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Assessment of the Correlation between Severity of Coronary Artery Disease and Waist–Hip Ratio

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Abstract

AIM: This study was conducted to investigate the correlation between waist/hip ratio (WHR) as a measurement of obesity and severity of coronary artery disease (CAD) assessed by angiography in Kosovo.

METHODS: The study included 82 patients with suspected or known CAD who were referred for coronary angiography. All patients were subjected to full individual medical history, clinical examination including measurement of arterial blood pressure, body weight, height, body mass index (BMI), waist circumference, hip circumference, waist/hip ratio, and waist/height ratio. Coronary angiography was performed using standard techniques to determine the presence and severity of coronary artery lesions with the Gensini score.

RESULTS: Among the 82 patients in the study, the mean age in the CAD group was 66.76 ± 9.12 years and the mean age in the non-CAD group was 64.80 ± 8.30 years. Patients in the CAD group had a mean BMI of 28.17 ± 3.32 kg/m^2 and those in the non-CAD group had a mean BMI of 28.76 ± 4.68 kg/m^2. Patients in the CAD group had a mean waist/height ratio of 1.76 ± 7.56 and those in the non-CAD group had a mean waist/height ratio of 0.57 ± 0.08. Patient in the CAD group had a mean waist/hip ratio of 0.93 ± 0.06 and those in the non-CAD group had a mean waist/hip ratio of 0.88 ± 0.07. Thirty-seven patients (45.1%) had no coronary artery disease (Gensini score = 0), 15 (18.3%) had mild disease (Gensini score = 1-32), 14 (17.1%) had moderate disease (Gensini score = 32-58), and 16 (19.5%) had severe disease (Gensini score ≥ 58).

CONCLUSION: There was a significant positive correlation between waist/hip ratio and presence of CAD in Kosovar patients.

Introduction

Obesity is a growing health problem in most developed and in some developing countries. It is a very important risk factor for cardiovascular diseases as well as for type 2 diabetes mellitus and hypertension. Different methods exist for clinical evaluation of obesity. The body mass index (BMI), waist circumference (WC), waist/hip ratio (WHR), and waist/height ratio (WHtR) are some of the clinical tools enabling health teams to evaluate obesity and fat distribution. A central fat distribution is considered more atherogenic than peripheral obesity and attention has been paid to methods that can clinically evaluate central obesity [1]. The incidence of obesity is increasing in developing countries because of the westernization of diet and lifestyle [2].

Obesity is a proven independent risk factor for CAD in both sexes, and is in general a growing health problem [3-5]. Body weight, BMI, WC, and WHR are primary methods used to determine obesity. While BMI reflects general obesity, WC and WHR are related to central-type obesity, where body fat is primarily located in the abdomen. Prospective epidemiological studies have revealed that central obesity (determined by WC and WHR) is more relevant to CAD risk compared to general obesity (determined by BMI). While WHR is used commonly to evaluate central obesity, WC is shown to have a better correlation with abdominal fat localization (6-9). However, it also has been argued that BMI does not adequately reflect body fat distribution, and abdominal obesity, which captures the distribution of fat mass, may be an even more important predictor of CAD [10, 11].

In epidemiological settings WC, WHR, and WHtR are used as markers of visceral fat mass or abdominal adiposity to assess CAD risk.

To the best of our knowledge, this is the first study performed in Kosovo to focus on the correlation between WHR and the presence of CAD.

Material and Methods

Subjects of the study

The study was approved by the Ethics Committee of the Faculty of Medicine in the University of Prishtina, in accordance with the Declaration of Helsinki Guidelines. Written consent was obtained from all participants in the study. The prospective study consisted of 82 patients who underwent coronary angiography for suspected or known coronary atherosclerosis. Patients had to be clinically stable without major concomitant non-cardiovascular disease on assessment at the University Clinical Center of Kosovo. Patients with acute coronary syndrome, heart valve disease, elevated serum troponin levels, severe heart failure, chronic renal failure, and chronic inflammatory disease were excluded from the study.

