

Anthropometric Measures as Predictors of Cardiovascular Disease Risk Factors in the Urban Population of Iran

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Abstract

Background: Overweight and obesity are an important public health problem in society, due to their association with various chronic diseases.

Objective: The purpose of this study is to determine the prevalence and distribution of overweight and obesity, using different anthropometric measurements and to identify the best anthropometric indicator which is most closely related to cardiovascular disease (CVD) risk factors in an Iranian urban population.

Methods: This cross-sectional study was conducted with 991 men and 1188 women aged 15 to 74 years. Body mass index (BMI), waist circumference (WC), waist-to-hip ratio (WHR), waist-to-height ratio (WHtR) and percentage of body fat were measured. A fasting blood specimen was obtained. CVD risk factors, including fasting blood glucose, triglycerides, total cholesterol (Tchol), low-density (LDL-C) and high-density-lipoprotein cholesterol (HDL-C) were assessed.

Results: Based on BMI, more than 49% of men and 53% of women were either overweight or obese with 10.2% of men and 18.6% of women being obese. In both men and women, the prevalence of overweight was greater among 40-49 year olds and the prevalence of obesity was greater among those 50+ years. Using the multiple regression analysis, BMI, WHtR and WHR explained the highest percentage of variation of triglycerides, Tchol/HDL-C ratio and LDL-C in men, respectively, whereas WHR explained the highest percentage of variation of triglycerides and WC explained the highest percentage of variation of Tchol/HDL-C ratio and LDL-C in women.

Conclusion: Our data indicated that WHR and WHtR were the anthropometric indicators that best predicted CVD risk factors in men and WHR and WC in women. (*Arq Bras Cardiol* 2012;98(2):126-135)

Keywords: Body weights and measures; body weight; cardiovascular diseases; risk factors; urban population; Iran.

Introduction

The prevalence of overweight and obesity is rapidly increasing in developing as well as in industrialized countries^{1,2}. Unhealthy diets and physical inactivity are the main contributors to overweight and obesity, which are among the leading risk factors for major non-communicable diseases. Previous research has consistently shown that both absolute total body fat and central distribution of body fat are closely associated with the risks of diabetes, hypertension, hyperlipidemia and cardiovascular disease (CVD)³. Cardiovascular disease mortality is about 3-fold higher among obese men and women, and about 21 and 28% of cardiovascular disease mortality in men and women, respectively may be attributed to overweight and obesity⁴.

Iran is an urbanized city-state country in the Middle East Region and is considered to be a country in nutrition transition. Like most countries that have undergone rapid economic and demographical transition, non-communicable diseases, especially cardiovascular disease, are the major cause of mortality and morbidity in Iran with a high prevalence reported⁵. On the other hand, although abdominal visceral adipose tissue measured by computed tomography (CT) or magnetic resonance imaging may more accurately reflect body fat distribution to predict metabolic risks^{6,7}, the inherent high cost and radiation hazard prevent their use in large-scale epidemiological studies or self-assessments. Various indicators for obesity have been described over the last 25 years or so⁸. Body mass index (BMI) is often used to reflect total body fat while the waist circumference (WC), waist to hip ratio (WHR), and waist to height ratio (WHtR) are used as surrogates for central body fat^{9,10}. Recent studies have shown that WC is the best simple anthropometric measure of abdominal visceral adipose tissue, and may be the best indicator for predicting cardiovascular risks¹¹⁻¹³. Since there are marked gender differences in regional body fat distribution, the anthropometric indicators may also vary in applicability by sex.

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Whereas the prevalence of obesity has been increasingly reported in all regions of the world, the status of the prevalence of obesity as a better predictor of cardiovascular risk factors in an urban population of Iran is unknown. Therefore, this study was designed to: (1) provide baseline data on the prevalence and distribution of overweight and obesity, using anthropometric measurements in the population from urban cities in Iran; and (2) determine the relationships between selected cardiovascular risk factors and anthropometric indicators and to identify the anthropometric indicator most closely related to CVD risk factors and whether the magnitude of association varies with gender in the study population.

