Original Article

The Leading Anthropometric Indicator of Cardiovascular Health Risks among Female Nurses: A Cross-Sectional Study

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Abstract

Aim: Medical team members are directly concerned with community health, and their well-being plays a key role in community well-being. We aimed to explore the association between anthropometric indices and cardiovascular risk factors in female nurses and determine the best cardiovascular risk predictor. **Methods:** Anthropometric measurements and cardiovascular risk factors were collected from a randomized sample of 138 female nurses aged 20-52 years employed in three hospitals in Zahedan in southeast Iran. **Results:** The prevalence of being overweight ($25 \leq BMI \leq 29.9\ kg/m^2$) and obese ($BMI \geq 30\ kg/m^2$) and central obesity in terms of WHpR ≥ 0.8, WHtR ≥ 0.49, and WC ≥ 88 cm was 31.9%, 12.3%, 76.1%, 61.6%, and 28.3% respectively. Abnormal BMI, WC, and WHtR was significantly associated with all cardiovascular risk factors including high TC, TG, LDL-C, HDL-C, LDL-C:HDL-C, and TC:HDL-C, while abnormal WHpR was only associated with hypercholesterolemia, hypertriglyceridemia, and high TC:HDL-C ratio. Thus BMI was a superior predictor of elevated levels of TC, TG, HDL-C, LDL-C: HDL-C, and SBP, whereas abnormal TC: HDL-C and LDL-C were best indicated by WC and WHtR, respectively. Nevertheless, no anthropometric index was superior at distinguishing high FBS, fibrinogen, and DBP values. **Conclusions:** A considerable proportion of female nurses were overweight or obese. BMI was the strongest and most accurate predictor of most cardiovascular risk factors in this sample of Iranian female nurses. Our study underscores the need to perform large epidemiological studies targeting medical staff to determine a valuable and easily applicable indicator of cardiovascular risk factors and implement proper health promotion programs.

Keywords: Body Mass Index (BMI); Cardiovascular diseases; Hyperlipidemias; Obesity; Waist-height ratio; Waist-hip ratio

Introduction

In recent decades, cardiovascular disease (CVD) has become more abundant due to lifestyle changes. [1] According to the World Health Organization (WHO), CVD is the leading cause of death worldwide (30%), and the cause of 45% of deaths in Iran. [2-4] Cardiovascular mortality, which is closely associated with cardiovascular risk factors (abdominal obesity, high blood pressure, low high-density lipoprotein cholesterol [HDL-C], high triglyceride [TG], and high fasting blood sugar [FBS] levels), increases with body fatness. [5,6] Visceral fatty depots have the potential to increase free fatty acids and adipokines with atherogenic, pro-inflammatory, and prothrombotic properties, which triggers the development of CVD and diabetes. [7]

Nowadays, obesity is not only one of the major health concerns in Western societies but also one of the most important causes of life-threatening diseases in developing countries. [8] Evidence indicates that obesity, which is characterized by the accumulation of body fat, is associated with poor health outcomes including CVD, dyslipidemia, hypertension, hyperglycemia, insulin resistance, and hyperuricemia, which singly or in combination exacerbate the progression of CVD, diabetes mellitus, non-alcoholic fatty liver disease, osteoarthritis, certain cancers, and a conglomeration of metabolic disorders known as metabolic syndrome. [9-12] Being overweight or obese is associated with approximately 44% of the diabetes and 23% of the CVD burden. [11]

In 2008, more than 1.6 billion adults across the globe were overweight and approximately 600 million men and women were obese. [11] In recent decades, Iran has encountered an increasing trend in overweight/obesity and diet-related chronic diseases, a tendency that seems faster in the female population.

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How to Cite this Article: Shahraki M, et al. The Leading Anthropometric Indicator of Cardiovascular Health Risks among Female Nurses: A Cross-Sectional Study. Ann Med Health Sci Res. 2017; 7: 52-59

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[13] The prevalence of being overweight occurs in 51.4% of the total population of Iran (46% of males and 56.8% of females), and the prevalence of obesity is 19.4% in the total population (12.4% of males and 26.5% of females). The prevalence of hypertension, hyperglycemia, and hypercholesterolemia are reported as 33.7%, 8.3%, and 51.7%, respectively, in Iranians, and more specifically, 31.7%, 8.9%, and 54.7%, respectively, in Iranian women (World Health Organization, 2010). [14] According to a 2007 study by Maddah in north Iran, 13.3% of young Iranian female physicians were overweight or obese, and low serum levels of HDL-C were observed in 66.7%. He reported an increasing trend in the prevalence of obesity in medical professionals, which is a cause of great concern. [15]

Deleterious health consequences of obesity can be simply, inexpensively, and accurately predicted by anthropometric indices. [16] Body mass index (BMI) provides a simple measurement that defines total body fat, while waist circumference (WC), waist-to-hip ratio (WHpR), and waist-to-height ratio (WHtR) are significant predictors of both total body fat and abdominal visceral fat. [16,17]

Although the correlation between central and visceral fat distribution and cardiovascular risk factors has been well documented, controversy remains over which index is the best discriminator of the highest risk for cardiovascular disturbances. [12]

