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Original Article

Prevalence of Metabolic Syndrome in Angiographically Confirmed Coronary Artery Disease

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Abstract

Background: Coronary artery disease (CAD) is one of the most common causes of death in the developed world with the high prevalence of cardiac risk factors and associated morbidity. These risk factors were mostly contributed in the metabolic syndrome. **Objective:** The study aimed to determine the prevalence of metabolic syndrome among patients with angiographically documented CAD and its relation with the severity of CAD. **Materials and Methods:** In the current cross-sectional study, a total of 320 patients aged 18 years and older of both genders and diagnosed with CAD by medical and clinical examinations and angiography findings were included in the study. Patients with normal angiographic or nonsignificant coronary stenosis and those with acute coronary syndrome were excluded from the study. **Results:** The prevalence of metabolic syndrome in patients diagnosed with CADs was 68.4% in this study. The numbers and severity of coronary arteries involved were importantly increased through increasing the numbers of the components of the metabolic syndrome that the patient have it. The majority of the patients with right coronary artery (67.6%), circumflex artery (63.2%), left anterior descending (66.7%), and multivessel (69.8%) had metabolic syndrome with no significant difference ($P = 0.913$). Moreover, the most of the patients with one vessel (66.4%), two vessels (68.2%), three vessels (72.2%), and four vessels (66.7%) were metabolic syndrome ($P = 0.846$). Between the individual components, diabetes mellitus (DM) was the most significant risk factor accounts for the number and severity of the CAD in all CAD patients. **Conclusions:** The prevalence of metabolic syndrome is high among patients with angiographically documented CAD. Patients having metabolic syndrome have more severe and more complex CAD.

Keywords: Comorbidity, coronary artery disease, metabolic syndrome

Introduction

The metabolic syndrome (syndrome X, insulin resistance syndrome) consists of a constellation of metabolic abnormalities that confer increased risk of cardiovascular disease (CVD) and diabetes mellitus (DM). The term "metabolic syndrome" was first used in the National Cholesterol Education Program (NCEP) Adult Treatment Panel III (ATP III) to describe the co-occurrence of obesity, dyslipidemia, hypertension (HT), and abnormal glucose metabolism (Expert Panel on Detection and Treatment of High Blood Cholesterol in 2001).[1]

However, the association of metabolic disorders and cardiovascular risk factors had been recognized for many decades.[2,3] In his American Diabetes Association Banting lecture in 1988, Reaven used the term "syndrome X" to describe the relationship of insulin resistance, HT, type 2 diabetes (T2D), and CVDs.[4] Other investigators have referred to the clustering of metabolic and cardiovascular risk factors as the "insulin resistance syndrome."[5]

Coronary artery disease (CAD) is one of the most common causes of death in the developed world,[6] the high prevalence of cardiac risk factors and associated morbidity have been reported in Iraqi adult population,[7] these risk factors were mostly contributed in the metabolic syndrome, and it became a growing health problem in Iraq due to alteration in lifestyle, low physical activity, the epidemic of obesity and insulin resistance. Although in Iraq, little studies were found to identify the prevalence of the metabolic syndrome in patients

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having CAD, and the majority of them accomplished among inpatients presenting with ACS before attending angiography catheterization, meanwhile they were an unconfirmed CAD.

Worldwide the prevalence of metabolic syndrome varies in part reflecting the age, ethnicity of their population and the diagnostic criteria applied, in general increases with age. The highest recorded prevalence was among native Americans 60% of women and 45% in men ages 45–59 years meeting criteria of the NCEP ATP III were as in the US, is less common in African–American men and more in Mexico–American woman based on data from the National Health and Nutrition Examination Survey 2003–2006. In France, studies of a cohort of 30–60 years have shown <10% prevalence for each sex although 17.5% of people 60–64 years of age were affected.[8]

In a recent 2016 Iranian study among 200 CAD patients, the prevalence of metabolic syndrome was 49.5% women and 40% men,[1] In Turkey reported a prevalence of 33.9%, The population for this analysis were 2108 men and 2151 women.[9,10] In Tunisia, metabolic syndrome prevalence was 45.5% based on the IDF criteria and 24.3% according to the (ATP III) definition which included 3435 adults.[11] In Palestinians, in East Jerusalem, metabolic syndrome was found in 115 (33.6).[12] In Northern Jordan, the prevalence of metabolic syndrome was 36.3%.[13]

The aim of this study was to determine the prevalence of metabolic syndrome among patients with angiographically documented CAD and its relation with the severity of CAD.