Methods

Study Population

The study individuals were recruited through a random telephone survey¹⁴ from 7 big cities of Iran based on their populations and invited to one of the appointed health screen centers to undergo anthropometric examination and laboratory tests. In this cross-sectional study, 2179 healthy individuals aged 15 to 74 years (991 men and 1188 women) without any previous systemic diseases or medications related to body weight change or affecting glucose and lipid levels, were included in our study and completed blood tests and anthropometric measurements. The individuals were divided by gender and age (into five age groups: 15–19, 20–29, 30–39, 40–49 and 50+ years old). All the individuals were volunteers and gave their consent for participation into the study, whose protocol was approved by the Ethics Committee of the School of Medical Sciences of Tarbiat Modares University and was in accordance with the Declaration of Helsinki.

Anthropometric measures

The following anthropometric variables were evaluated in all individuals: weight, height, BMI, WC, WHR, WHtR, sum of three-point skinfolds and percentage of body fat. For height, the individuals were instructed to stand as straight as possible with their back against a wall-mounted vertical ruler. Feet were flat on the floor with shoes removed. Weight was measured to the nearest 100 g using a calibrated balance beam scale and with the individual standing and wearing underwear only. BMI was calculated as weight/height squared (kg/m^2)¹² and was classified into five categories: underweight (BMI < 18.5 kg/m^2), normal weight (BMI 18.5–24.9 kg/m^2), overweight (BMI 25.0–29.9 kg/m^2) and obese (BMI \geq 30.0 kg/m^2)¹⁵. Circumferences were measured to the nearest millimeter using a flexible tape. WC was taken at the end of normal expiration, with the measuring tape positioned at the midway between the lower rib and the iliac crest. Men with waist circumference of < 94, 94–101.9 and \geq 102 cm were classified as normal weight, overweight and obese, respectively, while women were classified in the same obesity categories based on WC < 80, 80–87.9 and \geq 88 cm. Hip circumference was measured at the level of maximal protrusion of the gluteal muscles. WHR was calculated as WC (cm) divided by hip circumference (cm) and WHtR was calculated as WC (cm) divided by height (cm). Men with WHR < 0.90, 0.90–0.99 and \geq 1.0 were classified

as normal weight, overweight or obese, respectively, while women were classified in the same categories based on WHR of < 0.80, 0.80–0.84 and \geq 0.85¹. Skinfold thickness (Chest, abdominal, mid thigh for men and triceps, supraillium, mid thigh for women) was measured in triplicate to the nearest mm, on the right side of the body by Holtain Skinfold Caliper (Holtain Ltd, Crymmych, Dyfed, UK). The mean of three measurements represented the value for each site. Percentage of body fat (PBF) was calculated using the three-site equation^{16,17}.

Blood sampling and analysis

Blood samples were collected between 7:00 am and 9:00 am after a 12-hour overnight fast. Serum total cholesterol (Tchol) and triglycerides (TGs) were measured using enzymatic colorimetric tests with cholesterol esterase and cholesterol oxidase and glycerol phosphate oxidase, respectively. High-density lipoprotein cholesterol (HDL-C) was measured using the same method after precipitating apolipoprotein B containing lipoproteins with phosphotungstic acid. Serum glucose concentration was assayed using the enzymatic colorimetric method with the glucose oxidase technique (Chemistry analyzer, Roche/Hitachi 904, with Pars Azmoun kits, Tehran, Iran). Inter- and intra-assay coefficients of variations were 2 and 0.5% for Tchol and 1.6 and 0.6% for TGs and both 2.2% for serum glucose, respectively. Low-density lipoprotein cholesterol (LDL-C) was calculated from the serum Tchol, TGs, and HDL-C concentrations expressed in mg/dl using the Friedwald formula¹⁸ if TGs concentration is lower than 400 mg/dl.

Statistical analysis

All variables are presented as mean and standard deviation or percentage. Independent t-test and repeated-measures analysis of variance (ANOVA) were used to compare quantitative variables between the two groups (men and women) and more than two groups, respectively. Age-adjusted partial correlation coefficients were calculated to investigate the association between anthropometric variables and cardiovascular risk factors. Multiple regression analysis (stepwise method) of the data was carried out. All tests for statistical significance were two-tailed and performed assuming a type I error probability of \leq 0.05. All data were analyzed by the SPSS software package (SPSS for Windows; SPSS Inc., Chicago, IL, USA; Version 16.00).