Compared to overall obesity, which is indicated by BMI, central deposition of excess fat is a stronger indicator of the risk of morbidity and mortality. [18,19] Some studies have indicated that WC may be a better screening tool for detecting CVD risk factors, especially hypercholesterolemia and hypertriglyceridemia. [3,20-23] Some studies have shown that WHtR has a greater effect on CVD risk factors, [7,24-27] whereas others have suggested that WHpR is the best predictor of CVD risk factors, namely hyperglycemia, hypertriglyceridemia, and low HDL-C. [3,22-26] In recent years, some studies have proposed the use of BMI or WC as good anthropometric indicators of high systolic blood pressure (SBP), hyperglycemia, hypertriglyceridemia, and low HDL-C levels [28], while others advocate the combination of BMI and WC as a good predictor of CVD risk factors. [29]

According to the literature, little work has focused on CVD risk factors of medical team members. Since a medical team is directly concerned with community health, and since their well-being plays a key role in community well-being, we chose nurses as our examination group. The present study aimed to (a) estimate the association between central and overall anthropometric indices and cardiovascular risk factors, and (b) determine the best anthropometric predictor of cardiovascular risk factors.

Methods

Participants

This clinical cross-sectional study was carried out from November 2010 through January 2011 on 138 Iranian female nurses employed in three hospitals (Emam Ali, Khatam, and Tamin Ejtemaei) in Zahedan. Zahedan is the center of Sistan and Balochestan Province, which is located in southeast Iran. It is one of the largest provinces of Iran, with approximately 2 million residents.

Inclusion and exclusion criteria

Female nurses 20 to 52 years old were included in the study. The exclusion criteria included having secondary obesity due to hyperthyroidism or Cushing syndrome, type 2 diabetes mellitus, hyperglycemia due to any other disease, other chronic diseases, or active severe and acute infective disease at the time of blood sampling; being pregnant; having a drug addiction; taking oral contraceptives, cholesterol-lowering medications, beta blockers, or any other medication; being on any special diet for the previous 2 months; and being below 20 or more than 60 years old. Based on these criteria, out of 300 female nurses working in the three above-mentioned hospitals, 138 were eligible to participate. The aim of the study and the methods used were explained to the participants separately. Written consent was given by all subjects before data collection began. Participants attended a clinical visit to give a blood sample, have their anthropometric measurements taken, and return self-completed questionnaires.

Anthropometric measurements

Standing body height was measured by a stadiometer with an accuracy of 0.1 cm, with the participant standing without shoes, heels together, head in the horizontal Frankfurter plane, shoulders relaxed, and arms hanging freely. Body weight was measured to the nearest 0.1 kg with a digital scale (Seca) as the participant stood with shoes removed. WC was measured with an accuracy of 0.5 cm midway between the 12th rib margin and the iliac crest in the horizontal plane at the end of normal exhalation.

HC was measured at the fullest point around the buttocks to the nearest 0.5 cm. All girth measurements were done using a calibrated non-elastic tape. BMI was measured as weight in kilograms divided by standing height in square meters. According to WHO (1997) classification, underweight is defined as BMI<18.5 kg/m^2, normal weight is 18.5 ≤ BMI ≤ 24.9 kg/m^2, overweight is 25 ≤ BMI ≤ 29.9 kg/m^2, and obese is BMI ≥ 30 kg/m^2. [30] WHpR and WHtR ratios were calculated by WC in centimeters divided by HC in centimeters and height in meters, respectively.

All measurements were regularly calibrated. Initially, the stadiometer was examined using a standard calibrated measurement tape. The Seca scale was set at zero between anthropometric measurements. All anthropometric measurements were done on the basis of World Health Organization (1987) standards.

A self-administered questionnaire that consisted of queries about age, marital status, husband's education, biggest meal, number of consumed meals a day, number of food snacks between meals, predominant oil type, frequency of physical activity per week, number of pregnancies, prehistory of cardiovascular disease, and family history of cardiovascular disease was given to the participants beforehand, and they were asked to bring their completed questionnaires to the clinical visit.

Evaluation of cardiovascular risk factors

Each participant's arterial blood pressure was measured on the right arm using a standardized mercury column sphygmomanometer at sitting position after at least 5 minutes of rest. The participant's arm was supported at the level of the heart. All subjects wore loose clothing. Within 30 minutes before taking the blood pressure, no stimulant drink, such as tea or coffee, was allowed. Systolic blood pressure (SBP) was accepted as the first Korotkoff sound phase, and diastolic blood pressure (DBP) was the fifth phase (disappearance of sound) to the nearest 2 mmHg. Hypertensive subjects were defined as SBP ≥ 140 mmHg or DBP ≥ 90 mmHg, or use of blood-pressure-lowering medications.

Blood samples were collected from the antecubital vein between 7:30 to 10 a.m., in a sitting position, after more than 10 to 12 hours of fasting. Serum was centrifuged within 3 hours after collection. All biochemical analysis was performed at the private Pastor Laboratory located in Zahedan. Total cholesterol (TC), TG, and HDL-C were measured enzymatically with an auto-analyzer. TC was assayed using the enzymatic colorimetric method with cholesterol esterase, cholesterol oxidase, and glycerol phosphate oxidase. The analysis was carried out using Pars Azmon kits (Pars Azmon Inc., Tehran, Iran) and an auto-analyzer. Precipitation of the apolipoprotein B-containing lipoproteins with phosphotungstic acid was used to measure HDL-C. Low-density lipoprotein cholesterol (LDL-C) was calculated with Friedewald's equation. FBS was determined by an enzymatic colorimetric method using glucose oxidase.

