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Differences in the number of stented coronary arteries based on the seven traditional obesity parameters among patients with coronary artery diseases undergoing cardiac catheterization

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ABSTRACT

Background: Obesity has been correlated with certain sociodemographic and health variables of patients with coronary artery diseases (CADs). There are seven traditional obesity parameters, which have been used to measure obesity (body mass index [BMI], waist-to-height ratio [WHtR], waist-hip ratio [WHR], body adiposity index [BAI], body shape index [BSI], waist circumference [WC], and hip circumference [HC]). This study aimed to describe the differences in the number of stented coronary arteries based on the aforementioned seven traditional obesity parameters among patients with CADs undergoing cardiac catheterization.

Method: A descriptive cross-sectional study was conducted among 220 hospitalized patients with CADs undergoing a cardiac catheterization. Data were analyzed using frequencies, percentages, bar graphs presentation, and receiver operating characteristics.

Results: Receiver operating characteristic curve indicated that the best cut off point of WC is 95 cm in predicting number of stented coronary arteries with a sensitivity of 76% and a specificity of 68%. BMI had a high sensitivity with the number of stented coronary arteries. The sensitivity values of parameters ranged from 0.45 to 0.92 and the specificity values ranged from 0.25 to 0.68. All traditional obesity parameters except the BSI had a good ability to be highly associated with the number of stented coronary arteries.

Conclusions: Healthcare providers, including nurses, should pay a high attention to these obesity parameters while caring of patients with CAD undergoing cardiac catheterization.

Keywords: stented coronary arteries, traditional obesity parameters, coronary artery diseases, cardiac catheterization

INTRODUCTION

According to the World Health Organization (WHO) [1], there were 1.9 billion overweight people and those with obesity (body mass index [BMI] between 25 and 29.9, aged 18 years old or above, over 650 million of them were obese [BMI≥30]). Furthermore, the WHO estimated that the overweight and obesity ranged from 74% to 86% in women and 69% to 77% in men globally [1]. Obesity is considered a risk factor for many diseases including coronary artery diseases (CADs) [2].

Numerous obesity parameters have been used to measure obesity and to classify obesity into stages. These parameters were compared to each other in relation with CADs and its risk factors [3]. Although there was no agreement on which parameter is associated with the development of CAD and thereafter outcomes [4,5], it seems that central obesity parameters have high associations with CADs [6].

Various socio-demographic variables play significant roles in increasing or decreasing the risk of developing obesity [7]. Findings from various studies reported that combined with different socio-demographic indicators such as age, insufficient physical activity, mental stress, low quality of morbidities management, and environmental factors such as smoking and diet, all contribute to obesity [8-12]. For example, socio-demographic variables such as low level of education, old age, female gender, and high income affect body weight and increase BMI [13]. However, although the prevalence of obesity is high in high-income countries, it also rises in low- and middle-income countries [14-17].

Obesity and various sociodemographic variables such as increasing in age are considered significant risk factors for developing CADs [18-20]. Previous studies reported the presence of an association between obesity and socio-demographic characteristic [21-23]. For example, socioeconomic status, age, and gender play an important role in obesity onset, which finally increases the risk for developing

CADs [24]. According to [25], among patients with cardiovascular diseases, obesity was a trend risk factor with the presence of impact patients' socio-demographic. They found that BMI was higher in the high-income cardiovascular vascular disease patients' group than in middle and low-income groups. Moreover, in [26], it was found that among older adults, abdominal obesity (waist circumference [WC]>90 cm and waist-to-height ratio [WHtR]≥0.50) is associated significantly with having CADs as well as atherosclerosis.

Although BMI is used widely to measure body fat across various human sociodemographic such as gender, ethnicity, and age [27], several previous studies reported that using other traditional obesity parameters, especially WC and WHtR, have a strong relationship with cardiovascular diseases and their risk factors than using BMI alone [28-30]. Because BMI does not take into account body fat distribution, which may mask important indicators or risk factors for CADs, such as visceral adiposity (e.g abdominal obesity) rather than overall adiposity [31].

