Gender-Difference in the Association Between Anthropometric Parameters and the Risk Factors of Cardiovascular Diseases in Rural Chinese People: The Handan Eye Study

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Abstract

Background

Body mass index (BMI), waist circumference (WC), waist to hip ratio (WHR), waist/hip/height ratio (WHHR), sagittal abdominal diameter (SAD), and SAD/height ratio (SADHR) are all anthropometric tools used to categorize obesity status. This study aimed to determine associations between different anthropometric indices and the risk of cardiovascular disease (CVD) in Chinese rural areas.

Methods

The Handan Eye Study is a population-based, longitudinal study. In total, 6830 participants, aged 30 years or older, participated in the baseline study (HES-1). Among them, 5394 subjects of the 6323 survivors (follow-up rate: 85.3%) took part in the 6-year follow-up study (HES-2). As a new anthropometric parameter, SAD was added into HES-2. Meanwhile total cholesterol, high-density lipoprotein protein cholesterol (HDL-C), low-density lipoprotein cholesterol (LDL-C), triglyceride (TG), and other biochemical data were recorded. This cross-sectional study analyzed these anthropometric obesity indices and correlations with CVD. Prevalence of metabolic syndrome (MS) was used as the indicator of CVD.

Results

Among the 5394 patients in this study, multivariate analysis revealed higher BMI and WC in women compared to men (24.61 vs. 23.66, $p < 0.0001$). SAD, WHR, and WHHR showed a smaller correlation to CVD risk factors when compared with other anthropometric parameters. WC and SADHR were more effective predictors of CVD and MS. In men, BMI exhibited a greater proportionality to high-TG (0.693) and hypertension (0.593) and SADHR showed a correlation to low-HDL (0.561) as well as high-glucose (0.664). WC and SADHR were the most effective diagnostic parameters in women.

Conclusions

Within a rural Chinese population, women were observed to be comparatively more overweight than men. SADHR and BMI serve as effective indicators of CVD and MS in men, whereas SADHR and WC are more effective indicators of CVD and MS in women. Age and gender affect anthropometric obesity indices and correlations with CVD.

Introduction

Cardiovascular disease (CVD) is currently the leading cause of mortality, accounting for one third of all deaths world-wide [1]. Over the past decade, death caused by CVD has increased by approximately 12.5% worldwide. CVD risk factors include hypertension, abnormal lipid metabolism, diabetes, obesity, smoking, alcohol consumption, and low levels of physical activity [2].

In recent research, obesity has been shown to play a leading role in CVD pathogenesis [3]. Body mass index (BMI) is widely used to determine overweight and obesity. It is suggested that BMI is related to diabetes and hypertension, and increased BMI may serve as an indicator for CVD. Interestingly, abdominal fat is associated with CVD and its risk factors, including glucose tolerance, diabetes, hypertension, and lipid metabolism [4–6]. Waist circumference (WC) and waist to hip ratio (WHR) are conventionally used as the predominant measure of abdominal obesity [7]. A new anthropometric measurement, the waist/hip/height ratio (WHHR) serves as a novel marker of CVD prediction and mortality [8, 9]. Abdominal obesity, or visceral fat storage, significantly increases the risk of CVD, fatal coronary artery disease, type 2 diabetes and other metabolic disorders [10]. Sagittal abdominal diameter (SAD), the height of the abdomen when lying supine, may serve as a better predictor of abdominal obesity in CVD, hypertension, and diabetes [11–13]. Some studies have shown that SAD has a stronger correlation with CVD than BMI and WC [14]. SAD/height ratio (SADHR) is associated with CVD risks [15]. One obstacle to broadening the usage of these anthropometric parameters is that the parameters are not always consistent in predicting CVD [16]. A recent study showed that SAD is not more advantageous in predicting metabolic traits than WC, and the study also found that there is gender difference in the correlation between WC, BMI, SAD, and CVD [17]. Previous studies have indicated the essential role of gender in CVD development. However, comprehensive studies on the impacts of sex on anthropometric parameters are lacking [18].