In this study, the following criteria were used as cut-offs (thresholds) for variables: anthropometric indices: ≥ 30 kg/m^2, ≥ 88 cm, ≥ 0.8, and ≥ 0.49 for BMI, WC, WHpR, and WHtR, respectively; for blood variables: ≥ 100 mg/dl, ≥ 200 mg/dl, ≥ 150 mg/dl, ≥ 130 mg/dl, ≤ 50 mg/dl, ≥ 400 mg/dl, >2, and ≥ 5.6 for FBS, TC, TG, LDL-C, HDL-C, fibrinogen, LDL-C:HDL-C, and TC:HDL-C ratios, respectively; and for blood pressure: ≥ 130 mmHg and ≥ 85 mmHg for SBP and DBP, respectively.

Statistical analyses

The data were described using descriptive statistics including mean, standard deviation, and frequency distribution tables. Bivariate analysis was performed using an independent sample t-test, ANOVA, and LSD post-hoc test. The equality of variances and normality of data were checked and approved by Levene and Shapiro-Wilk tests, respectively. A multiple linear regression model was employed to measure the strength of obesity indices as predictors of measured blood parameters by inserting the same variables used in the bivariate analyses. To better understand the relationships and reporting odds ratios (OR), the measured blood parameters were then categorized as dependent variables, and a multiple logistic regression model was applied to measure the ability of the obesity indices to predict high blood parameters values. The Hosmer & Lemeshow test was employed to model estimation and to evaluate the goodness-of-fit of the logistic regression model. Significance level was defined as p<0.05. Statistical analysis was performed with SPSS software version 20 (SPSS, Chicago, IL, USA).

Results

The age, FBS, and cardiovascular parameters of participants are shown in Table 1. LDL-C, LDL-C: HDL-C, SBP, and DBP had a mean (SD) equal to 99.4 (42.5) mg/dl, 2.4 (1.3), 105.8 (13.2) mmHg, and 70.7(11.8) mmHg, respectively. The distribution of general and central obesity indices, blood parameters, and blood pressure is shown in Table 2. The prevalence of being overweight and obese (BMI ≥ 25.0 kg/m^2) was 44.2% in female nurse participants. Central obesity in terms of high WHpR (76.1% with WHpR ≥ 0.8) and high WHtR (61.6% with WHtR ≥ 0.49) was almost prevalent among the subjects, but only 28.3% had WC ≥ 88 cm. High SBP (SBP ≥ 130 mmHg) and high DBP (DBP ≥ 85 mmHg) was observed in four (2.9%) and 20 (14.5%) subjects, respectively. According to biochemical analysis, 22.5%, 17.4%, 24.6%, 53.6%, 14.5%, and 71.0% of nurses had high TC, TG, LDL-C, LDL-C:HDL-C, and TC:HDL-C and low HDL-C, respectively, while only a few subjects had high FBS (six subjects) or fibrinogen (five subjects) levels.

Table 1: The characteristics of Zahedanian female nurses.

Variable	Mean	SD
Age (years)	33.0	6.4
FBS (mg/dl)	84.8	17.6
TC (mg/dl)	167.9	37.9
TG (mg/dl)	114.6	50.9
LDL-C (mg/dl)	99.4	42.5
HDL-C (mg/dl)	46.2	8.8
BMI (kg/m^2)	25.0	4.5
WC (cm)	82.2	10.2
WHpR	1.8	0.4
WHtR	0.5	0.1
Fibrinogen (mg/dl)	275.6	69.7
LDL-C: HDL-C	2.4	1.3
TC: HDL-C	3.9	1.5
SBP (mmHg)	105.8	13.2
DBP (mmHg)	70.7	11.8

Table 2: The distribution of general and central obesity indices, blood parameters and blood pressure in Zahedanian female nurses.

Variables	N	%
BMI (kg/m^2)		
<18.5	8	5.8%
18.5-24.9	66	47.8%
25-29.9	44	31.9%
≥ 30	17	12.3%
WC (cm)		
<88	98	71.0%
≥ 88	39	28.3%
WHpR		
<0.8	32	23.2%
≥ 0.8	105	76.1%
WHtR		
<0.49	53	38.4%
≥ 0.49	85	61.6%

SBP (mmHg)		
<130	134	97.1%
≥ 130	4	2.9%
DBP (mmHg)		
<85	118	85.5%
≥ 85	20	14.5%
TC (mg/dl)		
<200	107	77.5%
≥ 200	31	22.5%
TG (mg/dl)		
<150	114	82.6%
≥ 150	24	17.4%
LDL-C (mg/dl)		
<130	103	74.6%
≥ 130	34	24.6%
HDL-C (mg/dl)		
<50	98	71.0%
≥ 50	40	29.0%
LDL-C:HDL-C		
≤ 2	64	46.4%
>2	74	53.6%
TC:HDL-C		
<5.6	118	85.5%
≥ 5.6	20	14.5%
FBS (mg/dl)		
<100	132	95.7%
≥ 100	6	4.3%
Fibrinogen (mg/dl)		
<400	124	89.9%
≥ 400	5	3.6%

The relationships between categorical data of general and central obesity indices and SBP, DBP, FBS, fibrinogen, and lipid profile parameters are demonstrated in Table 3. Subjects with BMI ≥ 30 kg/m², WC ≥ 88 cm, and WHtR ≥ 0.49 had significantly higher TC, TG, LDL-C, LDL-C:HDL-C, and TC:HDL-C and lower HDL-C levels than subjects with lower anthropometric characteristics. Meanwhile, subjects with WHpR ≥ 0.8 had significantly higher TC, TG, and TC: HDL-C than normal subjects.