Several studies reported that WC measurement is the best for representing visceral adiposity among other traditional measurements, and it has a high correlation with CADs risk factors [31,32]. However, WC does not take into account a person's height, so a tall or short people evaluation may be wrong [33]. For that reason, the WHtR is considered by various studies a good alternative measurement for WC [34-36]. According to [34], a systematic review and meta-analyses, the WHtR was the best predictor for CAD risk factors. Moreover, body adiposity index (BAI), hip circumference (HC), and body shape index (BSI) measures provide a good estimation for body fat adiposity [37-39].

However, according to [40], WHtR and WC are better measurement tools than BAI and HC in the evaluation of cardiovascular disease risk factors. Consequently, there is no agreement on the highly associated obesity parameters with the CADs in the literature. In addition, according to the best of knowledge, there was no direct study on the relationship between traditional obesity parameters and the number of stented coronary arteries in the literature. Therefore, this study aimed to describe the differences in the number of stented coronary arteries based on the seven traditional obesity parameters (WHtR, waist-hip ratio [WHR], BAI, BMI, BSI, WC, and HC) among patients with CADs undergoing cardiac catheterization.

MATERIALS & METHODS

Research Design

A correlative cross-sectional design was used in conducting this study.

Setting and Sample

The study was conducted at catheterization labs of two major referral healthcare settings located at the northern and middle regions of Jordan. The sample size was calculated using G power calculation. The family name of test was F test using linear hierarchical multiple regression. Given effect size=0.15, alpha=0.05, and power=0.8, the sample size was 172. For attrition rate, 25% of the sample size was added, so the total sample size was 220 participants. The inclusion criteria were aged 18 years old and above, and hospitalized patients with CADs undergoing cardiac catheterization. The exclusion criteria were having severe organ diseases, such as severe liver disease and renal failure, being pregnant, had coronary artery bypass graft surgery, having autoimmune diseases, and being immunosuppressed patients.

Measurements

Socio-demographic and health variables were collected from the electronic health records (EHRs) and the patients themselves, such as age, gender, education, marital status, monthly income, smoking, blood pressure, and daily activity, Serology tests were collected from the EHRs, such as low density lipoprotein (LDL), high density lipoprotein (HDL), serum triglycerides, high-sensitivity C-reactive protein (HS-CRP), random blood glucose (BG), and hemoglobin A1c (HbA1c).

The obesity parameters were measured using flexible and rigid anthropometric tapes for weight, height, WC and HC. Participants' wights were measured using a Tanita BWB-800 (Arlington Heights, Illinois, USA) digital scale, with regular patient gown (light standard gown provided by the hospital) and without shoes. The BWB-800 was calibrated professionally once each year. WC was measured to the nearest 0.1 cm at the midpoint between the lowest rib margin and the level of the anterior superior iliac crest by a flexible anthropometric tape. HC was measured to the nearest 0.1 cm at the greatest protrusion of the gluteal muscles. WHR and WHtR were calculated as WC/HC and WC/height, respectively. A BSI was calculated using the following formula (waist circumference (cm))/[(BMI)^$^{2/3}$]×([Height (m)]^$^{0.5}$). An BMI was calculated using the following formula (weight (kg))/[height (m)]^^{2}. A BAI was calculated using the following formula (hip circumference (cm))/[Height (m)]^$^{1.5}$-18.

Data Collection

The research assistants gathered the data from participants once they met the study eligibility criteria. The participants included in the study were either that on elective cardiac catheterization or those who were referred from their cardiologists for further investigation. Each participant had a certain number as a symbol which was used instead of his/her name. So, there was a list of patients' names and their numbers, which was made by the principal researcher to ensure patients' confidentiality. The basic data (weight, height, WC and HC) were recorded by well-trained registered nurses who had received three training sessions conducted by the primary researcher, each training sessions was one hour long. The data were collected at the admission assessment before cardiac catheterization by a flexible anthropometric tape for WC and HC, and a rigid anthropometric tape for height and weight. Data collection was done during the period from March 2021 to July 2021.