Results

Anthropometric measurements

There were significant trends across the age groups for each anthropometric measure in both genders ($p < 0.05$; Table 1). Within any given age category, men had higher weight and WHR and lower PBF than women ($p < 0.001$). The greatest differences in WC and WHR were seen between the 20–29 and 30–39 y age groups and 40–49 and 50+ y age groups in men and women, respectively ($p = 0.000$). The greatest difference in WHtR were seen between the 15–19 and 20–29 y age groups and 40–49 and 50+ y age groups in men and women, respectively ($p = 0.000$).

Table 1 - Anthropometric variables by gender and age groups in the urban population of Iran

	n	Height	Weight	WC	BMI	WHR	WHR	PBF
Men								
15-19	139	170.2±7.9*	62.2±12.0*	74.5±8.9	21.4±3.1	0.82±0.05*	0.43±0.06	11.2±5.7*
20-29	204	174.9±5.8*	72.8±10.9*	82.2±8.8*	23.7±3.2	0.85±0.05*	0.48±0.09	15.0±6.6*
30-39	327	170.8±6.8*	76.6±12.8*	91.1±10.9*	26.0±3.8	0.92±0.06*	0.51±0.06	25.3±7.2*
40-49	200	170.3±6.9*	79.1±13.5*	96.3±8.9*	26.8±3.0*	0.96±0.05*	0.54±0.06	29.9±6.5*
50+	121	169.6±7.4*	74.9±12.6*	95.5±10.9	25.9±3.9*	0.97±0.07*	0.56±0.06*	30.2±6.9*
Total	991	171.7±7.2*	72.0±13.3*	88.5±12.4*	25.0±3.9*	0.91±0.07*	0.49±0.08*	22.7±9.7*
Women								
15-19	145	160.4±5.1	57.3±9.8	72.7±9.0	21.9±3.8	0.78±0.06	0.45±0.07	26.9±9.9
20-29	193	161.5±5.3	60.8±11.5	77.9±11.6	23.4±4.3	0.79±0.08	0.48±0.07	27.1±9.6
30-39	427	159.2±5.9	66.6±11.7	84.2±11.4	26.1±4.7	0.81±0.08	0.52±0.07	31.5±6.9
40-49	283	159.5±6.1	71.2±10.8	89.2±11.0	27.7±4.3	0.83±0.08	0.54±0.07	35.1±5.9
50+	140	156.5±6.0	69.9±11.1	96.0±12.6	28.4±4.8	0.91±0.10	0.60±0.09	36.1±6.1
Total	1188	159.5±5.9	65.9±12.1	84.3±13.1	25.8±4.9	0.82±0.09	0.52±0.08	31.5±8.2

WC - Waist Circumference in cm; BMI - Body Mass Index in kg/m²; WHR - Waist-to-Hip Ratio; WHtR - Waist-to-Height Ratio; PBF - Percentage of Body Fat. *Significantly different from women values (p < 0.01). All values are expressed as mean±SD.

Prevalence of overweight and obesity

Irrespective of age or measures used, women had a higher prevalence of obesity than men (Table 2). Based on BMI, almost half of men and over 50% of women were either overweight or obese with 10.2% of men and

18.6% of women in the obese category. The prevalence of BMI obesity increased with age until 50+ yrs. This trend was more pronounced among women (main effect for age-gender interaction p = 0.001). The difference in the prevalence of obesity between men and women was particularly large in the older age group (50+ years).