Our study aimed to use epidemiological data to analyze the association between obesity indicators (BMI, WC, WHR, SAD, WHHR, and SADHR) and CVD risk factors. Since metabolic syndrome (MS) is a major risk factor for CVD [19–21], we calculated the correlation between the diagnosis of obesity indicators and MS. We determined that the best anthropometric parameter for predicting CVD risk is SADHR in the general population. We also confirmed that gender plays a key role in determining the association between anthropometric parameters and CVD.

Materials And Methods

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Study Design

The Handan Eye Study-2 (HES-2) was a 6-year cohort study. The baseline design (HES-1) was described previously [22]. This study enrolled 6830 adults (aged > 30 years old) from 13 villages in Handan City, Hebei Province in northern China. The villages were randomly selected using clustered sampling. HES-1 was designed to provide information on risk factors for major ocular diseases, visual impairment, and blindness. HES-2 focused on incidence. The Handan Eye study is registered on the Chinese Clinical Trial Registry website <http://www.chictr.org.cn/> (registry number ChiCTR-EOC-17013214). The study was approved by the ethics committee of Beijing Tongren Hospital, Capital Medical University (approval number TREC2006-22) and followed the Declaration of Helsinki Ethical Principles for Medical Research. Informed consent was signed by all the subjects in this study.

Recruitment in Follow-ups

To recruit the subjects in the follow-up study, village leaders and local doctors explained the new study to the villagers who participated in HES-1 using social media (including television and radio broadcasts) as well as one-on-one meetings. Doctors performed home visits to the subjects who had difficulty understanding the follow-ups.

The follow-ups were performed in village clinics for subjects with disabilities.

5394 subjects (> 35 years old) out of 6323 survivors participated in HES-2. The follow-up rate was 85.31%. Details of the HES-2 study has been described elsewhere[23].

Anthropometry

Standing height was measured to the nearest millimeter using a stadiometer.

Body weight was measured to the nearest 0.1 kg. Participants were measured in light clothing without footwear.

Blood pressure was measured twice (at an interval of 2 to 3 minutes) using an Omron medical electronic sphygmomanometer (OMRON, Kyoto, Japan). If the difference between the two systolic pressure measurements exceeded 10 mmHg or the diastolic pressure difference exceeded 5 mmHg, a third measurement was performed and the two closest records were used. Participants who could not be measured using the Omron device were measured using a mercury sphygmomanometer.

Waist circumference (WC) was measured at the minimum circumference between the iliac crest and the rib cage (usually 0.5 to 1 cm above the umbilicus) using an anthropometric measure tape.

Hip circumference (HC) was measured at the maximum protuberance of the buttocks using an anthropometric measure tape (cm). All anthropometric measurements were performed in duplicate and the values were averaged. WHR was calculated as WC divided by the hip circumference, and WHHR was calculated as WHR divided by height (cm). Participants were measured in light clothing.

Sagittal abdominal diameter (SAD) was measured using a portable sliding-beam caliper (Holtain Ltd, Crymch, UK). Participants rested on a lightly padded bed in a flexed position when the examiner marked the level of the iliac crests. The examiner lowered the caliper's upper arm, lightly touching the abdomen. The SAD was recorded in duplicate to the nearest 0.1 cm [24]. SADHR was calculated as SAD (cm)/height (cm).

Biochemical analysis

Participants fasted for at least 8 hours before blood collection (collection took place between 7:00 AM and 9:00 AM). These blood samples were temporarily stored in a portable incubator and were transferred to the Laboratory of the Handan Eye Hospital for analysis at noon on the same day. Blood samples were centrifuged at 1500 G for 10 minutes in order to perform a biochemical analysis (glucose content, total triglycerides, total cholesterol, high density lipoprotein, low density lipoprotein, urea, and creatinine). Glycated hemoglobin (HbA1c) was detected using high performance liquid chromatograph. The remaining blood samples were centrifuged and were stored at -80 °C for future analysis.