Table 4 reveals the best anthropometric predictors of cardiovascular variables. BMI was the most powerful predictor of most of the serum lipid and lipoproteins, namely TC, TG, HDL-C, and LDL-C: HDL-C, with a p-value<0.05. WC was the strongest determinant of TC: HDL-C and was a significant predictor of TC and HDL-C, with a smaller adjusted R2 compared to BMI. WHpR was another significant determinant of TC: HDL-C, with a smaller adjusted R2 of 7%. WHtR predicted 8.1% of TG and 8.9% of LDL-C. BMI and WHtR were also good determinants of SBP and predicted 9.6% and 8% of SBP variance, respectively. None of the anthropometric indices significantly predicted DBP, FBS, and fibrinogen.

Table 5 demonstrates the prediction of cardiovascular risk factors with anthropometric indices by odds ratio. Subjects within obesity BMI range (BMI ≥ 30 kg/m²) had significantly higher risk for high TC, TG, LDL-C, and LDL-C:HDL-C and low HDL-C with odds ratios of 6.6, 3.27, 9.1, 7.8, and

Table 3: The relationship between general & central obesity indices and CVD risk factors in Zahedanian female nurses.

	TC (mg/dl)		TG (mg/dl)		LDL-C (mg/dl)		HDL-C (mg/dl)		LDL-C: HDL-C		TC: HDL-C	
	Mean	S.E[1]	Mean	S.E	Mean	S.E	Mean	S.E	Mean	S.E	Mean	S.E
BMI (kg/m²)												
<18.5 group I	156.5	10.2	92.0	9.1	89.7	11.8	51.0	3.1	1.9	0.3	3.2	0.3
18.5-24.9 group II	162.7	4.4	107.3	5.6	94.4	4.8	47.5	1.0	2.1	0.1	3.6	0.2
25-29.9 group III	168.0	5.8	122.2	9.2	98.1	6.5	45.4	1.1	2.3	0.2	3.9	0.2
≥ 30 group IV	197.0	8.4	139.5	9.8	134.1	10.3	39.8	1.8	3.5	0.3	5.2	0.4
P-value	0.006 *		0.047 **		0.006 ***		0.003 ****		0.001 *****		0.001 *****	
WC (cm)												
<88	160.3	3.6	105.1	4.1	91.6	4.0	48.2	0.9	2.0	0.1	3.5	0.1
≥ 88	185.4	5.8	137.5	10.3	118.2	6.8	41.3	1.1	3.0	0.2	4.7	0.3
P-value	0.0001		0.001		0.001		0.0001		0.0001		0.0001	
WHpR												
<0.8	155.6	6.7	95.6	6.0	88.1	7.2	48.9	1.4	1.9	0.2	3.4	0.2
≥ 0.8	171.0	3.6	120.0	5.2	102.4	4.1	45.4	0.9	2.5	0.1	4.0	0.1
P-value	0.043		0.017		0.095		0.052		0.076		0.04	
WHtR												
<0.49	156.6	4.8	96.2	4.1	88.8	5.3	49.7	1.1	1.9	0.1	3.3	0.2
≥ 0.49	174.7	4.1	126.0	6.2	106.4	1.7	43.9	0.9	2.6	0.1	4.2	0.2
P-value	0.006		0.001		0.02		0.0001		0.003		0.001	

	SBP (mmHg)		DBP (mmHg)		Fibrinogen (mg/dl)		FBS (mg/dl)	
	Mean	S.E	Mean	S.E	Mean	S.E	Mean	S.E
BMI (kg/m²)								
<18.5 group I	100.6	3.0	66.2	4.1	279.2	12.4	87.1	5.4
18.5-24.9 group II	105.3	1.1	70.8	1.2	266.7	8.2	83.0	0.7
25-29.9 group III	107.1	1.7	71.4	1.6	284.7	11.3	87.4	4.4
≥ 30 group IV	105.6	6.3	70.2	4.7	293.7	23.5	84.5	1.6
P-value	0.6		0.7		0.4		0.5	
WC (cm)								
<88	105.1	1.0	71.3	1.0	270.7	7.0	83.1	0.7
≥ 88	107.0	3.1	68.8	2.3	288.4	12.2	89.4	4.8

P-value	0.4		0.2		0.2		0.056	
WHpR								
<0.8	104.3	1.7	69.5	1.7	260.3	8.6	81.7	0.9
≥ 0.8	106.0	1.3	70.9	1.2	280.4	7.5	85.8	1.9
P-value	0.5		0.5		0.1		0.24	
WHtR								
<0.49	103.8	1.2	69.7	1.4	268.0	8.8	82.7	1.1
≥ 0.49	107.0	1.6	71.2	1.4	280.0	8.3	86.1	2.3
P-value	0.17		0.47		0.32		0.25	

[1]Standard error of the mean.
* The difference is between group I and IV, group II and IV and group III and IV.
**The difference between all groups, which means all groups are different from each other.
*** The difference is between group I and IV, group II and IV and group III and IV.
**** The difference is between group I and IV.
***** The difference is between group I and IV and group II and IV.
****** The difference is between group I and IV and group II and IV.