Statistical Analysis

The frequencies, percentages, means, and standard deviations were used for descriptive analysis. The assumptions of normality, linearity, multicollinearity, and outliers were checked for any violations. Bivariate Pearson's correlations were used to assess the correlation (strength of relationship between the obesity parameters and socio-demographic and health variables among patients with CAD undergoing cardiac catherization. The specificity and the sensitivity were calculated for each traditional obesity parameter. The

Table 1. Socio-demographic and health variables for the study participants (n=220)

	n (%)	Mean (SD)	Median (Min, Max)
Gender			
Male	161 (73.2%)		
Female	59 (26.8%)		
Age (years)		49.9 (11.4)	49 (24, 90)
Marital satus			
Single	53 (24.1%)		
Married	137 (62.3%)		
Divorced	15 (6.8%)		
Widower	15 (6.8%)		
Employment			
Employed	108 (49.1%)		
Not employed	68 (30.9)		
Retired	44 (20%)		
Educational Level			
Illiterate	10 (4.5%)		
Primary school education	40 (18.2%)		
High school education	72 (32.7%)		
Bachelor's degree	56 (25.5%)		
Master's degree	27 (12.3%)		
Doctoral degree	15 (6.8%)		
Smoking (cigarette/day)			
Nonsmokers (0)	84 (38.2%)	26 (14)	25 (0, 60)
Light smokers (<10)	10 (4.5%)		
Moderate smokers (10-20)	72 (32.7%)		
Heavy smokers (>20)	54 (24.6%)		

Table 2. Obesity parameters' descriptions among study participants

	Mean (SD)	Median (Min, Max)
Weight (kg)	80 (14.42)	80 (50, 126)
Waist circumference	102.7 (13.3)	102 (65, 140)
Hip circumference	110.6 (13.4)	110.5 (68, 151)
Waist-to-height ratio	0.64 (0.1)	0.63 (0.37, 0.98)
Waist hip ratio	0.92 (0.07)	0.92 (0.45, 1.2)
Body adiposity index	0.35 (0.09)	0.35 (0.049, 0.67)
Body mass index	32.2 (4.6)	32.3 (23, 42.1)
Body shape index	0.094 (0.08)	0.084 (0.01, 0.1)

statistical package for social science software version 25 (SPSS) and a significance level of 0.05 were used in all data analyses.

Ethical Considerations

The institutional review board (IRB) approvals were obtained from the Jordan University of Science and Technology and target hospitals. The principal researcher and the trained research assistants explained the purpose of the study, how it would take place, and the intended benefits and potential risks of the study for all of the participants. The participants would have time to read the informed consent and they would be answered on all of their questions about the study prior making decision whether to participate in the study or not.

RESULTS

Of the total 220 participants recruited in this study, 73.2% were male patients (N=161). The average age of the participants was 49.9±11.7 years. The most participants (62.3%) were married. Nonsmokers reported for 38.2% of the participants (**Table 1**).

Regarding the description of obesity parameters' measurement among study's patients (**Table 2**), weight started from 50 kg to 126 kg (mean=80, SD=14.4). WC started from 65 cm to 140 cm (mean=102.7, SD=13.3). HC started from 68 to 151 (mean=110.6, SD=13.4). BMI started from 23 to 42.1 (mean=32.2, SD=4.6).

Figure 1 reveals that the risk of having stented coronary arteries increased with the increase of the WC with the best cut off point at 0.95 meter (sensitivity 0.76 and specificity 0.68), which was determined by receiver operating characteristic (ROC).

Figure 2 reveals that the risk of having stented arteries increased with the increase of HC with the best cut off point at 103 cm (sensitivity 0.92 and specificity 0.58), which was determined by ROC.

Figure 3 reveals that the risk of having stented arteries increased with the increase of the WHtR, with the best cut off point at 0.67 (sensitivity 0.45 and specificity 0.25), which was determined by ROC.

Figure 4 reveals that the risk of having stented arteries increased with the increase of the WHR with the best cut off point at 0.89 meter (sensitivity 0.73 and specificity 0.38), which was determined by ROC.

Figure 5 shows no significant differences between BAI values and two or three stented coronary arteries. However, BAI values from 0.295 to 0.344 had higher incidence of one coronary stented artery. BAI had poor sensitivity and specificity in relation with number of stented coronary arteries.