Table 2 - Prevalence (%) of obesity by body mass index, waist circumference and waist-to-hip ratio in men and women aged 15 and above

Age groups	n	BMI		WC		WHR	
		Overweight	Obese	Overweight	Obese	Overweight	Obese
Men							
15-19	139	9.3	2.8	3.6	1.4	10.7	2.1
20-29	204	23.5	4.4	9.3	3.9	22.0	1.0
30-39	327	45.8	13.7	23.2	16.8	59.3	11.6
40-49	200	63.0	12.5	36.5	26.5	56.5	35.0
50+	121	44.6	14.8	28.9	24.7	56.1	32.2
Total	991	39.4	10.2	21.0	14.9	43.8	15.3
Women							
15-19	145	12.4	2.7	14.4	5.5	18.6	15.8
20-29	193	21.7	6.7	22.8	15.5	24.8	23.3
30-39	427	40.9	17.3	30.6	32.3	21.3	32.5
40-49	283	42.7	28.6	28.2	54.7	21.5	45.2
50+	140	37.8	35.7	26.4	66.4	17.1	71.4
Total	1188	34.4	18.6	26.3	35.7	21.0	36.7

BMI - Overweight was defined as BMI between 25–29.9 and obesity as BMI ≥ 30 kg/m² in men and women. WC - Overweight was defined based on WC 94–101.9 cm and 80–87.9 in men and women respectively and obesity based on WC ≥ 102 cm in men and ≥ 88 cm in women. WHR - Overweight was defined based on WHR 0.90–0.99 and WHR 0.80–0.84 in men and women respectively and obesity based on WHR ≥ 1 in men and ≥ 0.85 in women. BMI - Body Mass Index ; WC - Waist Circumference; WHR - Waist-to-Hip Ratio.

Cardiovascular risk factors

Glucose, TGs and Tchol/HDL-C ratio were significantly higher in men, while LDL-C and HDL-C were significantly higher in women ($p < 0.05$; Table 3). The mean values of glucose, Tchol and TGs increased significantly in ascending age groups in men, while values of Tchol, TGs, LDL-C and Tchol/HDL-C ratio increased significantly in ascending age groups in women ($p < 0.05$).

Anthropometric indicators and cardiovascular risk factors based on BMI groups

The mean values of weight, WC, WHR, WHtR and PBF increased significantly in ascending BMI categories in both genders ($p < 0.001$; Table 4). In addition, significant differences were observed in cardiovascular risk factors according to different BMI groups in men ($p < 0.05$), while it was just significant in Tchol/HDL-C ratio for women.

Correlation between anthropometric measurements

WC, BMI, WHR and WHtR were strongly correlated in both sexes ($p \leq 0.001$; Table 5), suggesting that measures of obesity based on these parameters will provide comparable information. However, PBF showed a weaker correlation with the other anthropometric measurements in women.

Correlation between anthropometric measurements and cardiovascular risk factors

In men, a highly significant correlation was found between WC, BMI, WHR and WHtR on the one hand and serum lipid values on the other hand ($p < 0.05$; Table 6). When adjustments were made for both age and BMI, there were just

significant correlations between WC, WHR, WHtR and HDL-C and between WC and Tchol/HDL-C ratio ($p < 0.05$). When adjustments were made for both age and WC, there were just significant correlations between BMI, WHR, WHtR and triglycerides (data not shown in table; $p < 0.05$). There were weaker correlations between anthropometric measurements and serum lipid values in women. WC, WHR and WHtR had significant correlations with most of the serum lipid values ($p < 0.05$). When adjustments were made for both age and BMI, there were just significant correlations between WC, WHtR and Tchol/HDL-C ratio and between WHR and triglycerides ($p < 0.05$). When adjustments were made for both age and WC, there were just significant correlations between WHR and triglycerides (data not shown in table; $p < 0.05$).

Independent determinants of cardiovascular risk factors

In men, WHR was a significant predictor for glucose, Tchol and LDL-C, whereas WHtR was a significant predictor for glucose, HDL-C and Tchol/HDL-C ratio (Table 7). On the other hand, BMI was a significant predictor for triglycerides and HDL-C. The percentage of variation of glucose and lipid levels explained by these parameters, however, was modest. WHR explained 7.4% of glucose variation, 31.1% of Tchol variation and 29.2% of LDL-C variation. WHtR explained 9.3% of glucose, 15.2% of HDL-C and 36% of Tchol/HDL-C ratio variation. BMI explained 26.4% of triglyceride and 10% of HDL-C variation. In women, WHR was a significant predictor for glucose, Tchol and triglycerides, whereas WC was a significant predictor for LDL-C, HDL-C and Tchol/HDL-C ratio. WHR explained 17% of glucose, 20.4% of Tchol and 31.7% of triglyceride variation. WC explained 16.1% of LDL-C, 8.6% of HDL-C and 22.7% of Tchol/HDL-C ratio variation.

