siervogel RM. Childhood obesity predicts adult metabolic syndrome: the Fels Longitudinal Study. J Pediatr. 2008;152:191-200.
17. Sorof JM, Poffenbarger T, Franco K, Bernard L, Portman RJ. Isolated systolic hypertension, obesity, and hyperkinetic hemodynamic states in children. J Pediatr. 2002;140:660-6.
18. Finucane FM, Pittock S, Fallon M, Hatunic M, Ong K, Burns N, Costigan C, Murphy N, Nolan JJ. Elevated blood pressure in overweight and obese Irish children. Ir J Med Sci. 2008;177:379-81.
19. Hanevold C, Waller J, Daniels S, Portman R, Sorof J. The effects of obesity, gender, and ethnic group on left ventricular hypertrophy and geometry in hypertensive children: a collaborative study of the International Pediatric Hypertension Association. Pediatrics. 2004;113:328-33.
20. Berenson GS. Obesity- a critical issue in preventive cardiology:the Bogalusa Heart Study. Prev Cardiol. 2005;8: 234-41.
21. Dietz WH, Bellizzi MC. Introduction: the use of body mass index to assess obesity in children. Am J Clin. 1999;70: 1235-55.
22. Weiss R, Dziura J, Burgert TS, Tamborlane WV, Taksali SE, Yeckel CW. Obesity and the metabolic syndrome in children and adolescents. N Engl J Med. 2004;350:2362-74.
23. Graf C, Rost SV, Koch B, Heinen S, Falkowski G, Dordel S et al. Data from the StEP TWO programme showing the effect on blood pressure and different parameters for obesity in overweight and obese primary school children. Cardiol Young. 2005;15:291-8.
24. Larsson B, Svardsudd K, Welin L, Wilhelmsen L, Bjorntorp P, Tibblin G. Abdominal adipose tissue distribution, obesity,and risk of cardiovascular disease and death: 13 year follow up of participants in the study of men born in 1913. Br Med J. 1984;288:1401-04.
25. Rankinen T, Kim SY, Perusse L, Despres JP, Bouchard C. The prediction of abdominal visceral fat level from body composition and anthropometry: ROC analysis. Int J Obes Relat Metab Disord. 1999;23:801-9.
26. Pi-Sunyer FX. Health implications of obesity. Am J Clin Nutr. 1991;53:1595S-1603.
27. Sung RY, Yu CC, Choi KC, McManus A, Li AM, Xu SL, Chan D, Lo AF, Chan JC, Fok TF.Waist circumference and body mass index in Chinese children: cutoff values for predicting cardiovascular risk factors. Int J Obes. 2007;31:550-8.
28. Genovesi S, Antolini L, Giussani M, Pieruzzi F, Galbiati S, Valsecchi MG, Brambilla P, Stella A. Usefulness of waist circumference for the identification of childhood hypertension. J Hypertens. 2008;26:1563-70.
29. Lee S, Bacha F, Arslanian SA. Waist circumference, blood pressure, and lipid components of the metabolic syndrome. J Pediatr. 2006;149:809-16.

Short Communication

Waist circumference as an indicator of high blood pressure in preschool obese children

Bin Chen MD, Hai-fei Li MD

Department of Children Healthcare, Shenzhen Maternal and Child Healthcare Hospital, Shenzhen, China

腰围是一个学龄前儿童高血压的指标

目的：研究学龄前儿童腰围与血压的关系，以探讨腰围对血压的预示作用。方法：测量 939 名 3-6 岁学龄前儿童的体重、身高、腰围、臀围和血压。结果：肥胖儿童收缩压和舒张压明显高于正常体重儿童($p<0.001$)，超重男童的收缩压和舒张压明显高于正常体重男童($p<0.01$)。校正年龄和性别的体质指数（BMI）与收缩压和舒张压明显相关。校正年龄、性别和 BMI 的腰围与收缩压明显相关。接收者操作特征（Receiver operating characteristic，ROC）曲线显示 BMI、腰围和腰围-身高比可作为辨别儿童高血压的敏感指标。多重直线逐步回归分析结果表明，BMI 和腰围均为男童收缩压的独立影响因素，仅有 BMI 为儿童舒张压的独立影响因素。结论：3-6 岁男童腰围与高血压存在显著相关性。除了 BMI 之外，腰围可以作为学龄前儿童高血压的预示指标，尤其对于男童更有意义。

关键词：学龄前儿童、肥胖、腰围、血压、体质指数