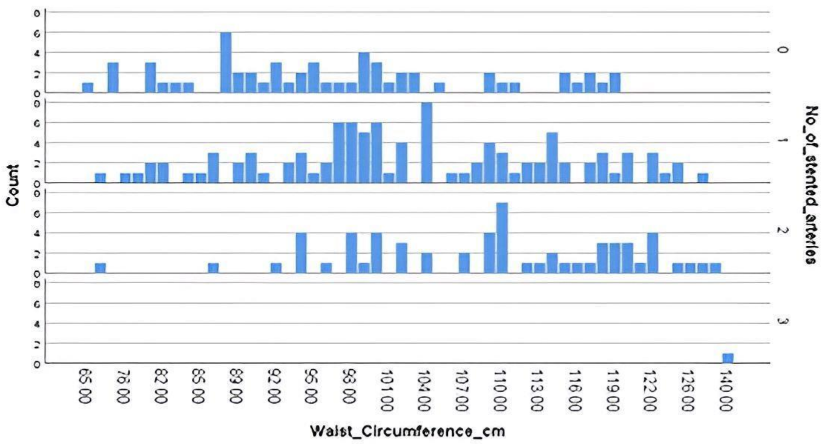

Figure 1. Relationship between WC & number of stented coronary arteries

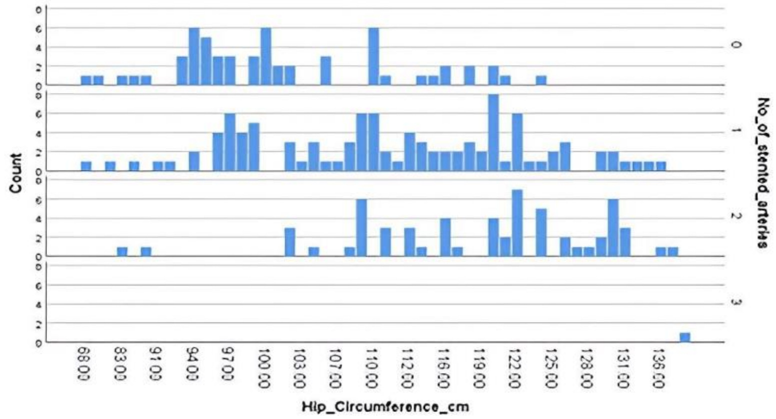

Figure 2. Relationships between HC & number of stented CAD

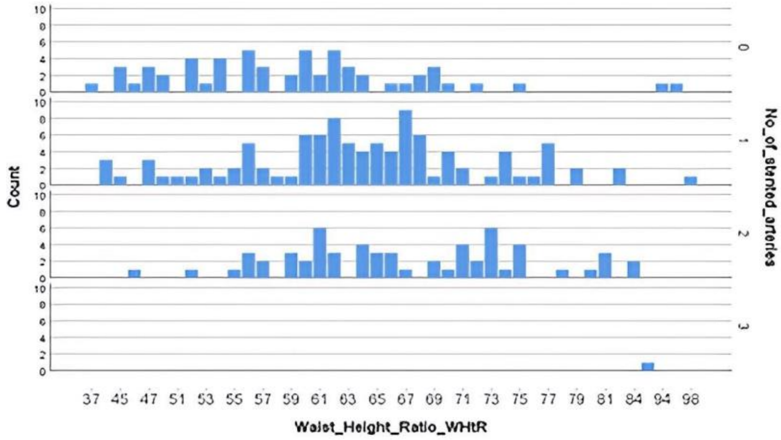

Figure 3. Relationships between WHtR & number of stented coronary arteries

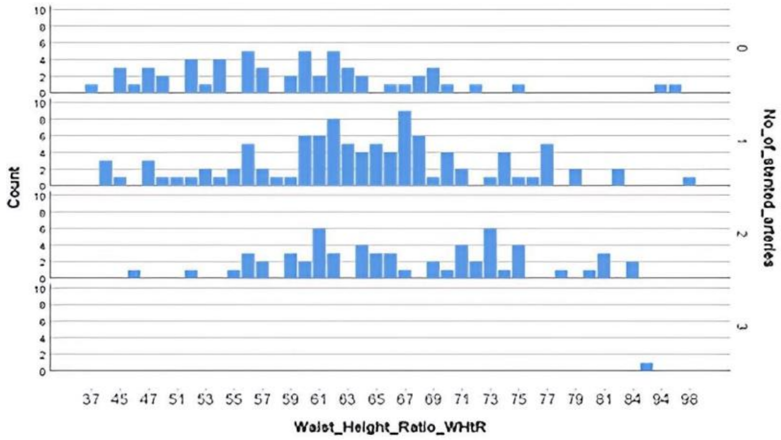

Figure 4. Relationships between WHtR & number of stented coronary arteries

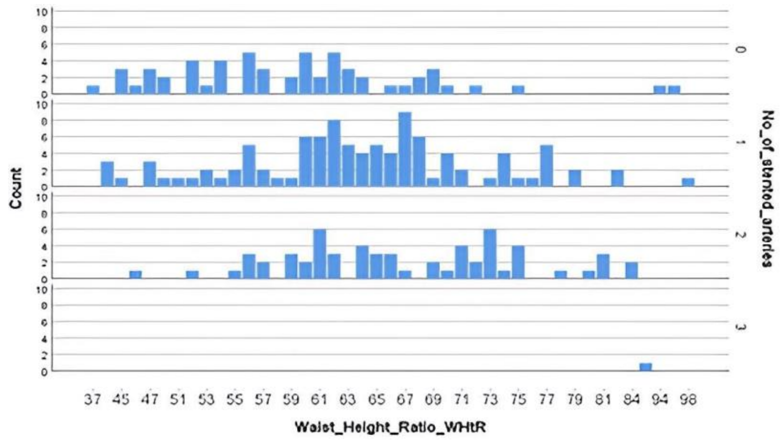

Figure 5. Relationships between WHtR & number of stented coronary arteries

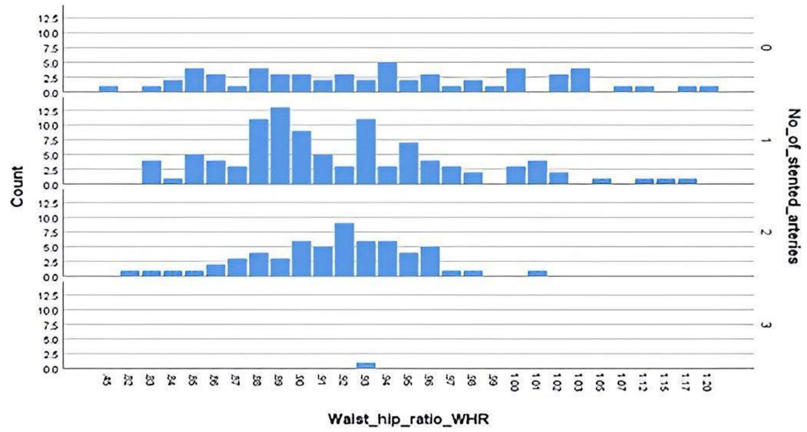

Figure 4. Relationships between WHR & number of stented coronary arteries

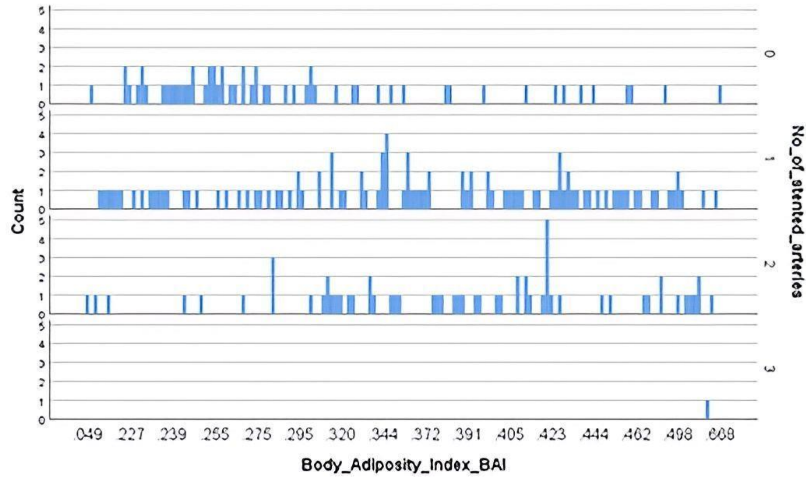

Figure 5. Relationship between BAI & number of stented coronary arteries

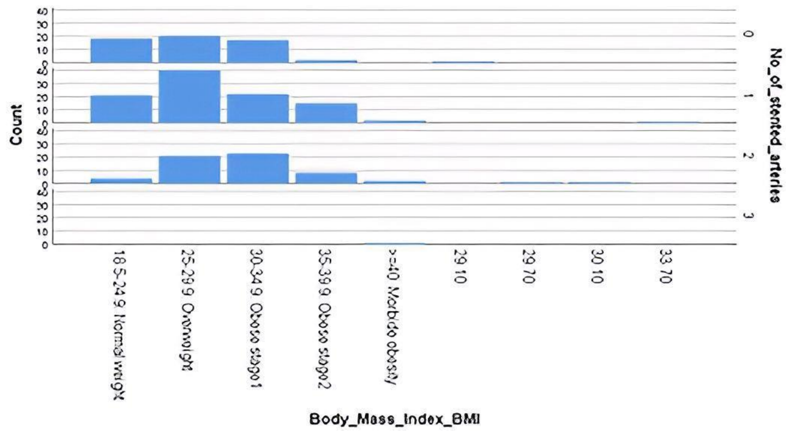

