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 ≤ BMI ≤ 29.9 kg/m²) and obese (BMI ≥ 30 kg/m²) and central obesity in terms of WHpR ≥ 0.8, WHR ≥ 0.49, and WC ≥ 88 cm was 31.9%, 12.3%, 76.1%, 61.6%, and 28.3% respectively. Abnormal BMI, WC, and WHR was significantly associated with all cardiovascular risk factors including high TC, TG, LDL-C, HDL-C, LDL-C:HDL-C, and TCHDL-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, LDL-C:HDL-C, and SBP, whereas abnormal TC: HDL-C and LDL-C were best indicated by WC and WHR, 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.
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). 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.

Deleterious health consequences of obesity can be simply, inexpensively, and accurately predicted by anthropometric indices. 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. 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.

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. Some studies have indicated that WC may be a better screening tool for detecting CVD risk factors, especially hypercholesterolemia and hypertriglyceridemia.

Some studies have shown that WHtR has a greater effect on CVD risk factors, whereas others have suggested that WHpR is the best predictor of CVD risk factors, namely hyperglycemia, hypertriglyceridemia, and low HDL-C. 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, while others advocate the combination of BMI and WC as a good predictor of CVD risk factors.

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 Ejtemaiei) 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/m², normal weight is 18.5 ≤ BMI ≤ 24.9 kg/m², overweight is 25 ≤ BMI ≤ 29.9 kg/m², and obese is BMI ≥ 30 kg/m². 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 auto-analyzer. TC was assayed using the enzymatic colorimetric method using glucose oxidase.

In this study, the following criteria were used as cut-offs (thresholds) for variables: anthropometric indices: ≥ 30 kg/m², ≥ 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/m²) 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.
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 \( \geq 30 \text{ kg/m}^2 \), WC \( \geq 88 \text{ cm} \), and WHR \( \geq 0.49 \) had significantly higher TC, TG, LDL-C, and LDL-C:HDL-C, and TC:HDL-C and lower HDL-C levels than subjects with lower anthropometric characteristics. Meanwhile, subjects with WHR \( \geq 0.8 \) 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. WHR was another significant determinant of TC: HDL-C, with a smaller adjusted R2 of 7%. WHR predicted 8.1% of TG and 8.9% of LDL-C. BMI and WHR 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 \( \geq 30 \text{ kg/m}^2 \)) 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...
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 WHR were prone to high TC (OR: 5.0), TC: HDL-C (OR: 3.0), and they had the highest risk of high TG (OR: 19.2). According to the present study, BMI, WC, and WHR 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 ≤ BMI<30 kg/m²)
and obese (BMI ≥ 30 kg/m²) 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. A recent study in the city of Arak showed that 33.4% of females were overweight and 25.6% were obese. In Florianopolis, in southern Brazil, 26.4% of women were reported to be overweight and 16.7% were obese. According to WHO, the global prevalence of overweight and obese women is 21% and 14%, respectively, 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. 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. Within a large study in Spain, a considerable proportion of women were characterized with abdominal obesity and high WHtR (55% and 77%, respectively). The rates of abdominal obesity, high WHpR, and high WHtR in Canadian women were 43%, 43%, and 60%, respectively.

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. 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. Impaired fasting glucose and low HDL-C were present in 24% and 40% of black South African women, respectively. 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. 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, due to 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 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. 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. In contrast, some studies have had different correlations.

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 Iranian women. Some studies reported BMI as a valuable and easily applicable indicator of elevated lipid profiles, with equal discriminative power as a central obesity indicator, while several studies found WHtR to be a strong indicator of dyslipidemia, and others reported WC as the best CVD risk factor indicator. 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


