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Research Article

Gender-specific associations of anthropometric measures of adiposity with blood pressure and hypertension in young Chinese Medical College Students

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Keywords: Obesity; Anthropometry; Blood pressure; Hypertension; Chinese

Abstract

Purpose: There are uncertainties about whether general or central obesity is the more important determinant for blood pressure and hypertension in young Chinese. We aim to investigate the association between adiposity measures and blood pressure and hypertension in young medical students.

Methods: A total of 380 medical students were recruited from the 2012 batch in the Clinical College of Dali University. Anthropometric measures and office blood pressure were measured. Blood pressure status was defined by Chinese hypertension guidelines and ACC/AHA 2017 hypertension guidelines, respectively. We examined the associations of adiposity measures (body weight, body mass index [BMI], waist circumference, hip circumference, waist-to-hip ratio [WHR], waist-to-height ratio [WHtR], ponderal index [PI], body adiposity index (BAI) and conicity index [CI]) with blood pressure and hypertension by sex.

Results: In 380 subjects (women 66.6%, mean age 21.5 years), the prevalence of obesity (BMI ≥ 28 kg/m2) was 2.1%, and the prevalence of hypertension was 2.6% (≥ 140/90 mmHg) and 24.5% (≥ 130/80 mmHg), respectively. In correlation analyses and multivariable-adjusted linear regression analyses, most adiposity measures of central obesity were significantly associated with blood pressure in men, while in women, either adiposity measures of central or general obesity were associated with blood pressure. The predictive power of adiposity measures for hypertension was generally low in men. However, adiposity measures of either general obesity or central obesity were predictive for hypertension defined by Chinese hypertension guidelines in women.

Conclusion: There are gender-specific associations of central and general obesity with blood pressure and hypertension in young Chinese medical students.

Introduction

Overweight and obesity are increasing at higher rates than ever in young adults in developing countries like China due to urbanization, sedentary lifestyle, unhealthy eating habits, and inadequate physical activity [1-3]. Indeed, in a nationwide population-based study in rural China from 2010 to 2014, the prevalence of combined overweight and obesity among men was 33.8% according to the Chinese criteria (body mass index, BMI ≥ 24.0 kg/m^2) [4], and the prevalence of obesity was 6.3% (BMI ≥ 28.0 kg/m^2) [5]. The prevalence of overweight and obesity varied in different ethnic groups, geographic regions, age, education, and GDP levels, and an increasing trend was observed over the 5-year study period [5]. Obesity has become a severe public health problem and a major disease burden in China. The Chinese government has adopted strategies such as government leading, prevention from childhood, comprehensive school-based intervention, multi-sector cooperation, and active social participation, to prevent and control obesity and obesity-related health problems.

Obesity is a significant risk factor for hypertension, and obesity-related hypertension is prevalent in young adults. Obesity has been found to increase the risk of hypertension and numerous other diseases, including insulin resistance, metabolic syndrome, diabetes mellitus, sleep-breath disorders, coronary artery diseases, stroke, and certain forms of cancer [6-9]. Obesity is usually defined by a BMI of 28 kg/m^2 or higher in China [4], but this does not take into account the morbidity and mortality associated with more modest degrees of overweight, nor the detrimental effect of intra-abdominal fat [9]. Several other anthropometric measures of adiposity have been proposed recently to evaluate general or central obesity, which including body weight, waist circumference, hip circumference, waist-to-hip ratio (WHR), waist-to-height ratio (WHtR), ponderal index (PI), body adiposity index (BAI) and conicity index (CI).