Table 3 - Cardiovascular risk factors by gender and age groups in urban population of Iran

	FBG	Tchol	TGs	LDL-C	HDL-C	Tchol/HDL-C Ratio
Men						
15-19	84.2±8.7	154.7±35.1	140.4±99.2	80.5±26.8	45.5±12.3*	3.72±1.7
20-29	81.5±6.1	181.4±45.6	119.0±61.7	110.6±42.2	44.0±11.5*	4.32±1.4*
30-39	90.5±11.3	189.4±41.9	167.0±56.6*	101.6±30.7	45.9±17.1	4.43±1.3
40-49	95.3±14.0*	193.1±33.5	182.7±66.0*	105.9±29.6	39.7±11.1*	5.70±3.5*
50+	108.0±18.4	211.6±32.9	202.2±77.6	102.9±25.3	40.3±10.5	5.75±2.6
Total	91.2±14.1*	186.1±40.9	163.0±73.3*	101.1±32.2*	43.3±13.4*	4.78±2.3*
Women						
15-19	81.9±12.4	154.0±31.3	90.4±48.3	88.9±25.0	56.7±10.5	2.78±0.6
20-29	80.4±6.1	173.1±44.7	100.2±32.5	107.3±35.0	53.0±11.9	3.34±0.7
30-39	86.4±15.6	187.0±42.2	130.5±56.3	118.1±33.5	47.5±12.5	4.09±1.0
40-49	86.7±10.9	186.1±41.4	128.1±58.2	119.2±31.6	48.4±10.2	3.97±1.1
50+	91.1±23.5	201.0±59.8	178.2±82.4	121.9±46.4	50.1±19.9	4.77±2.5
Total	85.2±14.0	180.4±44.6	123.5±60.5	112.0±34.9	50.5±12.8	3.79±1.3

FBG - fasting blood glucose; Tchol - total cholesterol; TGs - triglycerides; LDL-C - Low-density lipoprotein-cholesterol; HDL-C - High-density lipoprotein-cholesterol.

* Significantly different from women values ($p < 0.05$). All values are expressed as mean±SD.

Table 4 - Comparison of anthropometric measurements and cardiovascular risk factors according to BMI groups in both men and women

	Underweight	Normal Weight	Overweight	Obese
n	29	470	391	101
Men				
Weight	49.3±5.1*	65.2±7.7*	80.9±7.7*	94.6±11.4*
Height	167.9±6.8*	171.9±7.2*	172.2±6.8*	171.0±8.5*
WC	67.4±5.0*	80.3±8.0*	95.3±6.4*	106.8±9.4*
WHR	0.80±0.04*	0.86±0.06*	0.95±0.05*	0.98±0.06*
WHtR	0.40±0.02*	0.46±0.07	0.54±0.06	0.60±0.06
PBF	8.7±3.5*	16.8±7.9*	28.2±6.8*	31.8±5.7*
FBG	85.4±12.2	88.2±15.3	92.1±11.7	103.1±14.4*
Tchol	154.4±31.5	170.5±38.0	199.1±37.7	210.7±39.7
TGs	75.2±16.3	140.0±67.1	176.1±64.6*	248.1±58.1*
LDL-C	88.6±27.4	90.5±31.5*	113.3±31.7	97.0±23.6
HDL-C	50.6±4.7	45.9±16.4	42.4±9.3*	32.3±13.6*
Tchol/HDL-C Ratio	3.03±0.39	4.04±1.47	4.88±1.34*	8.37±5.15*
n	46	508	410	224
Women				
Weight	46.3±3.8	57.3±6.2	69.2±5.9	81.9±9.8
Height	162.6±5.0	160.8±5.4	159.1±5.6	156.7±6.5
WC	64.3±4.3	76.3±8.3	87.9±8.4	100.2±10.7
WHR	0.73±0.04	0.79±0.07	0.83±0.08	0.88±0.09
WHtR	0.39±0.02	0.47±0.06	0.54±0.05	0.62±0.07
PBF	17.7±6.9	28.2±7.9	34.4±5.8	37.8±5.1
FBG	78.8±5.2	82.9±10.4	88.6±18.3	85.8±13.1
Tchol	141.8±18.4	175.7±41.2	187.5±47.4	186.8±46.6
TGs	76.2±33.9	114.0±54.3	127.2±56.0	144.4±73.5
LDL-C	85.4±21.4	105.9±32.7	118.2±33.8	119.5±39.4
HDL-C	57.2±9.5	52.7±13.9	48.4±12.1	48.5±12.1
Tchol/HDL-C Ratio	2.54±0.60	3.53±1.12	4.16±1.70	3.97±1.04