Table 4: Linear regression analysis of blood parameters on general & central obesity indices in Zahedanian female nurses.

Variables	Obesity indices	Beta	Standardized beta	Adjusted R^2	t-statistic	p-value
TC (mg/dl)	BMI	1.8	1.213	0.12	2.3	<0.05
	WC	1.4	0.99	0.10	2.04	<0.05
TG (mg/dl)	BMI	0.95	1.1	0.09	2.75	<0.05
	WHtR	0.21	0.27	0.081	2.63	<0.05
LDL-C (mg/dl)	WHtR	0.19	0.16	0.089	5.1	<0.01
HDL-C (mg/dl)	BMI	-0.31	-0.27	0.11	3.7	<0.01
	WC	-0.21	-0.19	0.09	2.2	<0.05
LDL-C:HDL-C	BMI	0.3	0.107	0.08	2.02	<0.05
TC:HDL-C	WC	0.27	0.21	0.13	3.07	<0.01
	WHpR	0.22	0.19	0.07	2.07	<0.05
SBP (mmHg)	BMI	0.31	0.21	0.096	3.2	<0.01
	WHtR	0.18	0.22	0.08	2.11	<0.05
DBP (mmHg)	-	-	-	-	-	-
FBS (mg/dl)	-	-	-	-	-	-
Fibrinogen (mg/dl)	-	-	-	-	-	-

- As the BMI factor usually remains in the model and shows a relation with dependent variables and because its adjusted r2 and its standardized B is higher than other obesity indices, therefore it can be the best predictor of cardiovascular disease risk factors. Meantime Hosmer-Lemes how modeling shows that in all the cases BMI is the only variable which remains in the model and has a significant relation with dependent variables.
- In addition to obesity indices, age and marital status is also entered to the model which means the model is also adjusted based on these two variables.

Table 5: Odds for the presence of hypertension hyperglycemia and dyslipidemia according to general and central obesity indices.

Odds ratio (95%CI)				
Women (n=138)	**BMI≥ 30 kg/m²**	**WC ≥ 88 cm**	**WHpR ≥ 0.8**	**WHtR ≥ 0.49**
TC ≥ 200 (mg/dl)	6.6 (2.27-19.5)**	5.0 (2.13-11.9)**	2.3 (0.7-7.1)	3.2 (1.2-8.6)*
TG ≥ 150 (mg/dl)	3.3 (1.06-10)*	3.3 (1.28-7.9)*	3.9 (0.8-17)	19.2 (2.5-14.7)*
LDL-C≥ 130 (mg/dl)	9.1 (2.9-29)**	4.1 (1.8-9.5)*	2.0 (0.7-5.6)	3.1 (1.24-7.2)
HDL-C ≤50 (mg/dl)	3.4 (1.35-15)*	3.8 (1.36-10)*	2.0 (0.8-4)	2.3 (1.08-4.5)*
LDL-C:HDL-C>2	7.8 (1.72-36)*	3.0 (1.34-6.6)*	1.6 (0.7-3.6)	2.5 (1.2-5.2)*
TC:HDL-C ≥ 5.6	2.8 (0.9-9.3)	3.0 (1.14-8)*	2.9 (0.95-6.8)	2.8 (0.89-9)
SBP ≥ 130 (mmHg)	3.6 (0.3-42)	2.5 (0.35-19)	2.4 (0.4-18)	1.1 (0.7-11)
DBP ≥ 85 (mmHg)	2.1 (0.6-7.4)	1.1 (0.38-3)	1.9 (0.41-15)	2.8 (0.89-9)
FBS ≥ 100 (mg/dl)	1.8 (0.18-17)	2.6 (0.5-13)	1.1 (0.73-19)	3.2 (0.36-28)
Fibrinogen≥ 400 (mg/dl)	1.9 (0.2-18)	0.6 (0.07-6.1)	1.1 (0.81-14)	1.0 (0.15-6)

* Significant in 0.05
**significant in 0.01
Logistic regression models including age/marital status as confounding factors.

3.4, respectively. Subjects above the WC cut-off point had significantly higher lipid parameters including high TC (OR: 5), TG (OR: 3.2), LDL-C (OR: 4.1), LDL-C: HDL-C (OR: 3), and TC: HDL-C (OR: 3.0) and low HDL-C (OR: 3.8). Women with high WHtR were prone to high TC (OR: 3.2) and LDL-C: HDL-C (OR: 2.5) and low HDL-C (OR: 2.3), and they had the highest risk of high TG (OR: 19.2). According to the present study, BMI, WC, and WHtR are the best predictors of LDL-C (OR: 9.1), TC (OR: 5), and TG (OR: 19.2), respectively.