Coronary angiography

Single-vessel disease was defined as > 50% luminal stenosis in a minimum of two views. Two experienced reviewers scored the angiograms. In case of disagreement between the reviewers, the average value of both angiograms was chosen. Reviewers were not aware of the diagnosis. Narrowing of the coronary artery lumen is assigned a Gensini score [12]. The score is 1 for 1-25% narrowing, 2 for 26-50%, 4 for 51-75%, 8 for 76-90%, 16 for 91-99%, and 32 for a completely occluded artery. The primary score is multiplied by a factor that takes into account the importance of the position of the lesion in the coronary arterial tree. For example, 1.5 is the multiplication factor for a mid-left anterior descending artery (LAD) lesion, with 1 for distal LAD, 2.5 for proximal LAD, and 5 for left main stem lesions. The Gensini score was expressed as the sum of the scores for all three coronary arteries to evaluate the overall extent of coronary artery disease [12].

Measurements

Patients were assessed in an examination gown, with upper body clothing and shoes removed. Each measurement was performed twice and the average was used for the analysis. We used the nearest 0.1 units of measurement for height and weight. BMI and WHtR were expressed in corresponding units, i.e., weight (kg) divided by the square of height (m^2), and waist circumference divided by height. WC was also categorized according to World Health Organization (WHO) criteria [13]. For the WHR, the waist is measured between the lowest rib and iliac crest, and the hip circumference is taken at the widest area of the hips at the greatest protuberance of the buttocks. The waist measurement is then divided by the hip measurement. For the decisive benchmark of metabolic syndrome, the WHO uses the ratio of > 9.0 in men and > 8.5 in women.

Laboratory measurements and blood samples were taken in the morning after an overnight fast and were stored immediately at -70°C after centrifugation until being assayed.

Statistics

The data were entered and analyzed with Statistical Package for the Social Science (SPSS), version 22 (SPSS Inc., Chicago, IL, USA). Continuous variables were primarily analyzed using a t-test, while binary data were primarily analyzed using a chi-squared test. Continuous variables were presented as means ± standard deviation (SD). Additionally, single (unadjusted) and multiple (adjusted) binary logistic regression analysis was carried out with the CAD group as the dependent variable, and the other significant variables as independent predictors. A p value of 0.1 was used as a criterion to identify variables for inclusion in the binary logistic regression models. Other adjusting variables included diastolic blood pressure (DBP), WHR, male sex, and smoking.

Results

Among the 82 patients in the study, the mean age was 65.78 ± 12.86 years, 46 patients (56.1%) were males, and 36 (43.9%) were females. Sixty-two patients (75%) had hypertension, 29 (35%) had diabetes mellitus, and 23 (28%) had dyslipidemia. Family history of CAD was positive in 42 patients (51%).

Patients in the CAD group had a mean BMI of 28.17 ± 3.32 kg/m^2 and those in the non-CAD group had a mean BMI of 28.76 ± 4.68 kg/m^2. Patients in the CAD group had a mean WC of 96.97 ± 8.63 cm and those in the non-CAD group had a mean WC of 95.13 ± 11.52 cm. Patients in the CAD group had a mean WHtR of 1.76 ± 7.56 and those in the non-CAD group had a mean WHtR of 0.57 ± 0.08. The mean WHR was 0.93 ± 0.06 in the CAD group and 0.88 ± 0.07 in the non-CAD group. The number of male patients in the study group was significantly higher (n = 29, 70.7%) than in the control group (n = 17, 41.5%) (p = 0.008).

WHR values in the study group (mean 0.93 ±

0.06) and control group (mean 0.88 ± 0.07) were significant (p-value: 0.0001), as shown in Table 1.