BMI groups were defined by: Underweight, < 18.5; Normal weight, 18.5 – 24.9; Overweight, 25 – 29.9; Obese, ≥ 30 kg/m². *Significantly different from women values (p < 0.05). All values are expressed as mean±SD. WC - Waist Circumference; WHR - Waist-to-Hip Ratio; WHtR: waist-to-height ratio; PBF - Percentage of body fat; FBG - fasting blood glucose; Tchol - total cholesterol; TGs - triglycerides; LDL-C - Low-density lipoprotein-cholesterol; HDL-C - High-density lipoprotein-cholesterol.

Table 5 - Age-adjusted partial correlation coefficient among anthropometric measures in urban population of Iran

	Men			Women	
	WC	BMI	WHR	WHtR	PBF
Waist Circumference	–	0.769	0.716	0.871	0.459
Body Mass Index	0.859	–	0.335	0.723	0.529
Waist/Hip Ratio	0.769	0.581	–	0.666	0.282
Waist/Height Ratio	0.712	0.625	0.568	–	0.499
Percentage of Body Fat	0.740	0.622	0.583	0.479	–

All coefficients significantly different (p < 0.001). WC - Waist Circumference; BMI - Body Mass Index; WHR - Waist/Hip Ratio; WHtR - Waist/Height Ratio; PBF - Percentage of Body Fat.

Table 6- Age-adjusted partial correlation coefficient among anthropometric measures and cardiovascular risk factors in men and women

Men	WC	BMI	WHR	WHtR	PBF
FBG	0.083	0.072	0.052	0.125	0.002
Tchol	0.389***	0.364***	0.374***	0.363*	0.210*
TGs	0.440***	0.515***	0.473***	0.582***	0.305**
LDL-C	0.271**	0.251*	0.297**	0.277	0.039
HDL-C	-0.415***	-0.318**	-0.374***	-0.430**	-0.238*
Tchol/HDL-C	0.499***	0.470***	0.444***	0.537***	0.219*
Women					
FBG	0.118	0.111	0.154	0.138	0.051
Tchol	0.224*	0.130	0.226*	0.271*	0.028
TGs	0.270**	0.205*	0.368***	0.272*	0.029
LDL-C	0.251*	0.185	0.176	0.288*	0.010
HDL-C	-0.232*	-0.182	-0.119	-0.204	-0.126
Tchol/HDL-C	0.276**	0.159	0.230*	0.282*	0.047

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. WC - Waist Circumference; BMI - Body Mass Index; WHR - Waist-to-Hip Ratio; WHtR: waist-to-height ratio; PBF - Percentage of body fat; FBG - fasting blood glucose; Tchol - total cholesterol; TGs - triglycerides; LDL-C - Low-density lipoprotein-cholesterol; HDL-C - High-density lipoprotein-cholesterol.

Table 7 - Multiple regression analysis of relationship between anthropometric variables and cardiovascular risk factors in men and women