Diagnosis criteria for metabolic syndrome (MS)

The diagnosis criteria for MS used in this study were established by the Chinese Joint Committee for Developing Chinese Guidelines (JCDCG) Guidelines on Prevention and Treatment of Dyslipidemia in Adults (2007) [25]. MS was diagnosed if more than three of the followings were met:

1. Central obesity: waistline ≥ 90 cm for men and waistline ≥ 85 cm for women;
2. Elevated glucose: fasting blood glucose ≥ 6.1 mmol/l and/or 2hPG ≥ 7.8 mmol/l and/or with previous diabetes diagnosis and medication;
3. Hypertension: systolic blood pressure/diastolic blood pressure $\geq 130/85$ mmHg;
4. Elevated triglyceride: fasting blood triglyceride ≥ 1.7 mmol/l;
5. Reduced HDL-C: fasting blood HDL-C < 1.04 mmol/l.

Median (inter-quartile range) was used for continuous variables and N (%) was used for categorical variables. WILCOXON rank-sum and Chi-square tests were utilized to compare the difference between genders. Age- and gender-specific prevalence of MS were calculated and standardized to the Chinese population [26]. A Spearman correlation analysis was used for binary correlations (unadjusted) and partial correlations between anthropometry indictors and the risk factors of CVD. Area under the curve (AUC) was calculated to reveal the strength of associations. A p value of < 0.05 was considered statistically significant. All data analyses were performed using SAS version 9.1 (SAS Institute, Cary, NC).

Results

Within the study population, there was no significant difference between men and women in age, diastolic blood pressure, and SAD. Men were taller in height (168 cm vs. 156 cm, $p < 0.0001$) and higher in weight (67 kg vs. 60 kg, $p < 0.0001$). Women exhibited higher SDP, glucose, TC, TG, HDL, LDL, and HCRP than men ($p < 0.0001$). SADHR was higher in women (12.76 vs. 11.85, $p < 0.0001$). Women displayed a higher BMI than men (24.61 vs. 23.66, $p < 0.0001$) (Table 1). Percentages were calculated using categorical variables. The percentage of overweight and obesity in the study population was higher in the women than the men (46.37% and 8.46% vs. 39.99% and 5.23%). Women had a higher percentage of abdominal obesity based on WC (2.44% vs. 2.26%) and MS (29.32% vs. 24.69%).