Materials and Methods

The cross-sectional prospective study enrolled all patients whom underwent elective coronary angiography in Azadi Heart Center/Duhok, Iraq, between September 2017 and May 2018.

The patient's ages were between 18 years and older of both genders, diagnosed with CAD by medical and clinical examinations and angiography findings. Patients with normal angiographic or nonsignificant coronary stenosis and those with acute coronary syndrome were excluded from the study.

Metabolic syndrome was diagnosed according to the ATP III criteria, including three or more of the following metabolic abnormalities: abdominal obesity (waist circumference [WC] >102 cm in men and >88 cm in women), high blood pressure (≥130 mmHg systolic or ≥85 mmHg diastolic), hypertriglyceridemia (>150 mg/dl, 1.7 mmol/L), low high density lipoprotein cholesterol (HDL-C) (<40 mg/dl, 1.03 mmol/L) in men and (<50 mg/dl, 1.29 mmol/L) in women, high fasting glucose (fasting serum glucose (>110 mg/dl).[14]

Diagnosis of patients with CAD was based on the result of coronary angiography, in which >50% stenosis regarded as significant vessel disease (VD), while those below this rate had been excluded from this study.[14-16]

Statistical methods

The descriptive purposes of the study, including the prevalence of metabolic syndrome in CAD patients were determined in frequency and percentage. The continuous normally distributed characteristics of patients were determined in mean and standard deviation (SD). The difference of metabolic syndrome among angiography findings was examined in Chi-squared and Fishers' exact test. The predictors of angiography findings were examined in univariant analysis of variance. The null hypothesis was rejected in $P < 0.05$. The statistical calculations were performed using Statistical Package for the Social Sciences version 24 (SPSS, IBM Company, Chicago, USA).

Results

The demographic and clinical characteristics of the 320 CAD patients (180 males and 140 females; aged 32–85 years, the mean age 57.74, SD: 9.96) with and without metabolic syndrome are presented in Table 1; of these, 68.4% had metabolic syndrome; (56.3% males vs. 52.1% females) ($P < 0.05$).

The majority of patients had abnormal high density lipid cholestetol (HDL-C), Triglyceride (TG), Waist circumference (WC), and were known diabetes mellitus DM or impaird fasting blood sugars (FBS) and hypertension (HT). For HDL.C (81.7% males and 73.6% females), for TG; (78.50%), WC; (77.9% females and 49.4 males), HT; (56.3% males and 43.8% females) while DM; 52% [Table 1].

Again the mean and percentages of WC, BMI, BP, FBS, TG, and low-density lipoprotein cholesterol ($P < 0.0001$) in CAD patients with metabolic Syndrome were significantly higher, and HDL-C levels ($P < 0.0001$) were significantly lower than in those without Metabolic Syndrome. Low serum HDL (36.28 ± 7.76 vs. 47.23 ± 9.64, $P < 0.001$), high serum TG (227.89 ± 71.57 vs. 140.22 ± 56.36, $P < 0.0001$), HT; 187 (85.8%) versus 25 (24.8%), P (<0.0001), DM; 153 (70.2%) versus 15 (14.9%), P (<0.0001), and they were the most significant risk factors for CAD in metabolic patients versus nonmetabolic ones [Table 2 and Figure 1].

The majority of the patients with right coronary artery (RCA) (67.6%), circumflex artery (CX) (63.2%), left anterior descending (LAD) (66.7%), and multivessel (69.8%) had metabolic syndrome with no significant difference ($P = 0.913$). Moreover, the most of the patients with 1 vessel (66.4%), two vessels (68.2%), three vessels (72.2%), and four vessels (66.7%) were metabolic syndrome ($P = 0.846$) [Table 3 and Figure 2].