Table 1: Demographic and clinical characteristics of non-CAD and CAD groups

Variables	Group I Non-CAD (n = 41)	Group II CAD (n = 41)	p value*
BMI (kg/m^2) (mean ± SD)	28.76 ± 4.68	28.17 ± 3.32	0.51
WC (cm)	95.13 ± 11,52	96.97 ± 8.63	0.44
WHtR (mean ± SD)	0.57 ± 0.08	1.76 ± 7.56	0.32
WHR (mean ± SD)	0.88 ± 0.07	0.93 ± 0.06	0.0001*
SBP (mmHg1 (mean ± SD)	145.61 ± 13.29	145.85 ± 11.98	0.93
DBP (mmHg2 (mean ± SD)	81.34 ± 7.75	84.88 ± 7.79	0.042*
Age (mean ± SD)	64.80 ± 8.30	66.76 ± 9.12	0.31
Sex (M), n (%)	17 41.5%	29 70.7%	0.008*

*, Statistically significant differences; n=Number.

Table 2 presents the unadjusted and adjusted odd ratios (ORs) of CAD according to waist/hip ratio. After adjusting for confounder variables, the odds of having CAD were increased 14-fold (95% confidence interval [CI], 0.94-207.60), compared to those with a WHR <0.8.

In patients with a WHR of 0.8-0.99, the odds of having CAD significantly increased by 3.77-fold (95% CI, 0.40-35.51) compared to those with a WHR <0.8.

Significant differences were seen in binary logistic regression models for CAD analysis according to WHR (OR 14; 95% CI 0.94-207.60; p = 0.06), DBP (OR 2.75; 95% CI 1.12-6.87; p = 0.03), male sex (OR 3.41; 95% CI 1.37-8.52; p = 0.01), and smoking (OR 4.15; 95% CI 1.65-10.44; p = 0.001).

Table 2: Binary Logistic Regression Models for CAD (Unadjusted and Adjusted), DBP, WHR

	Unadjusted Odds Ratio (95% CI)	p value	Adjusted Odds Ratio (95% CI)	p value
DBP ≥ 90 mmHg2	2.75 (1.12-6.87)	0.03	3.35 (1.05-10.69)	0.04
WHR < 0.8	1.00 (Reference)	0.13	1.00 (Reference)	0.67
0.8 - 0.99	3.77 (0.40-35.51)	0.25	3.42 (0.23-50.38)	0.37
≥ 1	14 (0.94-207.60)	0.06	3.03 (0.13-71.20)	0.49
Sex (Male)	3.41 (1.37-8.52)	0.01	2.9 (0.81-10.35)	0.10
Smoker	4.15 (1.65-10.44)	0.00	3.51 (0.98-12.52)	0.05

Thirty-seven patients (45.1%) had no CAD (Gensini score = 0), 15 (18.3%) had mild disease (Gensini score = 1-32), 14 patients (17.1%) had moderate disease (Gensini score = 32-58), and 16 (19.5%) had severe disease (Gensini score ≥ 58). There was non-significant correlation between Gensini score and body mass index (p-value= 0.115) as shown in (Table 3).

Table 3. Correlation between BMI and Gensini

Gensini	BMI							
	Normal 18-24.9 (kg/m^2)		Overweight 25-29.9 (kg/m^2)		Obese ≥30 (kg/m^2)		Total	
	N	%	N	%	N	%	N	%
None (0)	7	46.7	13	35.1	17	56.7	37	45.1
Mild (1-32)	3	20	11	29.7	1	3.3	15	18.3
Moderate (32-58)	1	6.7	6	16.2	7	23.3	14	17.1
Severe (≥58)	4	26.7	7	18.9	5	16.7	16	19.5
Total	15	100	37	100	30	100	82	100
chi-square test, P-value				0.115				

Discussion

The current study showed a significant correlation between WHR and CAD (p = 0.0001) but not between BMI and CAD. This may be explained by the fact that BMI quantifies general adiposity; although individuals who are overweight or obese are likely to have excess fat, BMI does not give an indication of how this fat is distributed in the body. However, fat distribution is an important determinant of CAD, independent of BMI and other classic risk factors for CAD [14]. Welborn and Dhaliwal [15] and Srikanthan, Seeman, and Karlamangla [16] confirmed that WHR was a superior clinical measurement for predicting all-cause and cardiovascular disease mortality. Furthermore, one report [15] stated that the hip circumference indicated a lower risk for body fat accumulation, and thus including it in the WHR equation enhances the accuracy of measurement. It should be emphasized that most of the cross-sectional studies that compared WHR and WC as markers of risk factors have demonstrated superiority of WHR [6, 17].