Dependent Variable	Explanatory Variables	Independent Variable Coefficients (β)	p-Value	R-square
Men				
FBG (mg/dL)	WHR	1.258	0.002	0.569
	WHtR	-0.930	0.014	
Tchol (mg/dL)	WHR	0.558	0.000	0.311
TGs (mg/dL)	BMI	0.514	0.002	0.264
LDL-C (mg/dL)	WHR	0.541	0.0001	0.292
HDL-C (mg/dL)	WHtR	-1.203	0.007	0.252
	BMI	0.872	0.047	
Tchol/HDL-C Ratio	WHtR	0.600	0.000	0.360
Women				
FGB (mg/dL)	WHR	0.413	0.001	0.170
Tchol (mg/dL)	WHR	0.370	0.002	0.265
TGs (mg/dL)	WHR	0.493	0.000	0.361
LDL-C (mg/dL)	WC	0.401	0.001	0.161
HDL-C (mg/dL)	WC	-0.294	0.018	0.086
Tchol/HDL-C Ratio	WC	0.353	0.005	0.282

All models were adjusted by age. FBG - fasting blood glucose; Tchol - total cholesterol; TGs - triglycerides; LDL-C - Low-density lipoprotein-cholesterol; HDL-C - High-density lipoprotein-cholesterol; WC - waist circumference; BMI - body mass index; WHR - waist-to-hip ratio; WHtR - waist-to-height ratio.

Discussion

The International Obesity Task Force reported that the Middle East is one of the regions with the highest prevalence rates of obesity worldwide¹⁹. In our study, prevalence of overweight as defined by BMI increased to a peak of 63.0% and 42.7% in the 40–49 y age group in men and women, respectively. Prevalence of obesity as calculated by BMI continued to increase to a maximum of 14.8 and 35.7% in the 50+ y age group in men and women, respectively. In addition, central obesity is a recognized predictor of coronary artery disease, and men usually have a higher WC and WHR than women³; however, we found that central obesity was more frequent in the women of any age groups. The prevalence of general overweight and obesity in this population (BMI \geq 25 kg/m², males 49.6% and females 53%) is higher than that among the urban population of Cameroon (males 28.1% and females 48.1%)². Based on these findings, overweight and obesity were of high prevalence in the adult urban population of Iran and the prevalence of obesity in women of any age groups was higher than that of men. Ideal BMI for the prevention of cardiovascular disease is considered to be 22.6 and 21.1 for men and women, respectively²⁰. In this study, the mean BMI of each sex-age group was above these cutoff points. The results of few studies conducted in some cities of Iran showed large differences.

A study in Tehran, the capital of Iran, showed much higher prevalence rates of general and abdominal obesity; 67% of women and 29% of men were obese and abdominal obesity was detected in 93% of women and 74.1% of men²¹. Hosseinpanah et al²² studied the prevalence of obesity in a follow-up study in district 13 of Tehran. The prevalence of general obesity was 15.8, 18.6 and 21% in men and 31.5, 37.7 and 38.6% in women in phases I, II and III, respectively, while the prevalence of abdominal obesity in men was 36.5, 57.2 and 63.3% and in women was 76.7, 83.8 and 83.6% in the three periods mentioned. These results showed an increasing trend of obesity in the adult Teheranian population over 6.6 years of follow-up. Prevalence rates in various studies from the Middle East show considerable variation.

In a study conducted in Egypt, the prevalence of obesity was 40.6% among women living in urban areas²³. The prevalence of obesity among Turkish women and men was 32.4% and 14.1%²⁴, whereas the prevalence of abdominal obesity was 29.4% (38.9% among women and 18.1% among men)²⁵. A recent national study in Lebanon demonstrated that the prevalence of overweight was higher in men than in women, i.e. 57.7% vs. 49.4%, respectively, but obesity was more prevalent in women (18.8%) than in men (14.3%)²⁶. Similarly, the prevalence of overweight was higher in men than women, i.e. 39.4% vs. 34.4%, respectively, but obesity was more prevalent in women (18.6%) than in men (10.2%) in our study.

Results from CT indicate that central obesity, especially intra-abdominal fat accumulation, is a critical variable in the study of the ratio of body fat distribution to metabolic complications³. Despite the close association between central adiposity and cardiovascular risks, there is still some controversy regarding the best anthropometric measure for central adiposity. Since there are marked gender differences in regional body fat distribution, the anthropometric indicators

may also vary in applicability by sex. In this study, we compared the correlations between five obesity parameters (BMI, WC, WHR, WHtR and PBF) and selected cardiovascular risk factors. The anthropometric measurements, except PBF, were strongly correlated with each other in this study. The correlations of indices of overall and central obesity are highly suggestive of an association between increased overall obesity (as measured by BMI) with increased abdominal obesity.