Figure 6. Relationships between BMI & number of stented coronary arteries

Figure 6 reveals that overweight patients had the highest risk to have one stented coronary artery, followed by normal weight and obese stage 1 had the same risk to have one stented coronary artery. Regarding the risk to have two stented coronary arteries, obese stage 1 patients had the highest risk to have two stented coronary arteries, followed by overweight patients, followed by obese stage 2. Nevertheless, when applying BMI as continuous variable, the best cut off point was at 29.7 (sensitivity 0.74 and specificity 0.46) in relation with number of stented coronary arteries.

Figure 7 shows that BSI values had similar values regarding the number of stented coronary arteries, which meant that BSI may not be a good predictor for the number of stented coronary arteries due to low sensitivity and specificity according to our study.

DISCUSSION

This study is considered the first one regarding the relationship between the traditional obesity parameters and the number of stented coronary arteries. In this study, the associations between the number of current stented coronary arteries and the seven traditional obesity parameters were examined in a cross-sectional sample of 220 patients undergoing cardiac catheterization. The results of our study

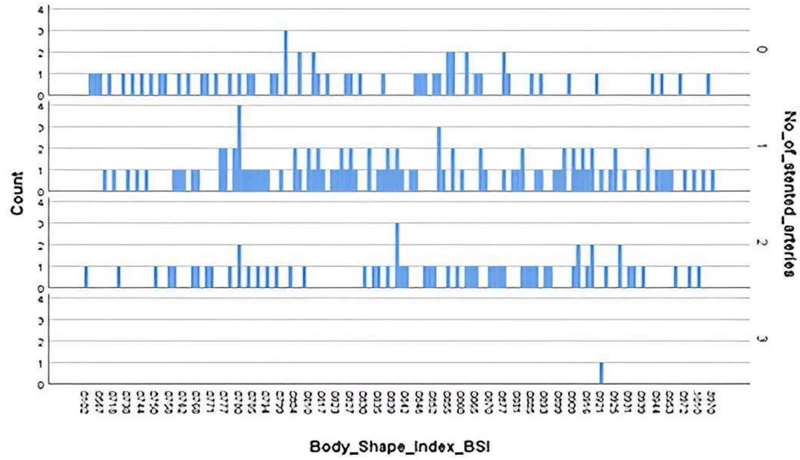

Figure 7. Relationship between BSI & number of stented coronary arteries

showed that all traditional obesity parameters except the BSI have a good ability to be highly associated with the number of stented coronary arteries, with increase in these parameters is associated with increase in numbers of stented coronary arteries.