Discussion

The prevalence of being overweight ($25 \leq BMI<30$ kg/m²) and obese (BMI ≥ 30 kg/m^2) in Iranian nurse participants was 31.9% and 12.3%, respectively. The rate of being overweight was slightly higher and the rate of being obese was lower than the general population of Iranian women, who were reported to be 31.5% overweight and 29.5% obese in 2008 (World Health Organization, 2011). In another study conducted in Iran (Isfahan City), rates of being overweight and obese were 42.6% and 24.2%, respectively, in adult women. [31, 32] A recent study in the city of Arak showed that 33.4% of females were overweight and 25.6% were obese. [33] In Florianopolis, in southern Brazil, 26.4% of women were reported to be overweight and 16.7% were obese. [34] According to WHO, the global prevalence of overweight and obese women is 21% and 14%, respectively [35], which shows that in our group of Iranian female nurses, the rate of being overweight was higher and being obese was lower than global estimates, which could be explained by multiple pregnancies, marital status, and low exercise levels in women residing in the part of Iran investigated. [36]

Since there is no consensus about the best measure of abdominal obesity, we applied the three most commonly used abdominal obesity measures (WC, WHpR, and WHtR). Although a wide variation was observed between abdominal obesity levels among the studied population according to the anthropometric index applied, central fat distribution was almost prevalent in female nurse participants (28.3% with WC ≥ 88 cm, 76.1% with WHpR ≥ 0.8, and 61.6% with WHtR ≥ 0.49). A study performed in Tehran showed that 35.7% of women had WC ≥ 88 cm and 57.7% had WHpR ≥ 0.8. [22] Within a large study in Spain, a considerable proportion of women were characterized with abdominal obesity and high WHtR (55% and 77%, respectively). [2] The rates of abdominal obesity, high WHpR, and high WHtR in Canadian women were 43%, 43%, and 60%, respectively. [19]

The rates of dyslipidemia, impaired fasting glucose, and hypertension found in the studied population were lower than percentages reported in the Iranian population but appear to be higher than corresponding results of other studies. A study among women in the Zanjan Province reported that 39% had TG ≥ 150 mg/dl, 40% had TC ≥ 200 mg/dl, 93.1% had HDL-C ≤ 50 mg/dl, 29.6% had SBP ≥ 130 mmHg, and 25.1% had DBP ≥ 85 mmHg. [27] A study of 426 mothers in Germany disclosed rates of impaired fasting glucose (≥ 100 mg/dl), elevated blood pressure or diagnosed hypertension, and diagnosed hypercholesterolemia of 14%, 19%, and 11%, respectively. [37] Impaired fasting glucose and low HDL-C were present in 24% and 40% of black South African women, respectively. [38] The less-prevalent cardiovascular risks among the observed Zahedanian female nurses compared to the general population of Iranian women is explained by studies showing an inverse relationship between education level and cardiovascular risk factors. [39-41] The higher prevalence of cardiovascular risk factors among the studied population compared to global surveys could be due to unhealthy dietary habits (consuming more greasy and high energy density foods) and less active lifestyles among Iranians. [42,43]

There is a need to determine a sensitive and easily obtained indicator of cardiovascular risk associated with obesity. In this context, based on univariate analysis, our findings revealed that both general and central obesity indices, namely BMI, WC, and WHtR, were significantly associated with all cardiovascular parameters except FBS, fibrinogen, and blood pressure, while WHpR was associated with hypercholesterolemia, hypertriglyceridemia, and an abnormal TC: HDL-C ratio. The possible explanation for lack of meaningful correlation for FBS, fibrinogen, and blood pressure is that only a small portion of female nurses were identified with hyperglycemia, hypertension, and high fibrinogen levels. Our findings are compatible with several studies, namely a large study in Spain [2] and two other studies specifically investigating women [7,37] that showed a positive correlation between general and central obesity indices and CVD risk factors. Nonetheless, there is still a need to determine the most useful anthropometric variable to predict CVD risk factors, particularly in women.

In our sample of Zahedanian female nurses, elevated SBP could be well predicted by BMI, whereas no anthropometric indicator had the ability to predict DBP. Another study revealed a positive association between BMI and WC with SBP, while such correlation did not exist for DBP. [28] The study emphasized that BMI and WC both have the same discriminative power to identify individuals at increased cardiometabolic risk. Similar results pertaining to BMI and SBP correlation in women have been reported by a large cross-sectional study conducted in Tehran. [44] In contrast, some studies have had different correlations. [6,45]

According to linear and logistic regression analysis, BMI was a superior predictor of abnormal lipid profiles, except abnormal TC: HDL-C, which was best, indicated by WC within our sample. Nevertheless, no anthropometric index was superior at distinguishing individuals with higher risk of elevated FBS, fibrinogen, and DBP. The former result was also reported with Tehranian women. [44] Some studies reported BMI as a valuable and easily applicable indicator of elevated lipid profiles, with equal discriminative power as a central obesity indicator, [28,37,46] while several studies found WHtR to be a strong indicator of dyslipidemia, [7,25,27,45,47,48] and others reported WC as the best CVD risk factor indicator. [6,21] Due to the multifactorial nature of CVD risk factors, anthropometric measures could only elucidate 7% to 13% of CVD risk factor variance.

Conclusion

In conclusion, the results of the current study indicate that the rate of overweight female nurses is higher and obesity is lower than global estimations. The results also indicate that 28.3%, 76.1%, and 61.6% of female nurses in Iran suffer from high WC, WHpR, and WHtR, respectively. In addition, based on study findings, WC and WHtR can best anticipate elevated TC: HDL-C and LDL-C, respectively, while BMI is the best predictor of high TC, TG, HDL-C, LDL-C: HDL-C, and SBP. Our findings highlight the need for effective national programs regarding lifestyle changes for CVD risk prevention in the general population and specifically in health care custodians, which could positively affect community health status. Further research in different parts of Iran and other countries, among female nurses, with a larger number of participants, and focused on obesity and major CVD risk trends over time may be needed to confirm these results and increase their generalizability.