Table 1
Demographic data grouped by gender

	Total	Men	Women	z/	P value
Age (year)	52 ± 16	52 ± 17	52 ± 16	0.87 ^a	0.3851
SBP (mmHg)	135 ± 29	134 ± 26.5	136.5 ± 31	-13.39 ^a	< 0.001*
DBP (mmHg)	77 ± 16	77 ± 16.5	77 ± 16	-0.45 ^a	0.653
Pulse Rate (n)	76 ± 15	73.5 ± 15	77.5 ± 15	179.46 ^a	< 0.001*
Height (cm)	161 ± 13	168 ± 8	156 ± 8	50.03 ^a	0.001*
Weight (kg)	63 ± 13	67 ± 14	60 ± 11	24.18 ^a	0.001*
Glucose (mmol/l)	5.51 ± 0.75	5.41 ± 0.76	5.47 ± 0.83	-4.03 ^a	0.001*
TC (mmol/l)	4.52 ± 1.19	4.37 ± 1.12	4.64 ± 1.25	-9.41 ^a	0.001*
TG (mmol/l)	1.25 ± 0.93	1.19 ± 0.31	1.28 ± 0.91	-2.86 ^a	< 0.05*
HDL (mmol/l)	1.24 ± 0.34	1.19 ± 0.32	1.29 ± 0.35	-12.94 ^a	0.001*
LDL (mmol/l)	2.65 ± 0.83	2.58 ± 0.73	2.72 ± 0.88	-7.44 ^a	0.001*
HCRP (µg/ml)	0.86 ± 1.86	0.78 ± 1.73	0.93 ± 1.93	-2.45 ^a	< 0.05*
BMI < 18.5	258 ± 4.81	116 ± 4.86	142 ± 4.77	-7.61 ^a	< 0.001*
18.5 ≤ BMI < 23.9	2395 ± 44.63	1192 ± 49.92	1203 ± 40.40		
24.0 ≤ BMI < 27.9	2336 ± 43.53	955 ± 39.99	1381 ± 46.37		
BMI ≥ 28	377 ± 7.03	125 ± 5.23	252 ± 8.46		
BMI (kg/m ²)	24.17 ± 4.39	23.66 ± 4.28	24.61 ± 4.4	-7.96 ^a	0.001*
SAD (mm)	200 ± 37	199 ± 38	200 ± 36	-0.63 ^a	0.529
WC (cm)	86 ± 14	87 ± 13	86 ± 13.6	5.18 ^a	0.001*
Abdominal obesity	2599 ± 48.18	967 ± 40.19	1642 ± 54.62	111.12 ^b	< 0.001*
WHR	0.9 ± 0.06	0.92 ± 0.06	0.88 ± 0.06	25.54 ^a	< 0.001*
WHHR	0.57 ± 0.49	0.55 ± 0.04	0.57 ± 0.05	-16.84 ^a	< 0.001*
SADHR	12.38 ± 2.43	11.85 ± 2.26	12.76 ± 2.44	-16.95 ^a	< 0.001*
MS	1470 ± 27.25	594 ± 24.69	876 ± 29.32	13.67 ^b	< 0.001*
Note: SBP: systemic blood pressure; DBP: diastolic blood pressure; TC: total cholesterol; TG: triglycerides; HDL: HDL-cholesterol; LDL: LDL-cholesterol; HCRP: high sensitive C-reactive protein; SAD: sagittal abdominal diameter; BMI: body mass index; WC: waist circumference; SADHR: SAD to height ratio; WHHR: waist-hip-height ratio. a: WILCOXON rank-sum test; b: Chi-square test; *: p < 0.05; abdominal obesity: WC ≥ 90 for men; WC ≥ 85 for women.					

The prevalence of MS increased with age in both men and women. The prevalence in men younger than 50 was higher than in women, whereas it became lower in men older than 50 compared to women older than 50. The crude prevalence was 24.69% in men, 29.13% in women, and 27.25% in the entire population (Table 2).

Table 2
Age-standardized Prevalence of MS by gender

	Male		Female		Total	
	N	%	N	%	N	%
30–39	95	22.84	54	10.07	149	15.65
40–49	133	26.08	137	21.57	270	23.58
50–59	241	25.97	395	33.59	636	30.23
60–69	100	24.10	206	46.40	306	35.62
≥ 70	25	18.25	84	42.64	109	32.63
Standardized rate ^a (95%CI)	23.65(23.54–23.76)		20.23(20.12–20.33)		21.98(21.91–22.06)	
Crude rate(95%CI)	24.69(22.97–26.41)		29.13(27.52–30.78)		27.25(26.06–28.44)	

Table 2. Prevalence of MS in different ages (Standardized rate: Prevalence was standardized to the population of mainland China in 2010).

The bivariate correlations of WC showed the greatest association with SBP ($r = 0.244$), DBP ($r = 0.225$), HDL ($r = -0.229$), LDL ($r = 0.217$) and HCRP ($r = 0.282$). After categorizing with age and gender, WC was well-correlated with SBP ($r = 0.244$), DBP ($r = 0.225$), HDL ($r = -0.229$) and HCRP ($r = 0.226$). In contrast, BMI did not correlate with these parameters as effectively as WC. BMI partially correlated to TC ($r = 0.174$) and LDL ($r = 0.199$) (Table 3). BMI had the highest number of significant partial associations in men while WC had the highest number of significant partial associations in women (Table 4). The highest partial correlations between BMI also partially correlated with risk factors, including SBP ($r = 0.210$), TC ($r = 0.196$), TG ($r = 0.316$) and LDL ($r = 0.228$), in men whereas WC correlated with these factors in women. WC was well-correlated with 7 parameters out of 8. Taking age into consideration, WC correlated with SBP ($r = 0.242$), DBP ($r = 0.264$), HDL ($r = -0.225$) and HCRP ($r = 0.353$).