Previous studies have extensively investigated the predictive value of different adiposity measures for blood pressure (BP), hypertension, and other cardiovascular diseases [10-15]. BMI is widely used to estimate the prevalence of obesity within a population. BMI is steadily associated with an increased risk of hypertension and type 2 diabetes, although this measure does not account for variation in body fat distribution and abdominal fat mass, which can differ significantly across populations and can vary substantially within a narrow range of BMI [16]. Some studies also explored measures accounting for body fat distribution and abdominal fat in different populations [12,17,18]. However, the predictive values of those anthropometric measures were significantly different in men and women, in different ethnicities or age groups [6,11,19,20]. The data regarding the predictive value of distinct anthropometric measures of adiposity in apparently healthy young adults are scarce. Thus, we aim to investigate the relationship of anthropometric measures of adiposity with blood pressure and hypertension in a group of Chinese young college students.

Subjects and methods

Study subjects

The college students were recruited from the 2012 batch of Clinical College of Dali University from March to April 2015. All the students attending the class of Diagnostics were invited to participate in the present study. Our study was conducted in accordance with the principles of the Declaration of Helsinki. The study protocol was approved by the Ethics Committee of Dali University. All participants gave written informed consent.

A total of 406 students (participation rate 81.2%) were enrolled. We excluded 26 students because blood pressure was not measured (n = 4) or because of missing of other information (n = 22). Thus, the number of participants included in the present analysis was 380.

Clinical measurements

Trained doctors measured office BP on the non-dominant arm using the mercury sphygmomanometer two times after the subjects had rested in the sitting position for at least 5 mins. The two consecutive readings were averaged for analyses. Office hypertension was a BP ≥ 140/90 mmHg according to the 2018 Chinese hypertension guidelines [4]. We also defined hypertension as a BP ≥ 130/80 mmHg according to the 2017 ACC/AHA hypertension guidelines [21]. A standard questionnaire was used to collect information on age, sex, family history of hypertension, current medication and other information. Body weight was measured to the nearest 0.5 kg using a weighing scale with the students removing his/her footwear. Waist circumference and hip circumference were measured by a standard measuring tape. Waist circumference was measured across midpoint between the top of the iliac crest and the lower margin of the last palpable rib in the midaxillary line. Hip circumference was measured around the widest portion of the buttocks. For measurement of waist and hip circumference, the students were instructed to stand with close feet, arms at the side and body weight evenly distributed across the feet, and with light clothing. Anthropometric indices were calculated as follows:

BMI = weight (kg)/height^2 (m); WHR = waist circumference (cm)/hip circumference (cm); WHtR = waist circumference (cm)/height (cm); PI = weight (kg)/height^3 (m); BAI = hip circumference (cm)/height$^{1.5}$ (m) -18;

$$CI = \frac{\text{waist circumference(m)}}{0.109 \times \sqrt{\frac{\text{weight(kg)}}{\text{height(m)}}}}$$

We defined overweight (BMI 24-27.9 kg/m^2) and obesity (BMI ≥ 28 kg/m^2) according to the Chinese guidelines [4].

Statistical analysis

Statistical analyses were performed using SAS 9.3 (SAS Institute Inc., Cary, NC, USA). Means and proportions were compared with the Student's t - test and χ^2 tests, respectively. Men and women had distinctive features of obesity; thus, we performed gender-specific analyses. Pearson correlation analyses and multivariate linear regression analyses were used to explore the relationship of adiposity measures with blood pressure. The receiver operating characteristic curve (ROC) analysis was used to compare the performance of the adiposity measures as potential predictors of hypertension. The area under the curve (AUC) was used as a measure of predictive power. AUC of other adiposity measures was compared with BMI. All p values were two-sided, and significance was defined as a $p \le 0.05$.

Results

Characteristics of the study population

The 380 subjects included 253 women (66.6%) and had a mean (± SD) age of 21.5 ± 0.9 years. The prevalence of overweight and obesity was 7.1% and 2.1%, respectively. The prevalence of hypertension was 24.5% using the ACC/AHA 2017 hypertension guidelines and 2.6% using the China hypertension guidelines, respectively. Men compared with women had significantly higher age, body height, body weight, BMI, waist circumference, hip circumference, WHR, systolic and diastolic BP, a higher proportion of hypertension and overweight and obesity ($p \le 0.0008$). However, men had a lower pulse rate and BAI ($p \le 0.01$) and similar WHtR, PI, CI, and family history of hypertension ($p \ge 0.12$) as compared with women (Table 1).

