

The prevalence and the clinical characteristics of metabolic syndrome patients admitted to the cardiac care unit



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Objectives: Metabolic syndrome (MetS) is a group of multiple cardiovascular risk factors, including dysglycemia, central obesity, high cholesterol, and hypertension. Cardiovascular disease is one of the most common complications of MetS. Recent studies showed that prevalence of MetS among patients admitted with acute coronary syndrome was as high as 46%.

Design: We conducted a cross-sectional study of 203 patients at the two main hospitals in Ta'if, Saudi Arabia. Patients older than 18 years who were admitted to the Cardiac Care Unit (CCU) between the months of August 2013 and June 2014 were asked to participate. MetS diagnosis was made based on the International Diabetes Federation definition.

Results: A total of 203 patients participated, with 59.1% male and 40.9% were female. The mean age was 60.9 years with a mean body mass index of 28.97 kg/m² and a mean waist circumference of 95.45 cm. The prevalence of MetS was 47.8%, primarily among obese female patients who reported sedentary lifestyles. Additionally, MetS patients were more likely to be admitted with heart failure ($p < 0.05$) and more likely to have moderate-to-severe left-ventricular hypertrophy (LVH; $p < 0.05$) relative to non-MetS patients.

Conclusion: Of the patients admitted to the CCU, 47.8% had MetS, with those patients likely to be female and obese. Furthermore, the MetS patients were more likely to be admitted with heart failure and suffer from moderate-to-severe LVH.

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Introduction

Metabolic syndrome (MetS) represents a cluster of dangerous cardiovascular risk factors, including central abdominal obesity, high cholesterol, dysglycemia, and high blood pressure [1–3]. The complications of MetS are broad, with cardiovascular complications being the most common, especially coronary artery disease, heart failure, ischemic stroke [4], atrial fibrillation [5], and aortic stenosis [6].

The estimated prevalence of MetS in patients with acute coronary syndrome is high. The Gulf Registry of Acute Coronary Events (Gulf RACE) prospectively enrolled 6071 patients with acute coronary syndrome from 65 centers in six adjacent Middle Eastern gulf countries over a 6-month period. They diagnosed MetS based on guidelines from the International Diabetes Federation (IDF) Task Force on Epidemiology and Prevention, American Heart Association, National Heart, Lung, and Blood Institute, International Atherosclerosis Society, World Heart Federation, and the International Association for the Study of Obesity. There were 3108 (46%) out of the 6701 patients with MetS, and they were more likely to present with a non-ST segment elevation myocardial infarction (NSTEMI; 37% vs. 28%) and unstable angina (UA; 33% vs. 25%) as compared to ST segment elevation myocardial infarction (STEMI; 30% vs. 47%; all $p < 0.001$) [7].

In another study, Agoşton-Coldea et al. [8] performed a cross-sectional study in 256 patients with acute coronary syndrome. The prevalence of MetS was 47.26% as assessed by the criteria of the National Cholesterol Education Program-Adult Treatment Panel III (NCEP-ATP III). The cardiovascular risk has been correlated to MetS (OR 1.29; 95% CI, 1.05–1.54, $p = 0.047$) [8].

MetS is common in patients who are admitted to the CCU, and those people are at risk of developing other cardiovascular complications, such as ischemic heart disease. However, there are few studies that identify the size and impact of the problem in other patients, such as those with heart failure and arrhythmia. The objective of this study was to identify the prevalence and clinical characteristics of MetS in CCU patients in two of the major hospitals in Ta'if, whether presenting with acute coronary syndrome or other cardiac problems, using the new IDF definitions of MetS.

Abbreviations

BMI	body mass index
BP	blood pressure
CCU	Cardiac Care Unit
FBP	fasting plasma glucose
HDL	high-density lipoprotein
HF	heart failure
IDF	International Diabetes Federation
JNC 7	Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure
LDL	low-density lipoprotein
LVEF	left-ventricle ejection fraction
LVH	left-ventricular hypertrophy
MetS	metabolic syndrome
NCEP-ATP III	National Cholesterol Education Program-Adult Treatment Panel III
NSTEMI	non-ST-segment elevation myocardial infarction
RACE	Registry of Acute Coronary Events
STEMI	ST-segment elevation myocardial infarction
TG	triglyceride
UA	unstable angina
WHO	World Health Organization

Materials and methods

A cross-sectional study was conducted at the Division of Endocrinology and Cardiology at King Abdulaziz Specialist Hospital and King Faisal Hospital, Ta'if, Saudi Arabia. A total of 203 patients were admitted to the CCU between August 2013 and July 2014, and those older than 18 years participated in the study. We excluded unconscious patients. Detailed medical history, including presenting illness, past medical history, drug history, family history, special habits, and physical activity, was obtained from participating physicians directly from the patients after obtaining their consent. Anthropometric measurements, including height, weight, body mass index (BMI), waist circumference, and hip circumference, were measured.