Table 1: Prevalence of metabolic syndrome in coronary artery disease patients

Patients' characteristics	CAD (n=320)
Metabolic syndrome	
Yes	219 (68.4)
No	101 (31.6)

CAD: Coronary artery disease

Table 2: Baseline characteristics of metaboli and nonmetabolic patients (*n*=320)

Patients' characteristics (*n*=320)	MetS (*n*=219)	Non-MetS (*n*=101)	*P* (two-sided)
Age (year)	57.77±9.23	57.70±11.44	0.961*
Male	55.82±9.63	57.03±11.41	
Female	59.56±8.51	59.65±11.58	
HDL (mg/dL)	36.28±7.76	47.23±9.64	<0.0001*
Male, *n* (%)			
Normal	3 (2.9)	30 (40.0)	
Abnormal	102 (97.1)	45 (60.0)	
Female, *n* (%)			
Normal	17 (14.9)	20 (76.9)	
Abnormal	97 (85.1)	6 (23.1)	
TG (mg/dL)	227.89±71.57	140.22±56.36	<0.0001*
Normal, *n* (%)	30 (13.7)	71 (70.3)	
Abnormal, *n* (%)	189 (86.3)	30 (29.7)	
WC (cm)	102.85±10.08	91.67±10.26	<0.0001*
Male, *n* (%)			
Normal	29 (27.6)	62 (82.7)	
Abnormal	76 (72.4)	13 (17.3)	
Female, *n* (%)			
Normal	16 (14.0)	15 (57.7)	
Abnormal	98 (86.0)	11 (42.3)	
BMI	29.56±5.05	26.51±4.10	<0.0001*
Underweight, *n* (%)	1 (0.5)	0 (0.0)	
Normal weight, *n* (%)	22 (10.0)	16 (15.8)	
Overweight, *n* (%)	47 (21.5)	16 (15.8)	
Obese, *n* (%)	149 (68.0)	69 (68.3)	
Smoking, *n* (%)	80 (37.0)	50 (51.5)	0.016**
Gender, *n* (%)			<0.0001**
Males	105 (47.9)	75 (74.3)	
Female	114 (52.1)	26 (25.7)	
Hypertension, *n* (%)	187 (85.8)	25 (24.8)	<0.0001**
Male	81 (77.9)	14 (18.7)	
Female	106 (93.0)	11 (42.3)	
Diabetes mellitus, *n* (%)	153 (70.2)	15 (14.9)	<0.0001**
Male	64 (61.5)	12 (16.0)	
Female	89 (78.1)	3 (11.5)	
Family history, *n* (%)	81 (17.7)	65 (65.6)	<0.0001
Smokers	37% (117 male, 13 female)	51.50%	

*Independent *t*-test and **Chi-squared tests were performed for statistical analyses. HDL: High-density lipoprotein, TG: Triglyceride, WC: Waist circumference, BMI: Body mass index, MetS: Metabolic syndrome

The numbers and severity of coronary arteries involved were importantly increased through increasing the numbers of the components of the metabolic syndrome that the patient have it [Table 4], although not reaching the significant values, here the individual components such as obesity, HT, DM, dyslipidemias, smoking, and family history played there role in the pathogenicity of the nonmetabolic categorized CAD patients.

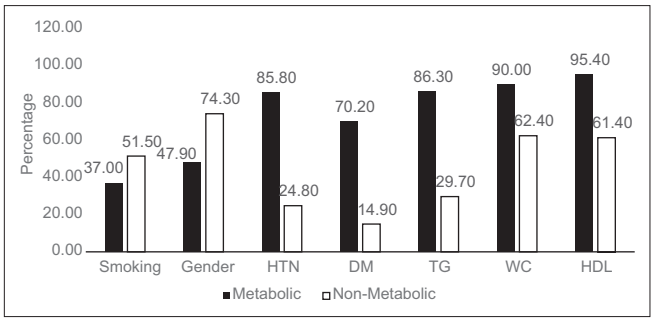

Figure 1: Prevalence of individual components of metabolic syndrome. *Gender represents males 1

Between the individual components, DM was the most significant risk factor accounts for the number and severity of the CAD in all CAD patients as follow: 2VD; (63 [37.5%] vs. 44 [29.1%], 3VD; (48 [28.6%] vs. 31 [20.5%]), (P = 0.045), multi-VD (MVD); (114 [67.9%] vs. 78 [51.7%]), (P = 0.029) as compression between diabetic and nondiabetic patients, respectively [Tables 4-6].