Gender-specific associations of adiposity measures with blood pressure

In men, hip circumference ($r = 0.185$, $p = 0.04$), BAI ($r = 0.193$, $p = 0.03$) and CI ($r = 0.232$, $p = 0.009$) were positively correlated to SBP, while waist circumference ($r = 0.194$, $p = 0.03$) and WHtR ($r = 0.204$, $p = 0.02$) were positively correlated to DBP in Pearson correlation analyses. In women, body weight, BMI, waist circumference, WHtR and PI were positively related to SBP ($r \ge 0.146$, $p \le 0.03$) and DBP ($r \ge 0.184$, $p \le 0.01$) (Table 2).

In multivariable linear regression analyses after adjusted for age, pulse rate and family history of hypertension, CI (β ± SE, 21.884 ± 9.362 mmHg, $p = 0.02$) was positively associated with SBP, and waist circumference (β ± SE, 0.142 ± 0.067 mmHg, $p = 0.04$) and WHtR (β ± SE, 24.491 ± 11.535 mmHg, $p = 0.04$) were positively associated with DBP in men (Tables 3,4). In women, body weight, BMI, waist circumference, WHtR and PI were positively related to SBP ($\beta \ge 0.165$, $p \le 0.03$) and DBP ($\beta \ge 0.237$, $p \le 0.02$) (Tables 3,4).

Predictive value of different adiposity measures for hypertension

The AUCs of adiposity measures were generally significantly higher if we defined hypertension according to Chinese hypertension guideline (BP ≥ 140/90 mmHg) rather than ACC/AHA 2017 hypertension guideline (BP ≥ 130/80 mmHg). We also found a significant gender difference in the predictive power of adiposity measures. In men, only WHR had a relatively higher predictive power (AUC 0.745) than other measures (AUC ≤ 0.705) if hypertension was defined as BP ≥ 140/90 mmHg. Furthermore, all adiposity measures were less predictive (AUC ≤ 0.568) if hypertension was defined as BP ≥ 130/80 mmHg (Tables 5,6). There was no significant difference in AUCs between other adiposity measures and BMI ($p > 0.05$).

In women, body weight (AUC 0.976), BMI (AUC 0.897), waist circumference (AUC 0.863), WHR (AUC 0.897), PI (AUC 0.829), and BAI (AUC 0.831) had a relatively higher predictive power for hypertension defined as BP ≥ 140/90 mmHg. Compared with BMI, body weight had a significantly higher predictive value while hip circumference, WHtR, PI, BAI, and CI had a significantly lower predictive value. If hypertension was defined as BP ≥ 130/80 mmHg, adiposity measures were less predictive for hypertension (AUC ≤ 0.660).

Discussion

Our study in young, healthy Chinese medical college students showed a gender-specific association between adiposity measures, blood pressure, and hypertension.

Table 1: Characteristics of subjects by sex.