Conflict of Interest

All authors disclose that there was no conflict of interest.

References

1. Sarrafzadegan N, Khosravi-Boroujeni H, Esmaillzadeh A, Sadeghi M, Rafieian-Kopaei M, Asgary S. The association between hypertriglyceridemic waist phenotype, menopause, and cardiovascular risk factors. Arch Iran Med 2013; 16: 161-166.
2. Felix-Redondo FJ, Grau M, Baena-Diez JM, Degano IR, De Leon AC, Guembe MJ, et al. Prevalence of obesity and associated cardiovascular risk: the DARIOS study. BMC Public Health 2013; 13: 542.
3. Shahraki T, Shahraki M, Roudbari M, Gargari BP. Determination of the leading central obesity index among cardiovascular risk factors in Iranian women. Food Nutr Bull 2008; 29: 43-48.
4. World Health Organization. Global health risks: Mortality and burden of disease attributable to selected major risks. Geneva, Switzerland: World Health Organization; 2009.
5. Shidfar F, Alborzi F, Salehi M, Nojomi M. Association of waist circumference, body mass index and conicity index with cardiovascular risk factors in postmenopausal women. Cardiovasc J Afr 2012; 23: 442-445.
6. van Dijk SB, Takken T, Prinsen EC, Wittink H. Different anthropometric adiposity measures and their association with cardiovascular disease risk factors: A meta-analysis. Neth Hear J 2012; 20: 208-218.
7. Rastovic M, Srdic Galic B, Stokic E, Sakac D, Mikalacki M, Korovljev D. Anthropometric indicators of mass and distribution of adipose tissue in the assessment of cardiovascular and diabetes risk in women. Med Pregl 2013; 66: 11-18.
8. Shahraki T, Shahraki M, Roudbari M. Waist circumference: A better index of fat location than WHR for predicting lipid profile in overweight/obese Iranian women. East Mediterr Heal J 2009; 15: 899-905.
9. De Souza NC, De Oliveira EP. Sagittal abdominal diameter shows better correlation with cardiovascular risk factors than waist circumference and BMI. J Diabetes Metab Disord 2013; 12: 41.
10. Lichtash CT, Cui J, Guo X, Chen YD, Hsueh WA, Rotter JI, et al. Body adiposity index versus body mass index and other anthropometric traits as correlates of cardiometabolic risk factors. PLoS One 2013; 8: e65954.
11. Misra A, Shrivastava U. Obesity and dyslipidemia in South Asians. Nutrients 2013; 5: 2708-2733.
12. Zhang ZQ, Deng J, He LP, Ling WH, Su YX, Chen YM. Comparison of various anthropometric and body fat indices in identifying cardiometabolic disturbances in Chinese men and women. PLoS One 2013; 8: e70893.
13. Rashidi A, Mohammadpour-Ahranjani B, Vafa MR, Karandish M. Prevalence of obesity in Iran. Obes Rev 2005; 6: 191-192.
14. World Health Organization. Global status report on noncommunicable diseases. 2010.
15. Maddah M. Obesity and dyslipidemia among young general physicians in Iran. Int J Cardiol 2007; 118: 111-112.
16. Staiano AE, Bouchard C, Katzmarzyk PT. BMI-specific waist circumference thresholds to discriminate elevated cardiometabolic risk in White and African American adults. Obes Facts 2013; 6: 317-324.
17. Li WC, Chen IC, Chang YC, Loke SS, Wang SH, Hsiao KY. Waist-to-height ratio, waist circumference, and body mass index as indices of cardiometabolic risk among 36,642 Taiwanese adults. Eur J Nutr 2013; 52: 57-65.
18. Farajian P, Renti E, Manios Y. Obesity indices in relation to cardiovascular disease risk factors among young adult female students. Br J Nutr 2008; 99: 918-924.
19. Shields M, Tremblay MS, Connor Gorber S, Janssen I. Abdominal obesity and cardiovascular disease risk factors within body mass index categories. Heal Rep 2012; 23: 7-15.
20. Al-Odat AZ, Ahmad MN, Haddad FH. References of anthropometric indices of central obesity and metabolic syndrome in Jordanian men and women. Diabetes Metab Syndr 2012; 6: 15-21. Esmaillzadeh A, Mirmiran P, Azizi F. Comparative evaluation of anthropometric measures to predict cardiovascular risk factors in Tehranian adult women. Public Heal Nutr 2006; 9: 61-69.
21. Gharakhanlou R, Farzad B, Agha-Alinejad H, Steffen LM, Bayati M. Anthropometric measures as predictors of cardiovascular disease risk factors in the urban population of Iran. Arq Bras Cardiol 2012; 98: 126-135.
22. Ho SC, Chen YM, Woo JL, Leung SS, Lam TH, Janus ED. Association between simple anthropometric indices and cardiovascular risk factors. Int J Obes Relat Metab Disord 2001; 25: 1689-1697.
23. Ashwell M, Gunn P, Gibson S. Waist-to-height ratio is a better screening tool than waist circumference and BMI for adult cardiometabolic risk factors: A systematic review and meta-analysis. Obes Rev 2012; 13: 275-286.
24. Azimi-Nezhad M, Ghayour-Mobarhan M, Safarian M, Esmailee H, Parizadeh SM, Rajabi-Moghadam M, et al. Anthropometric indices of obesity and the prediction of cardiovascular risk factors in an Iranian population. Scientific World Journal 2009; 9: 424-430.
25. Hadaegh F, Zabetian A, Sarbakhsh P, Khalili D, James WP, Azizi F. Appropriate cutoff values of anthropometric variables to predict cardiovascular outcomes: A 7.6 years follow-up in an Iranian population. Int J Obes 2009; 33: 1437-1445.
26. Mellati AA, Mousavinasab SN, Sokhanvar S, Kazemi SA, Esmailli MH, Dinmohamadi H. Correlation of anthropometric indices with common cardiovascular risk factors in an urban adult population of Iran: data from Zanjan Healthy Heart Study. Asia Pac J Clin Nutr 2009; 18: 217-225.
27. Abbasi F, Blasey C, Reaven GM. Cardiometabolic risk factors and obesity: does it matter whether BMI or waist circumference is the index of obesity? Am J Clin Nutr 2013; 98: 637-640.
28. Flegal KM, Kit BK, Orpana H, Graubard BI. Association of all-cause mortality with overweight and obesity using standard body mass index categories: A systematic review and meta-analysis. JAMA 2013; 309: 71-82.
29. World Health Organization. Obesity epidemic puts millions at risk from related diseases. WHO Press Release 1997.
30. World Health Organization. Overweight and obesity prevalence. 2011.
31. Siadat ZD, Abdoli A, Shahsanaee A. Association of an adult obesity, blood pressure adulthood socio-economic position. J Res Med Sci 2012; 17: 222-228.
32. Talaei A, Amini M, Moini A. Correlation of hypertension with waist circumference in Iranian adults. High Blood Press Cardiovasc Prev 2012; 19: 47-50.
33. Santos Silva DA, Petroski EL, Peres MA. Is high body fat estimated by body mass index and waist circumference a predictor of hypertension in adults? A population-based study. Nutr J 2012;11:112.
34. World Health Organization. Obesity: Situation and trends. Glob Heal Obs 2013.
35. Shahraki M, Shahraki T, Ansari H. The effects of socio-economic status on BMI, waist:hip ratio and waist circumference in a group of Iranian women. Public Heal Nutr 2008; 11: 757-761.
36. Florath I, Brandt S, Weck MN, Moss A, Gottmann P, Rothenbacher