The World Health Organization (WHO) recommendations on physical activity for health [9] were considered, which recommends adult do at least: 150 min of moderate-intensity physical activity or 75 min of vigorous-intensity physical activity or an equivalent combination of moderate- and vigorous-intensity activity.

Physical activity among patients was categorized according to these recommendations into healthy physical activity (for those who meet the recommendations), non-healthy physical activity (for those who did not meet the recommenda-

tions), and sedentary lifestyle (for those who were physically inactive).

Height and weight were measured while standing after removing shoes and heavy clothing and looking straight ahead with shoulders relaxed, arms at sides, back as straight as possible, legs straight, feet flat, and heels close together. The height was measured up to the top of the head in centimeters (cm), and the weight was measured in kilograms (kg). BMI was calculated and categorized according to the WHO classification into underweight ($<18.5 \text{ kg/m}^2$), healthy weight ($18.5\text{--}24.9 \text{ kg/m}^2$), overweight ($25\text{--}29.9 \text{ kg/m}^2$), and obese ($\geq 30 \text{ kg/m}^2$) [10].

The waist circumference was measured according to WHO STEPwise approach to surveillance protocol that states that the measurement should be made at the approximate midpoint between the lower margin of the last palpable rib and the top of the iliac crest [11]. According to the guidelines of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure (JNC 7), the blood pressure was measured while the patient was seated quietly for at least 5 min in a chair [12]. At least two measurements were made and the average was recorded.

Laboratory investigations, including fasting blood glucose, random blood glucose, triglyceride, high-density lipoprotein (HDL), low-density lipoprotein (LDL), total cholesterol, and HbA1c were measured. The cardiovascular markers were measured daily and the peak troponin levels were recorded. A board certified cardiologist performed cardiac echocardiogram tests with a Philips iE33 ultrasound machine (Philips, Amsterdam, The Netherlands), and the left-ventricle ejection fraction (LVEF) and the left-ventricle hypertrophy (LVH) were documented.

The definition of MetS was based on the new IDF definition [13]. Patients with MetS must have central obesity (defined as waist circumference $\geq 94 \text{ cm}$ for European males and $\geq 80 \text{ cm}$ for females; there were also ethnicity-specific values for other groups), as well as any two of the following four minor factors: (1) raised TG level: $\geq 150 \text{ mg/dL}$ (1.7 mmol/L) or specific treatment for this lipid abnormality; (2) reduced HDL cholesterol: $<40 \text{ mg/dL}$ (1.03 mmol/L) in males and $<50 \text{ mg/dL}$ (1.29 mmol/L) in females or specific treatment for this lipid abnormality; (3) systolic BP $\geq 130 \text{ mmHg}$ or diastolic BP $\geq 85 \text{ mmHg}$ or treatment of previously diagnosed hypertension; and (4) raised fasting plasma glucose (FPG) $\geq 100 \text{ mg/dL}$ (5.6 mmol/L) or previously diagnosed with type 2 diabetes mellitus.

The Institutional Review Board approval was completed at King Abdulaziz Specialist Hospital and King Faisal Hospital. All qualitative and quantitative data were entered in Microsoft Excel (Microsoft, Redmond, WA, USA) and analyzed with SPSS software version 16 (SPSS Inc., Chicago, IL, USA). The mean and standard deviation (SD) were calculated. The clinical characteristics were compared for patients with and without MetS, and we defined statistical significance as $p < 0.05$. Chi-square tests were performed for categorical variables and unpaired *t* tests for continuous variables. The prevalence of each MetS criteria was calculated and compared to the non-MetS patients.

Results

From August 2013 to July 2014, 203 patients were admitted to the CCU and agreed to participate in the study. There were 120 (59.1%) men and 83 (40.9%) women, with a mean age of 60.9 years (SD, 14.4 years), mean BMI of 28.97 kg/m^2 (SD, 5.4 kg/m^2), mean waist circumference of 95.45 cm (SD, 18.6 cm), and mean waist-to-hip ratio of 1.00 (SD, 0.1). We found that 53.7% had type 2 diabetes, 41.4% reported a sedentary lifestyle, and 14.8% were smokers.

The percentage of overweight or obese patients was 80.8%. The overall admission diagnosis was 26.1% with unstable angina (UA), 21.7% with heart failure (HF), 18.2% with non-ST elevation MI (NSTEMI), 16.3% with ST elevation MI (STEMI), 7.4% with arrhythmia, and 10.3% with other cardiac diagnosis (Table 1).