Characteristics	Men (n = 127)	Women (n = 253)	p
Age (year)	21.77 ± 0.96	21.43 ± 0.89	0.0008
Body height (cm)	172.28 ± 5.79	158.68 ± 5.52	< 0.0001
Body weight (Kg)	65.63 ± 11.88	50.30 ± 5.64	< 0.0001
Body mass index (Kg/m^2)	22.11 ± 3.91	20.02 ± 2.60	< 0.0001
Waist circumference (cm)	80.38 ± 10.18	72.63 ± 6.85	< 0.0001
Hip circumference (cm)	93.58 ± 8.03	89.30 ± 6.69	< 0.0001
Waist to hip ratio	0.859 ± 0.079	0.817 ± 0.103	< 0.0001
Waist to height ratio	0.467 ± 0.059	0.458 ± 0.048	0.16
Ponderal index	12.86 ± 2.40	12.66 ± 2.06	0.43
Body adiposity index	23.45 ± 3.90	26.76 ± 4.15	< 0.0001
Conicity index	1.20 ± 0.08	1.18 ± 0.07	0.12
Systolic blood pressure (mmHg)	111.76 ± 8.48	105.58 ± 7.57	< 0.0001
Diastolic blood pressure (mmHg)	75.19 ± 7.83	71.17 ± 7.24	< 0.0001
Pulse rate (beats/minute)	74.20 ± 12.48	77.72 ± 12.60	0.01
Family history of Hypertension n (%)	12 (9.45)	30 (11.86)	0.48
Overweight n (%)	18 (14.17)	9 (3.56)	< 0.0001
Obese n (%)	6 (4.72)	2 (0.79)	< 0.0001
Hypertension (≥ 130/80 mmHg) n (%)	49 (38.58)	44 (17.39)	< 0.0001
Hypertension (≥ 140/90 mmHg) n (%)	9 (7.09)	1 (0.40)	0.0001

Vales were mean ± standard deviation.

Table 2: Association of adiposity indices with blood pressure by sex.

Anthropometric measures	Men (*n* = 127)				Women (*n* = 253)				All (*n* = 380)			
	SBP (mmHg)	*p*	DBP (mmHg)	*p*	SBP (mmHg)	*p*	DBP (mmHg)	*p*	SBP (mmHg)	*P*	DBP (mmHg)	*P*
BW (Kg)	- 0.105	0.24	0.145	0.10	0.194	0.002	0.234	0.0002	0.251	<.0001	0.292	<.0001
BMI (Kg/m^2)	- 0.097	0.28	0.167	0.06	0.189	0.003	0.191	0.002	0.157	0.002	0.239	<.0001
WC (cm)	0.091	0.31	0.194	0.03	0.146	0.02	0.214	0.0006	0.245	<.0001	0.281	<.0001
HIPC (cm)	0.185	0.04	0.161	0.07	0.093	0.14	0.118	0.06	0.212	<.0001	0.193	0.0002
WHR	- 0.104	0.24	0.098	0.27	0.040	0.53	0.099	0.12	0.067	0.19	0.142	0.006
WHtR	0.104	0.24	0.204	0.02	0.141	0.03	0.184	0.003	0.144	0.005	0.204	<.0001
PI	- 0.086	0.34	0.167	0.06	0.166	0.008	0.154	0.01	0.077	0.13	0.164	0.001
BAI	0.193	0.03	0.162	0.07	0.096	0.13	0.082	0.19	- 0.012	0.81	0.010	0.85
CI	0.232	0.009	0.149	0.09	0.044	0.49	0.125	0.05	0.135	0.008	0.149	0.004

BW: Body Weight; BMI: Body Mass Index; WC: Waist Circumference; HIPC: Hip Circumference; WHR: Waist To Hip Ratio; Whtr: Waist To Height Ratio; PI: Ponderal Index; BAI: Body Adiposity Index; CI: Conicity Index; SBP: Systolic Blood Pressure; DBP: Diastolic Blood Pressure

Table 3: Multivariable adjusted association of adiposity indices with systolic blood pressure by sex.

Anthropometric measures	Men (*n* = 127)		Women (*n* = 253)		All (*n* = 380)	
	β ± SE	*p*	β ± SE	*p*	β ± SE	*P*
BW (Kg)	-0.061 ± 0.063	0.33	0.278 ± 0.084	0.001	0.197 ± 0.039	< 0.0001
BMI (Kg/m^2)	-0.196 ± 0.190	0.30	0.533 ± 0180	0.003	0.396 ± 0.132	0.003
WC (cm)	0.068 ± 0.073	0.35	0.165 ± 0.069	0.02	0.228 ± 0.048	< 0.0001
HIPC (cm)	0.186 ± 0.092	0.05	0.096 ± 0.071	0.18	0.235 ± 0.057	< 0.0001
WHR	-11.476 ± 9.656	0.24	3.748 ± 4.604	0.42	5.288 ± 4.412	0.23
WHtR	12.049 ± 12.488	0.34	21.577 ± 9.831	0.03	21.837 ± 8.200	0.008
PI	-0.306 ± 0.310	0.33	0.567 ± 0.228	0.01	0.279 ± 0.198	0.16
BAI	0.356 ± 0.191	0.06	0.143 ± 0.115	0.21	-0.032 ± 0.100	0.75
CI	21.884 ± 9.362	0.02	4.627 ± 6.492	0.48	13.976 ± 5.708	0.01