D, et al. Evidence of inappropriate cardiovascular risk assessment in middle-age women based on recommended cut-points for waist circumference. Nutr Metab Cardiovasc Dis 2014.

37. Ware LJ, Rennie KL, Kruger HS, Kruger IM, Greeff M, Fourie CM, et al. Evaluation of waist-to-height ratio to predict 5 year cardiometabolic risk in sub-Saharan African adults. Nutr Metab Cardiovasc Dis 2014; 24: 900-907.

38. Maddah M. Association of gender and education with blood lipids and fasting glucose levels in a sample of Iranian obese adults. Int J Cardiol 2007; 120: 281-283.

39. Shahraki M, Shahraki T, Shidfar F, Ansari H. Which modifiable, non-modifiable, and socioeconomic factors have more effect on cardiovascular risk factors in overweight and obese women? J Res Med Sci 2012; 17: 676-680.

40. Erem C, Hacihasanoglu A, Deger O, Kocak M, Topbas M. Prevalence of dyslipidemia and associated risk factors among Turkish adults: Trabzon lipid study. Endocrine 2008; 34: 36-51.

41. Esmaillzadeh A, Azadbakht L. Dietary energy density and the metabolic syndrome among Iranian women. Eur J Clin Nutr 2011; 65: 598-605.

42. Esmaillzadeh A, Azadbakht L. Food intake patterns may explain the high prevalence of cardiovascular risk factors among Iranian women. J Nutr 2008; 138: 1469-1475.

43. Azizi F, Esmaillzadeh A, Mirmiran FP. Obesity and cardiovascular disease risk factors in Tehran adults: a population-based study. East Mediterr Heal J 2004; 10: 887-897.

44. Savva SC, Lamnisos D, Kafatos AG. Predicting cardiometabolic risk: Waist-to-height ratio or BMI. A meta-analysis. Diabetes Metab Syndr Obes 2013; 6: 403-419.

45. Ledoux M, Lambert J, Reeder BA, Despres JP. Correlation between cardiovascular disease risk factors and simple anthropometric measures. Canadian Heart Health Surveys Research Group. CMAJ 1997; 157: S46-S53.

46. Browning LM, Hsieh SD, Ashwell M. A systematic review of waist-to-height ratio as a screening tool for the prediction of cardiovascular disease and diabetes: 0.5 could be a suitable global boundary value. Nutr Res Rev 2010; 23: 247-269.

47. Yang CY, Peng CY, Liu YC, Chen WZ, Chiou WK. Surface anthropometric indices in obesity-related metabolic diseases and cancers. Chang Gung Med J 2011; 34: 1-22.

48. Barzi F, Woodward M, Czernichow S, Lee CM, Kang JH, Janus E, et al. The discrimination of dyslipidaemia using anthropometric measures in ethnically diverse populations of the Asia-Pacific Region: the Obesity in Asia Collaboration. Obes Rev 2010; 11: 127-136.