Table 3
Correlation coefficients between anthropometrical parameters and CVD risk factors

	BMI		WC		SAD		WHR		WHHR		SADHR	
	Bivariate	partial	Bivariate	partial	Bivariate	partial	Bivariate	partial	Bivariate	partial	Bivariate	partial
SBP	0.187*	0.204*	0.244*	0.226*	0.143*	0.190*	0.138*	0.143*	0.186*	0.085*	0.166*	0.175*
DBP	0.223*	0.229*	0.225*	0.238*	0.207*	0.224*	0.109*	0.125*	0.069*	0.051*	0.191*	0.203*
FPG	0.138*	0.135*	0.163*	0.151*	0.184*	0.200*	0.090*	0.087*	0.112*	0.061*	0.19*	0.197*
TC	0.175*	0.174*	0.165*	0.139*	0.111*	0.137*	0.051*	0.066*	0.165*	0.069*	0.162*	0.144*
TG	0.273*	0.275*	0.268*	0.273*	0.265*	0.284*	0.107*	0.126*	0.122*	0.097*	0.278*	0.288*
HDL	-0.164*	-0.180*	-0.229*	-0.229*	-0.215*	-0.220*	-0.167*	-0.118*	-0.006*	-0.069*	-0.150*	-0.208*
LDL	0.196*	0.199*	0.217*	0.188*	0.152*	0.181*	0.089	0.096*	0.170*	0.080*	0.190*	0.182*
HCRP	0.244*	0.204*	0.282*	0.226*	0.235*	0.190*	0.136**	0.143*	0.177*	0.085*	0.255*	0.175*

Table 4
Correlation coefficients between anthropometrical parameters and CVD risk factors (men vs. women)

	BMI		WC		SAD		WHR		WHHR		SADHR	
	Bivariate	partial	Bivariate	partial	Bivariate	partial	Bivariate	partial	Bivariate	partial	Bivariate	partial
Men only												
SBP	0.172*	0.210*	0.177*	0.185*	0.101*	0.199*	0.081*	0.094*	0.105*	0.061*	0.114*	0.189*
DBP	0.204*	0.210*	0.198*	0.201*	0.206*	0.235*	0.095*	0.090*	0.040	0.020	0.189*	0.208*
FPG	0.123*	0.114*	0.158*	0.139*	0.197*	0.205*	0.116*	0.083*	0.098*	0.066*	0.200*	0.206*
TC	0.168*	0.196*	0.138*	0.153*	0.084*	0.149*	0.055*	0.067*	0.087*	0.082*	0.107*	0.161*
TG	0.321*	0.316*	0.277*	0.291*	0.284*	0.299*	0.116*	0.130*	0.071*	0.100*	0.288*	0.301*
HDL	-0.221*	-0.197*	-0.230*	-0.225*	-0.241*	-0.211*	-0.124*	-0.114*	-0.039	-0.055*	-0.222*	-0.197*
LDL	0.200*	0.228*	0.183*	0.196*	0.127*	0.191*	0.080*	0.090*	0.086*	0.081*	0.144*	0.195*
HCRP	0.135*	0.137*	0.182*	0.169*	0.162*	0.178*	0.102*	0.107*	0.112*	0.105*	0.168*	0.181*
Women only												
SBP	0.194*	0.197*	0.300*	0.242*	0.175*	0.173*	0.229*	0.166*	0.234*	0.096*	0.194*	0.157*
DBP	0.240*	0.242*	0.248*	0.264*	0.208*	0.216*	0.135*	0.147*	0.091*	0.074*	0.197*	0.200*
FPG	0.139*	0.141*	0.175*	0.145*	0.173*	0.181*	0.118*	0.071*	0.109*	0.049*	0.177*	0.177*
TC	0.159*	0.142*	0.205*	0.100*	0.128*	0.097*	0.147*	0.035*	0.171*	0.034*	0.152*	0.102*
TG	0.233*	0.232*	0.271*	0.229*	0.248*	0.243*	0.138*	0.085*	0.153*	0.074*	0.268*	0.248*
HDL	-0.163*	-0.164*	-0.209*	-0.225*	-0.205*	-0.222*	-0.100*	-0.116*	-0.063*	-0.075*	-0.194*	-0.213*
LDL	0.179*	0.165*	0.257*	0.155*	0.169*	0.145*	0.182*	0.075*	0.190*	0.056*	0.188*	0.146*
HCRP	0.322*	0.326*	0.360*	0.353*	0.292*	0.287*	0.206*	0.145*	0.220*	0.134*	0.316*	0.292*