Discussion

In this study, the prevalence of metabolic syndrome in angiographically confirmed CAD patients was 68.4% which is similar to studies in other regions of the world like in study by Achari *et al*., in which prevalence was 64.2% in Indian population,[17] while in Iranian adults the prevalence of metabolic syndrome among CAD patients was 49.5%.[18] Furthermore, in Pakistani patients, the prevalence was much more less 37%.[19]

Hence, the prevalence of Met S varies widely, depending on the type of study (hospital-based vs. population-based study), baseline characteristics of the study population (e.g., ethnicity, age, and history of ACS) and criteria used to define Met S. Furthermore, these differences could be due to lifestyle-related factors such as unhealthy food habits, urbanization, economic growth, physical inactivity and increased stress, high percentage of body fat, and abdominal obesity.

The individual components of the metabolic syndrome whether alone or in combination with risk factors have variable effects on CAD risk with some of them having the highest risk for CAD, however, each component acts as an independent risk factor for CAD, but all of them interact synergistically, and thus lead to increased risk of CAD.[6]

The prevalence of metabolic syndrome and its individual components with various rates in CAD patients has been reported in earlier studies, the abdominal obesity, dyslipidemia, HT, and hyperglycemia most often were reported as the metabolic syndrome components, and the severity of CAD increased with the number of components.[20-23]

In Shanghai, a study performed and showed that among individual components of metabolic syndrome, low HDL,

high FBG, and high BP had the highest OR for coronary heart disease, these three parameters had significant increases in number of disease vessel.[24]

In Korean population, a study showed that metabolic syndrome was independently linked to coronary parameters including obstructive plaque and coronary artery calcium score in the nondiabetic CAD patients, low HDL-C levels were markedly associated with CAD among the individual components of metabolic syndrome in these patients.[25,26]

However, there were no exact prevalence of metabolic syndrome in Iraq and or Kurdistan region, have been done before, and exactly in angiographic profile CAD patients, our results were near the results done in the Middle East countries.[27,28]

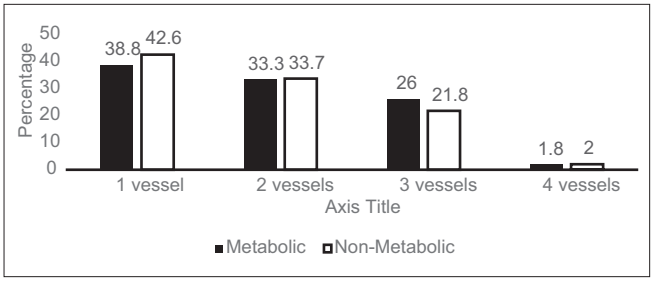

Figure 2: Prevalence of metabolic syndrome in angiography findings (vessel number)

Table 3: Angiography findings of coronary artery disease patients

Angiography findings of CAD patients (*n*=320)	Frequency distribution		*P* (two-sided)
	MetS (*n*=219), *n* (%)	Non-MetS (*n*=101), *n* (%)	
RCA	25 (11.4)	12 (11.9)	0.913 (Chi-squared test)
CX	12 (5.5)	7 (6.9)	
LAD	48 (21.9)	24 (23.8)	
Multivessel (69.8%)	134 (61.2)	58 (57.4)	
Vessel numbers			
1 vessel (66.4%)	85 (38.8)	43 (42.6)	0.859 (Chi-squared test)
2 vessels (68.2%)	73 (33.3)	34 (33.7)	
3 vessels (72.2%)	57 (26.0)	22 (21.8)	
4 vessels (66.7%)	4 (1.8)	2 (2.0)	

RCA: Right coronary artery, CX: Circumflex artery, LAD: Left anterior descending artery, CAD: Coronary artery disease, MetS: Metabolic syndrome

Unfortunately, in our study, the premature CAD was obvious in which the mean age were (57.77 ± 9.23) and (57.70 ± 11.44) for metabolic and nonmetabolic patients respectively, and the females were older than males by (4 years) [Table 2].

Concerning the gender, in our study, the prevalence of metabolic syndrome in female patients who present with CAD was higher when compared with overall cohort studies,[28-30] had shown a higher prevalence of metabolic syndrome in female presenting with ACS.