Values were β ± SE, and adjusted for age, pulse rate and family history of hypertension. BW: Body Weight; BMI: Body Mass Index; WC: Waist Circumference; HIPC: Hip Circumference; WHR: Waist To Hip Ratio; Whtr: Waist To Height Ratio; PI: Ponderal Index; BAI: Body Adiposity Index; CI: Conicity Index

Table 4: Multivariable adjusted association of adiposity indices with diastolic blood pressure by sex.

Anthropometric measures	Men (*n* = 127)		Women (*n* = 253)		All (*n* = 380)	
	β ± SE	*p*	β ± SE	*p*	β ± SE	*p*
BW (Kg)	0.105 ± 0.059	0.08	0.339 ± 0.080	< 0.0001	0.215 ± 0.035	< 0.0001
BMI (Kg/m^2)	0.333 ± 0.177	0.06	0.542 ± 0.0173	0.002	0.568 ± 0.118	< 0.0001
WC (cm)	0.142 ± 0.067	0.04	0.237 ± 0.065	0.0003	0.242 ± 0.043	< 0.0001
HIPC (cm)	0.168 ± 0.087	0.06	0.130 ± 0.068	0.06	0.196 ± 0.052	0.0002
WHR	8.2269.070 ±	0.37	7.372 ± 4.410	0.10	11.005 ± 3.988	0.006
WHtR	24.491 ± 11.535	0.04	27.731 ± 9.386	0.003	28.964 ± 7.394	0.0001
PI	0.524 ± 0.288	0.07	0.528 ± 0.219	0.02	0.572 ± 0.178	0.001
BAI	0.309 ± 0.179	0.09	0.122 ± 0.110	0.27	0.004 ± 0.091	0.96
CI	12.954 ± 8.890	0.15	12.373 ± 6.202	0.05	14.119 ± 5.192	0.007

Values were β ± SE, and adjusted for age, pulse rate and family history of hypertension. BW: Body Weight; BMI: Body Mass Index; WC: Waist Circumference; HIPC: Hip Circumference; WHR: Waist To Hip Ratio; Whtr: Waist To Height Ratio; PI: Ponderal Index; BAI: Body Adiposity Index; CI: Conicity Index

Table 5: Analysis of the predictive power of adiposity index for hypertension (≥ 140/90 mmHg) by sex.

Anthropometric measures	Men (*n* = 127)			Women (*n* = 253)			All (*n* = 380)		
	AUC	95% LCI	95%UCL	AUC	95% LCI	95% UCL	AUC	95% LCI	95% UCL
BW (Kg)	0.670	0.466	0.874	0.976*	0.958	0.994	0.864	0.778	0.949
BMI (Kg/m^2)	0.699	0.551	0.846	0.897	0.859	0.935	0.815	0.716	0.914
WC (cm)	0.685	0.502	0.867	0.863	0.822	0.904	0.802	0.682	0.923
HIPC (cm)	0.564	0.318	0.809	0.540*	0.481	0.599	0.629*	0.418	0.840
WHR	0.745	0.574	0.916	0.897	0.859	0.935	0.837	0.728	0.945
WHtR	0.684	0.500	0.869	0.774*	0.722	0.826	0.703	0.531	0.875
PI	0.705	0.565	0.846	0.829*	0.783	0.876	0.723*	0.590	0.857
BAI	0.577	0.336	0.817	0.831*	0.785	0.878	0.589	0.374	0.804
CI	0.624	0.398	0.851	0.564*	0.502	0.625	0.644*	0.446	0.841