The area under the curve (AUCs) of various anthropometrical indices and metabolic risk components are summarized in Table 5 and Table 6. SAD, WHR, and WHHR showed smaller AUCs compared with other indices. As a single diagnostic indicator, WC and SADHR had greater AUCs compared to other parameters. SADHR had the greatest AUC for 4 out of 5 parameters (Table 6). The AUC of BMI in men exhibited a greater correlation to high-TG (0.693) and hypertension (0.593). The AUC of SADHR showed an increase in low-HDL (0.561) and high-glucose (0.664) in men. WC and WC + SADHR exhibited the greatest diagnostic value out of all the parameters in women, with the combination of WC and SADHR being most effective (Table 6).

Table 5
Areas under ROC curve (AUC) of various anthropometric indices and MS risk factors

	BMI	WC	SAD	WHR	WHHR	SADHR	BMI + WC	BMI + SADHR	WC + SADHR
Low-HDL	0.510	0.555*	0.549*	0.544*	0.531*	0.527*	0.562*	0.527*	0.553*
High-TG	0.660*	0.657*	0.653*	0.575*	0.581*	0.660*	0.623*	0.678*	0.682*
Hypertension	0.600*	0.632*	0.577*	0.578*	0.590*	0.585*	0.635*	0.605*	0.635*
High-glucose	0.599*	0.623*	0.614*#	0.574*	0.595*	0.624*	0.628*	0.628*	0.647*
MS	0.739*	0.823*	0.730*#	0.694*	0.664*	0.726*	0.826	0.760*	0.834*
Note: * AUC compared to 0.05, P < 0.05									

Table 6
Areas under ROC curve (AUC) of various anthropometric indices and MS risk factors in men and women

	BMI	WC	SAD	WHR	WHHR	SADHR	BMI + WC	BMI + SADHR	WC + SADHR
Men only									
Low-HDL c	0.526*	0.537*	0.560*	0.513	0.504	0.561*	0.542*	0.563*	0.559*
High-TG	0.693*	0.672*	0.668*	0.594*	0.558*	0.668*	0.696*	0.698*	0.689*
Hypertension	0.593*	0.592	0.556*	0.544*	0.546*	0.557*	0.598*	0.591*	0.590*
High-glucose	0.600*	0.634*	0.641*	0.605*	0.590*	0.644*	0.639*	0.645*	0.661*
MS	0.762*	0.853*	0.757*	0.738*	0.644*	0.742*	0.856*	0.782*	0.861*
Women only									
Low-HDL c	0.518	0.549*	0.552*	0.507	0.494	0.547*	0.554*	0.547*	0.557*
High-TG	0.631*	0.652*	0.641*	0.588*	0.592*	0.650*	0.658*	0.660*	0.673*
Hypertension	0.602*	0.667*	0.596*	0.630*	0.623*	0.604*	0.670*	0.619*	0.671*
Glucose	0.592*	0.622*	0.595*	0.588*	0.590*	0.602*	0.624*	0.610*	0.583*
MS	0.719*	0.810*	0.711*	0.712*	0.676*	0.714*	0.811	0.740*	0.817*

Discussion

Our results suggest that SADHR and BMI are stronger predictors of CVD and MS in men, whereas SADHR and WC served as better predictors of CVD and MS in women. In contrast, we found that WHR and WHHR were poor predictors, though they have previously been considered to correlate with CVD [8].