Overall, 47.8% of the adult patients who were admitted to the CCU met the diagnostic criteria for MetS, with 12 (12.4%) having all four minor criteria, 43 (44.3%) with three, and 42 (43.3%) with at least two (Fig. 1). The most common criterion after central obesity was high fasting blood sugar or previously diagnosed type 2 diabetes, with 87 (89.7%) of patients with MetS having this criterion.

Versus non-MetS patients, those with MetS were more likely to be a woman (60% vs. 40%, $p < 0.05$), older (62.5 years vs. 59.4 years, $p = 0.12$), diabetic (68% vs. 40%, $p < 0.05$), overweight/obese (98% vs. 65%, $p < 0.05$), have a higher waist circumference (106 cm vs. 84.6 cm, $p < 0.05$), report having a more sedentary lifestyle (48.5% vs. 34.9%, $p < 0.05$), have a higher HbA1c (8.3% vs. 7.1%, $p < 0.05$), and triglyceride level (129.4 mg/dL vs. 120.7 mg/dL , $p = 0.37$; Table 3). Interestingly, patients with MetS in this study had lower LDL (84.8 mg/dL vs. 96 mg/dL , $p = 0.04$) and were less

Table 1. Baseline characteristics.

Baseline characteristics	Total sample, male and female	
	n	%
Middle East (Arab) populations	188	92.6
Mean age, (y; mean ± SD)	60.9 ± 14.4	
BMI (kg/m ²)	28.97 ± 5.39	
Waist circumference (cm)	95.45 ± 18.6	
Waist-to-hip ratio	1.001 ± 0.103	
Smoking		
Active smokers	30	14.8
Second-hand smoker	16	7.9
Former	34	16.7
Never	123	60.6
Physical activity		
Sedentary lifestyle	84	41.4
<150 min of moderate- or <75 min of vigorous-activity or a combination of both/wk	71	35
>150 min of moderate- or >75 min of vigorous-activity or combination of both/wk	48	23.6
Chronic diseases		
Diabetes mellitus, type 2	109	53.7
Using Metformin	67	33
Using Sulfonylurea	50	24.6
Hypertension	132	65.02
Using ACEI/ARB	84	41.4
BMI, kg/m ²		
18.5–24.9 (normal weight)	36	17.7
25.0–29.9 (overweight)	82	40.4
≥ 30.0 (obese)	82	40.4
Admission diagnosis		
Unstable angina	53	26.1
Heart failure	44	21.7
NSTEMI	37	18.2
STEMI	33	16.3
Arrhythmia	15	7.4
Other cardiac diagnosis	21	10.3
Metabolic syndrome	97	47.8
Total	203	100

ACEI/ARB = angiotensin-converting enzyme inhibitor/angiotensin receptor blocker; BMI = body mass index; NSTEMI = Non-ST-segment elevation myocardial infarction; SD = standard deviation; STEMI = ST-segment elevation myocardial infarction.

likely to be active smokers (5.1% vs. 23.4%, $p < 0.05$).

HF was the most common admission diagnosis among the MetS group, with a prevalence of 28.9% versus 15.1% in the non-MetS group ($p < 0.05$), followed by UA, with a prevalence of 27.8% versus 24.5% ($p = 0.6$) and NSTEMI 18.5% versus 17.9% ($p = 0.9$; Fig. 2). STEMI was more common in the non-MetS group relative to the MetS group, with a prevalence of 18.9% versus 13.4% ($p = 0.27$), respectively, as well as arrhythmia (10.4% vs. 4.1%, $p = 0.1$).

Cardiac echocardiogram showed that patients with MetS were more likely to have moderate-to-severe LVH (41.2% vs. 6.5%, $p < 0.05$) and lower LVEH (33.9% vs. 39.8%, $p = 0.24$; Figs. 3 and 4).

Interestingly, MetS patients tended to have lower Troponin T (1.23 µg/L vs. 37.4 µg/L, $p = 0.31$).

According to IDF MetS criteria, a higher percentage of MetS patients had elevated waist circumference values relative to normal patients (100% vs. 29.5%, $p < 0.05$). The MetS patients were more likely to have a high fasting blood sugar (89.7% vs. 53%, $p < 0.05$), low HDL (84.5% vs. 58.8%, $p < 0.05$), high BP (40% vs. 35.8%, $p < 0.05$), high TG (30% vs. 22%, $p = 0.18$; Table 4).

A higher percentage of MetS patients were women, with the most common diagnosis being UA (30.1%) and HF (26.5%) as compared to men with MetS, who presented more with UA (23.3%), STEMI (22.5%), and NSTEMI (19.2%). Women were less likely to be active smokers than

Table 2. Analysis of baseline characteristics based on gender.