*indicated AUC significantly different from that of body mass index ($p < 0.05$). BW: Body Weight; BMI: Body Mass Index; WC: Waist Circumference; HIPC: Hip Circumference; WHR: Waist To Hip Ratio; Whtr: Waist To Height Ratio; PI: Ponderal Index; BAI: Body Adiposity Index; CI: Conicity Index; LCL: Lower Confidence Interval; UCL: Upper Confidence Interval.

Table 6: Analysis of the predictive power of adiposity index for hypertension (≥ 130/80 mmHg) by sex.

Anthropometric measures	Men (*n* = 127)			Women (*n* = 253)			All (*n* = 380)		
	AUC	95% LCI	95% UCL	AUC	95% LCI	95% UCL	AUC	95% LCI	95% UCL
BW (Kg)	0.527	0.424	0.630	0.644	0.561	0.727	0.675	0.616	0.734
BMI (Kg/m²)	0.551	0.447	0.654	0.624	0.537	0.710	0.632	0.568	0.696
WC (cm)	0.558	0.454	0.662	0.627	0.539	0.714	0.643	0.580	0.706
HIPC (cm)	0.544	0.441	0.647	0.532*	0.430	0.633	0.581	0.512	0.650
WHR	0.553	0.446	0.659	0.660	0.575	0.745	0.646	0.584	0.709
WHtR	0.563	0.457	0.669	0.611	0.524	0.698	0.593	0.526	0.661
PI	0.564	0.459	0.668	0.604	0.516	0.693	0.583*	0.515	0.651
BAI	0.568	0.464	0.672	0.488*	0.389	0.586	0.451*	0.382	0.521
CI	0.551	0.445	0.656	0.569	0.483	0.654	0.569	0.503	0.634

*indicated AUC significantly different from that of body mass index ($p < 0.05$). BW: Body Weight; BMI: Body Mass Index; WC: Waist Circumference; HIPC: Hip Circumference; WHR: Waist To Hip Ratio; Whtr: Waist To Height Ratio; PI: Ponderal Index; BAI: Body Adiposity Index; CI: Conicity Index; LCL: Lower Confidence Interval; UCL: Upper Confidence Interval.

Indeed, in our lean college students (BMI mean ± SD, 20.7 ± 3.3 kg/m^2), only CI was significantly correlated with SBP, while waist circumference and WHtR correlated with DBP in men. Adiposity measures were also had relatively weak predictive values for hypertension in men. However, in women, except for hip circumference, WHR, BAI and CI, other adiposity measures including body weight, BMI, waist circumference, WHtR and PI were significantly associated with blood pressure and had a better predictive value for hypertension defined as BP ≥ 140/90 mmHg.

Usually, medical college students have better lifestyles and metabolic profiles than students from other universities or young adults from other professionalism. As showed in our study, only very few students would be classified as hypertension (2.6%, ≥ 140/90 mmHg) or obesity (2.1%, ≥ 28 kg/m^2), which were significantly lower than those in general population [22]. There have been many adiposity indices to assess obesity. BMI is the most frequently used and widely accepted index to characterize obesity in individuals and epidemiological studies. However, BMI does not provide an accurate measurement of body composition and may be influenced by ethnicity, sex, and age. Thus, some other indices including waist circumference, hip circumference, WHR, WHtR, PI, BAI and CI, have been proposed to evaluate obesity. We found that there was a gender-specific association of adiposity indices with SBP, DBP and hypertension, and the correlation of adiposity with blood pressure and hypertension was generally weaker in men than in women. Indeed, in men, only CI, waist circumference and WHtR, indices of central obesity were positively related to SBP and DBP. While in women, both indices of central obesity (waist circumference, WHtR) and general obesity (body weight, BMI, PI) were associated with blood pressure.