Previous studies found significant associations between these traditional parameters and developing coronary heart diseases or risk factors for these diseases such as hyperlipidemia [41,42]. Although there was no census on the most powerful obesity parameters highly associated with stenosed coronary arteries [4, 5], those parameters associated with central obesity, such as increase in WC, HC, WHR, and WHtR, are mostly connected with coronary arteries diseases [6, 43]. These results are consistent with our findings.

The ROC curve indicated that the best cut off point of WC is 95 cm in predicting number of stented coronary arteries with a sensitivity of 76% and a specificity of 68%. Several previous studies found that WC and especially WHtR correlates with risk factors of CADs more than other traditional parameters [29,30,44].

Consistent with our study result, Song and colleagues [45] and Oh and colleagues [46] found WHtR as a useful marker and an independent predictor for coronary artery calcification. Moreover, a previous study [47] results showed WC as an effective easy-to-use clinical tool for predicting the risk of developing CADs. According to Yalcin and colleagues [48], both WC and WHtR were significantly correlated with serious CADs and were higher in patients who have significant stenosis.

In this study, BMI was found to have high sensitivity with the number of stented coronary arteries. Therefore, BMI is a good indicator of the risk of having stented coronary arteries. Conversely, various previous studies reported that BMI among other traditional parameters is the weakest indicator or risk factor for CADs [28-31]. However, Kang and colleagues [49] found BMI measurements to have a significant inverse relationship with percutaneous coronary intervention patients' mortality rates. Moreover, Ortega and colleagues [50] reported that BMI is clinically important and it was the strongest predictor for CVD mortality among other measurements such as total body fat and fat mass index.

Although a high BSI indicates a greater abdominal adipose [51], similarly to our study results, Maessen and colleagues [52] revealed that BSI is unsuitable to be an indicator of CVD development or as a risk factor for CVD. Conversely, Wang and colleagues [53] found that the BSI is the best traditional measure for predicting the risk of having coronary heart diseases among Chinese adult males. This inconsistency needs more studies to investigate BSI correlation with CAD prediction.

Moreover, according to many studies, WHR which is one of the primary methods to evaluate central obesity also predicts significantly the risk of developing CAD, which is consistent with this study results [48, 54, 55]. According to Rashiti and colleagues [56], the WHR had the most significant positive relationship with the presence of CAD among Kosovar patients compared to BMI, HC, WHR, WC, and WHtR measurements. Moreover, Yalcin and colleagues [48] found that WHR values were higher in patients with significant stenosis.

Limitations and Implications

Although our study has many strengths, it has some limitations. First, the cross-sectional design used in this study does not allow validation of causality of the examined relationships. The convenience sampling used in the current study limit the generalizability of the findings. Therefore, we should be cautious when interpreting such results. Future research may need to examine the ability of the obesity parameters in predicting the number of stented arteries while controlling other variables associated with artery stenosis. Studies employing different methodologies and including larger and randomized samples of subjects are needed. Further studies needed to examine the predictors of numbers of stented arteries separately for males and females may be worthwhile [46]. In addition, the combination of different parameters may increase the accuracy of the prediction of number of affected and stented arteries [57], thus, future examinations should examine combined parameters.

CONCLUSIONS

The ROC curve indicated that the best cut off point of WC is 95 cm is highly associated with the number of stented coronary arteries with a sensitivity of 76% and a specificity of 68%. BMI had a high sensitivity with the number of stented coronary arteries. All traditional obesity parameters except the BSI had a good ability to be highly associated with the number of stented coronary arteries. Healthcare providers, including nurses, should pay a high attention to these obesity parameters while caring of patients with CAD undergoing cardiac catheterization.

Author contributions: AAH, IMA, & MR: study conception & design, data collection & analysis, and data interpretation and **AAH, IMA, MR, SA, DB, & SA:** manuscript preparation & final approval of the manuscript version to be published. All authors have greed with the results and conclusions.

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Declaration of interest: No conflict of interest is declared by authors.

Data sharing statement: Data supporting the findings and conclusions are available upon request from the corresponding author.

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