Among the individual components of metabolic syndrome, nearly all components, DM, HT. hypertriglyceridemia (TG), and HDL-C, central obesity (WC), were significantly abnormal ($P < 0.0001$), as compared with nonmetabolic syndrome patients.

Females were more diabetic, hypertensive, obese, hypertriglyceridemia, less or passive smokers, and older. While males were more smokers, thinner, and younger in ages due to cultural habits.

Nonmetabolic patients were mostly males, more smokers, and mostly were diabetic, hypertensive, and had low (HDL-C), and had a family history of CAD.

Regarding the association of high-level glucose, some studies have shown markedly associated with CAD. A study reported that the prevalence of CHD in diabetic patients with metabolic syndrome was significantly higher than in those without metabolic syndrome.[31]

The severity, the pattern of the lesion and characteristics type of coronary vessel involved in both metabolic and nonmetabolic syndrome patients, were studied, and it revealed that MVD; (2VD), (3VD), were more prevalent in metabolic syndrome group than those without metabolic syndrome (57.4% vs. 42.6%).

Similar observations had been reported by other studies. Kip *et al*.[32] reported statistically significant prevalence of severe CAD in patients with Met S (47% as compared to 25% in patients without Met S). Yavuz *et al*.[33] reported significantly higher number of patients with Met S having severe CAD as compared to patients without Met S (91% vs. 62%)[34] in a multicenter study also reported significantly higher prevalence of severe CAD in European American and African American patients having Met S as compared to patients without Met S (71% and 57% vs. 29% and 43%).

Table 4: Severity of coronary artery disease according to components of metabolic syndrome

Number of metabolic components	Single vessel disease	Double vessel disease	Triple vessel disease	Four vessel disease	*P*
0	2 (28.6)	2 (28.6)	3 (42.9)	0 (0.0)	0.670**
1	10 (40.0)	9 (36.0)	5 (20.0)	1 (4.0)	0.814*
2	17 (41.5)	14 (34.1)	9 (22.0)	1 (2.4)	0.968*
3	33 (49.3)	16 (23.9)	18 (26.9)	0 (0.0)	0.130**
4	49 (37.7)	49 (37.7)	30 (23.1)	2 (1.5)	0.617**
5	17 (34.0)	17 (34.0)	14 (28.0)	2 (4.0)	0.526*

*Chi-square and **Fisher's exact tests were performed for statistical analyses

Table 5: Univariate analysis of variance of angiography results

	Dependent variable: Angiography vessel number		Dependent variable: Angiography findings	
Predictors	***F* score**	***P***	***F* score**	***P***
Smoking	0.046	0.831	0.062	0.804
Gender	2.450	0.119	1.553	0.214
DM	4.065	**0.045**	6.323	**0.013**
Metabolic	0.258	0.612	0.108	0.743
Age	1.112	0.296	0.821	0.793

The bold numbers show the significant predictors. DM: Diabetes mellitus

Table 6: Angiography findings between diabetic and nondiabetic patients

Angiography findings	DM		*P* (two-sided)
	Yes (%)	No (%)	
Angiography results			
RCA	16 (9.5)	21 (13.9)	0.029
CX	7 (4.2)	12 (7.9)	
LAD	31 (18.5)	40 (26.5)	
Multi-vessel	114 (67.9)	78 (51.7)	
Angiography results (vessel number)			
1 vessel	54 (32.1)	73 (48.3)	0.029
2 vessels	63 (37.5)	44 (29.1)	
3 vessels	48 (28.6)	31 (20.5)	
4 vessels	3 (1.8)	3 (2.0)	

RCA: Right coronary artery, CX: Circumflex artery, LAD: Left anterior descending artery, DM: Diabetes mellitus

LAD artery was mostly diseased followed by (RCA) and (CX) nearly equally in both groups. Complex coronary lesions (diffuse and tubular) were more in metabolic syndrome group as compared to simple (discrete) lesions in nonmetabolic syndrome group. Our angiography findings were in accordance with observations.[35,36]

Conclusions

The prevalence of metabolic syndrome is high among patients with angiographically documented CAD. Patients having metabolic syndrome have more severe and more complex CAD.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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