Our findings were consistent with some previous studies. Taing, et al. [11] found that waist circumference and BMI were strongly and positively associated with blood pressure levels for both sexes and in all age groups in 7601 Indians aged 18-59 years. Moreover, waist circumference, an index of central obesity, compared with BMI, was a more important determinant of blood pressure and hypertension in Indian adults. The subjects in the present study were comparable to those in the youngest subgroup of their study (age, 18-29 years; mean BMI in men 20.6 kg/m^2, women 20.4 kg/m^2) [11]. Thus our study further provided evidence that central obesity is more important than general obesity in association with blood pressure in Asians. Previous studies have indicated that compared with Europeans, Asians seem to have more abdominal adiposity [16]. Moreover, independent of gender, higher abdominal adiposity, especially abdominal visceral fat, was associated with various metabolic risks, including insulin resistance [23], arterial stiffness [24], higher blood pressure [18] and odds of hypertension. Thus, as showed in our slim medical college students, adiposity indices that capture central fat distribution might be more informative for blood pressure status in young Chinese. The observed gender difference in the association of adiposity with blood pressure might be due to the different distribution of adipose tissues between the sexes [23,25]. Men generally have more massive amounts of visceral adipose tissues than women, while women have larger amounts of subcutaneous adipose tissues [23]. Indeed, in non-obese Japanese men but not in non-obese women, brachial-ankle pulse wave velocity (baPWV) was associated with the visceral/subcutaneous adipose tissue ratio [24]. It means that only considering visceral and subcutaneous adiposity may not be sufficient for the evaluation of arterial stiffness and subsequent high blood pressure in non-obese women. Thus, in non-obese women, the adiposity indices reflecting general obesity should be used in addition to central obesity indices to assess the obesity of women more accurately.

The associations of adiposity measures with hypertension were, for the most part, comparable to those observed with continuous blood pressure. The predictive value of adiposity measures for hypertension (≥ 140/90 mHg) was generally weaker in men than in women, and both general obesity measures and central obesity measures were predictive for hypertension. However, if we defined hypertension as ≥ 130/80 mmHg, the predictive power of all adiposity measures was decreased significantly either in men or in women. The prevalence of hypertension in the present medical college students was very low, and we also did not perform ambulatory blood pressure monitoring or repeated blood pressure measurements on different days, which might be more accurate to assess blood pressure status. The low prevalence of hypertension and the relatively younger age and lower prevalence of overweight and obesity might be part of the explanation for the observed relatively low predictive power of obesity measures for hypertension in the present study. In general, our results indicate that blood pressure may predominantly associate with abdominal obesity in slim young adults. Several mechanisms have been proposed to relate obesity with hypertension, which including oxidative stress, inflammation, impaired vascular function, upregulated sympathetic activity, abnormal leptin secretion, and physical compression of kidneys by excessive abdominal adiposity [26-28]. Though our study subjects were generally slim and healthy, interventions for the prevention of obesity in such young adults are also needed to lower the possibility of hypertension in the future.

Our study has some limitations that should be considered when interpreting the results. First, the cross-sectional design does not allow any causal inference. Second, our study population was small and had a younger age, had less blood pressure measurements, lower BMI, and a small number of prevalent hypertension. Furthermore, we did not collect information on smoking, drinking, physical activity and salt intake, which might be essential for the development of obesity and hypertension. Thus, our results may not be extrapolated to the general population. Future studies with a larger population, out-of-clinic blood pressure measurements or more BP measurements may provide additional valuable information. Notwithstanding these limitations, our study provides evidence of adiposity with blood pressure and hypertension in young slim Chinese adults.

Conclusion

In conclusion, in young slim Chinese medical college students, both general and central obesity measures are associated with blood pressure and prevalent hypertension. Greater emphasis should be given to central obesity measures, such as waist circumference and CI. Prospective observational studies and even larger scale cross-sectional studies are mandatory.

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