SAD showed no significant difference between men and women. The percentage of obesity and abdominal obesity were higher in women than men, inconsistent with a representative cross-sectional survey in Chinese adults [27]. This may be partially due to the sample selection in the study. Our study was conducted in a rural area and the people were all farmers. This could mean that the men in the sample engage in more physical activity than the women, based on their gender roles, which might result in a lower percentage of obesity.

Our study revealed that, for the year of 2011 in Handan, the estimated prevalence of metabolic syndrome was 27.25%. This prevalence was higher in women than in men. This result was consistent with previous research using the same diagnosis criteria, demonstrating that the estimated prevalence was 27.3% in men and 27.5% in women in 2010 [28]. Compared to the prevalence of MS in 2007, which was 25.8% in men and 18.0% in women [27], our results indicate an increased public health burden in China's rural areas. We found that men under 50 years old had a higher prevalence of MS than women under 50, however the difference of prevalence was reversed in those men and women over 50 years old, which is consistent with previously published studies [27–29]. This difference may be due to genetic, behavioral, and hormonal differences in pre-menopausal women that can delay chronic disease compared to age-matched men and post-menopausal women. Post-menopausal women were more prone to abdominal obesity, which is closely associated with increased CVD mortality [30, 31]. This association may be due to decreased levels of circulating estrogen and altered lipid levels after menopause [32].

We confirmed the significant roles that sex plays in the association between anthropometrical parameters and CVD risk factors. BMI, WC, and SADHR showed greater correlations with risk factors of CVD in the entire population. BMI and SADHR were the better predictors of CVD in men, whereas WC and SADHR were more predictive in women. These results were consistent with a previous cross-sectional analysis that showed higher AUCs of SAD and BMI for CVD in men in contrast to higher AUCs of SAD and WC for CVD in women [33]. Furthermore, hormones play key roles in the age-related increasing prevalence of metabolic syndrome, leading to the distinct correlation of BMI, SADHR, and WC in both men and women [34]. The predictive ability of SADHR was more obvious in men than women, which is consistent with previous research [33]. Therefore, SADHR may serve as a more useful metric in men. At a given BMI, men had more visceral fat than women, which may explain why SADHR proved to be a better parameter for predicting CVD in men [35, 36]. Visceral obesity may have a higher CVD risk than other fat indicators, however, some data has shown conflicting results on this topic [34, 37]. The major findings of a previous study indicate that SAD and WC were the best anthropometric measures for the prediction of abdominal visceral fat measured by a single-slice computed tomography (CT) scan [38]. SADHR may serve as an effective measure to indicate elevated CVD risk in both men and women.

Conclusion

In summary, we found that: (1) Central obesity and overweight as well as obesity were more frequent in women than in men within the sample population. (2) The prevalence of MS in the study population varied based on gender and age. Men under 50 years old had a higher prevalence of MS than women in the same age group and the trend was reversed in people over 50 years old, with women having a higher prevalence of MS than men. (3) SADHR and BMI may serve as effective indicators of CVD and MS in men, whereas SADHR and WC may be more effective indicators in women. SADHR is the best anthropometric measure for predicting CVD and MS in both men and women. Gender is a key factor to consider when choosing anthropometric parameters to assess patients for CVD risk.

Declarations

Consent for publication: Not applicable

Availability of data and materials: The datasets used and analyzed during the current study are available from the corresponding author on reasonable request.

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