The International Diabetes Federation has recommended waist circumference thresholds for increased risk of cardiovascular disease and diabetes: ≥ 94 cm in men and ≥ 80 cm in women. The American Heart Association (AHA) and National Heart, Lung, and Blood Institute (NHLBI) set the thresholds at ≥ 102 cm in men and ≥88 cm in women [7]. Cameron et al. [8] reported that higher WC was associated with increased risk in men but not in women, when adjusted for BMI and other covariates. That report was part of a prospective study of 6,072 Australian men and women during a follow-up period of 5 years [8]. Our study did not show a significant correlation of sex with WC but demonstrated that male sex is a significant risk factor for CAD (p = 0.008). In a large cohort study across Europe that involved patients of both sexes with a follow-up period of 9 years, Pischon et al. reported that higher WC (in men and women) and WHR (in women but not in men) were associated with higher mortality due to ischemic heart disease [11].

In a large cohort study of 1,346 middle-aged men free of CVD at baseline followed for 10.6 years, WHR, WC, and BMI were all directly associated with the risk of coronary events, with WHR providing additional information beyond BMI in predicting CAD, whereas BMI did not add to the predictive value of WHR [18].

WC, WHR and WHtR are used as measures of central obesity, while BMI is generally used to measure overall obesity.

Molarius and Seidell [19] emphasized the need to examine whether there could be age-related differences in the contribution of the pattern of fat distribution to risk factors. However, the WHO and

NHLBI reports barely address the question of the applicability of BMI and WC standards for older persons.

Several authors have reported the CAD risk associated with BMI, WC, WHR, or WHtR and have systematically compared some or all of these indicators to predict CAD [20-25].

Current studies confirm that obesity measured by any index usually is associated with increased risk of CAD. However, the findings comparing different measurements of total obesity (BMI) and abdominal obesity (WC, WHR, WHtR) in predicting CAD events have not been consistent. Some have suggested that total obesity rather than abdominal obesity is a better predictor of CAD [24, 25]. However, some investigators have found the reverse to be true [20, 23], and others did not find any significant difference (21, 22). This inconsistency in findings could be due to a number of reasons. There can be errors in self-reported measurements in some studies that can either cause spurious associations or can bias results towards the null. Inadequate or over adjustment of confounders and other cardiovascular risk factors also play a role in determining the nature of this association. Fat distribution and susceptibility to CAD vary by age, sex, and ethnicity and can cause these differences in the results as well.

Similar to our study, the Health Professionals Follow-up Study showed that WHR was a better predictor of CAD risk than BMI among elderly subjects; however, for young patients, BMI was a better predictor [26]. BMI was not a significant factor in our study, reinforcing the findings of Rimm et al. A possible explanation for our findings could be that the mean age was 65.78 ± 12.86 years in our population, and we did not include young patients.

Longer follow-up in the Health Professionals Study and the Nurses' Health Study also showed that WC was a better predictor of CAD risk than BMI among men and women above age 60, and BMI was more strongly associated with risk of CAD in younger compared to older participants [10]. WHR was proposed as the preferred measure of obesity for prediction of cardiovascular disease, with more universal application in individuals and population groups of different body builds. Benchmark studies of WHR as a dominant cardiovascular risk factor were reported in Swedish men and women in 1984 [10, 27].

Although a relatively small sample of patients were selected randomly from the general population, we showed a significant relationship between WHR and CAD. Further studies with larger patient groups are necessary to show statistical differences between BMI, WC, WHtR, WHR, systolic blood pressure (SBP), DBP, age, and sex.

In conclusion, there is a significant positive correlation between WHR and the presence and severity of CAD among Kosovar patients. Abdominal obesity is an independent risk factor for CAD and is more relevant than overall obesity. Since both total obesity and abdominal adiposity were associated with development of CAD, and since measurement of WC, WHR, WHtR, and BMI are inexpensive; we propose to include these in the general clinical setting for CAD risk assessment.

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