Després et al have reported that the regional distribution of body fat, especially an excessive deposition of abdominal fat, was associated with low concentrations of HDL-C.³ In the Canadian Heart Health Survey, Ledoux et al²⁷ found that anthropometric measures were moderately associated with the presence of high blood pressure, dyslipidemia and diabetes mellitus in adults and that BMI as well as waist circumference and WHR played a roughly equal role. Of all risk factors measured for CVD in this study, increased TGs and Tcho/HDL-C ratio were significantly associated with most of the anthropometric indices in both men and women; however, the correlations were more pronounced in men. Using computed tomographic scanning to measure adipose tissue, WC is found to be a better estimate of abdominal visceral adipose accumulation than WHtR and may be a better predictor of multiple cardiovascular risk factors than WHR¹⁰. Based on the results of multiple regression analysis in our study, BMI, WHtR and WHR explained the highest percentage of variation of TGs, Tcho/HDL-C ratio and LDL-C in men, respectively, whereas WHR explained the highest percentage of variation of TGs and WC explained the highest percentage of variation of Tcho/HDL-C ratio and LDL-C in women. Ho et al¹⁴ found that BMI in men and WHR in women were the important anthropometric indices to predict metabolic syndrome (hypertension or diabetes or dyslipidemia). Furthermore, the relationship between anthropometric indices and cardiovascular risk factors may be age-specific. Rimm et al²⁸, for instance, found in a large prospective study of US men, that before the age of 65 y, BMI was the best predictor of coronary heart disease, whereas in men aged \geq 65 y the WHR was a better predictor of risk. Goodman-Gruen and Barret-Connor²⁹ found that after the age of 80 y, WHR is a poor method of assessing central or visceral adiposity and waist circumference is a better measure of fat distribution. The Iowa Women's Health Study cohort³⁰ examined the relation of both self-reported WHR and BMI with 5-year mortality in a cohort of older women. They showed that WHR is strongly and positively associated with risk of death in a monotonic dose-response fashion. Onat and coworkers³¹ reported that only WHR was independently associated with coronary morbidity in women. In another study, Ward et al³² reported that WHR was related to triglycerides regardless of BMI and insulin levels in middle-aged and older people. Similar results were observed in our study. Clearly, there is a need for clarification about the appropriate use for these indicators when examining their relationship with CVD risk factors. The literature lacks a systematic evaluation of the proposed indicators for adiposity, taking into account possible differences between the genders, age categories and ethnic groups and different diseases as well as mortality. Important limitations of WHR are that WHR cannot be clearly interpreted, because two variables are

involved and a high ratio that may be obtained in an individual with a small hip circumference or a low ratio in an individual with a large hip circumference for the same abdominal girth³. On the other hand, the lack of a standard body location for measuring WC makes comparison with other studies difficult. Standard methodology is necessary to obtain reliable measures of abdominal circumference. It has also been reported that the association between WC and risk factors for cardiovascular disease may be population-dependent⁸. Furthermore, in the elderly, waist circumference measurements may be overestimated and be inaccurate, since the laxity of abdominal muscles, which is typical in the elderly, is likely to undermine the predictive value of abdominal circumferences³³. Therefore, no single cut-off point of WC is optimal for all ages and for different cardiovascular risk factors.

Conclusions

The study provided insights into the relationship between age, sex, overweight and obesity using a variety of anthropometric measures. Our results highlighted the high prevalence of general and abdominal overweight and obesity in both sexes of urban populations of Iran as defined by the WHO criteria and provided evidence to support the establishment of intervention programs to manage and prevent obesity-related disorders such as diabetes and hypercholesterolemia. There currently is an increasing rate of urbanization in developing countries, which may have an

impact on obesity and its associated CVD risk factors in the future. In addition, the association of anthropometric indices and cardiovascular risk factors varied with gender. Our data indicated that WHR and WHtR were the anthropometric indicators that best predicted CVD risk factors in men and WHR and WC in women living in Iran.

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Potential Conflict of Interest

No potential conflict of interest relevant to this article was reported.

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Study Association

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