Sociodemographic characteristics	Male n (W%)		Female n (W%)		p
Eastern Mediterranean & Middle East (Arab) populations	110	58.5	78	41.5	0.79
Smoking					
Active smokers	30	25	0	0	<0.05
2nd-hand smoker	6	5	10	12.05%	
Former	34	28.3	0	0	
Never	50	41.7	73	87.95%	
Physical activity (min/wk)					
Sedentary lifestyle	36	30	48	57.8%	<0.05
<150	43	35.8	28	33.7%	
>150	41	34.2	7	8.5	
Chronic disease					
Diabetes mellitus, type 2	55	45.8	54	65.1%	0.003
Using Metformin	35	29.2	32	38.6%	0.16
Using Sulfonylurea	26	21.7	24	28.9%	0.46
Hypertension	63	52.5	69	83.1%	<0.05
Using ACEI/ARB	34	28.3	50	60.2%	<0.05
BMI (kg/m ²)					
18.5–24.9 (normal weight)	23	19.2	13	15.7%	0.04
25.0–29.9 (overweight)	54	45	28	33.7%	
≥30.0 (obese)	41	34.2	41	33.7%	
Admission diagnosis					
Unstable angina	28	23.3	25	30.1	0.03
Heart failure	22	18.3	22	26.5	
NSTEMI	23	19.2	14	16.9	
STEMI	27	22.5	6	7.2	
Arrhythmia	8	6.7	7	8.4	
Other cardiac diagnosis	12	10	9	10.8	
Metabolic syndrome	47	39.2	50	60.2	
	Mean		Mean		
Age (y)	58.38		64.55		0.002
BMI	28.1		30.2		0.007
Waist circumference (cm)	94.5		96.8		0.39
Waist-to-hip ratio	1.01		0.97		0.004
Total	120	59.1	83	40.9	

ACEI/ARB = angiotensin-converting enzyme inhibitor/angiotensin receptor blocker; BMI = body mass index; NSTEMI = Non-ST-segment elevation myocardial infarction; STEMI = ST-segment elevation myocardial infarction.

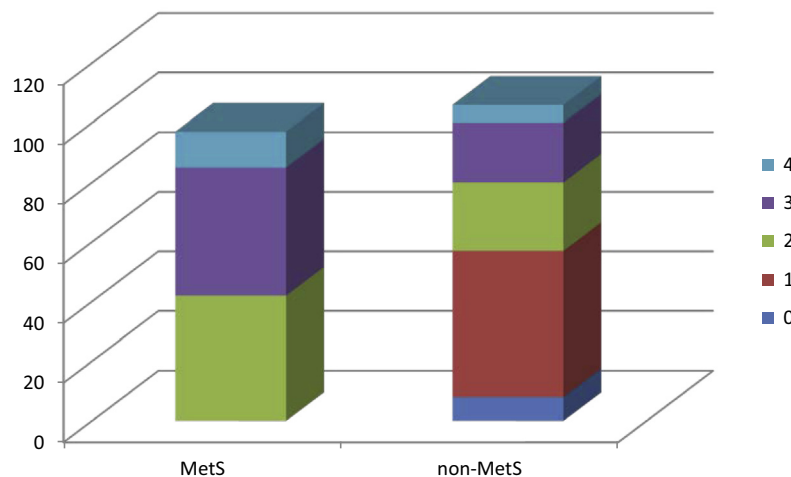


Figure 1. Distributions of the patient sample based on the number of minor factors present. MetS = metabolic syndrome.

Table 3. Analysis according to presence and absence of MetS.

Baseline characteristics	MetS group	Non-MetS group	p
Mean age (y)	62.5	59.4	0.12
Female, n (%)	50 (60.2)	33 (39.8)	0.003
Male, n (%)	47 (39.2)	73 (60.8)	
Mean BMI (kg/m ²)	31.8	26.4	<0.05
Overweight or obese (%)	97.9	65%	<0.05
Mean waist circumference (cm)	106.4	84.6	<0.05
Sedentary lifestyle (%)	48.5	34.9	<0.05
Active smoker (%)	5.1	23.4	<0.05
Diabetes mellitus, type 2 (%)	68	40.6	<0.05
Blood pressure			
Systolic	138.4	130.2	0.07
Diastolic	75.8	76.3	0.8
Laboratory results (mg/dL)			
Total cholesterol	141.9	151.3	0.17
Low-density lipoprotein	84.8	96	0.04
High-density lipoprotein	35.44	37.05	0.41
Triglyceride	129.43	120.67	0.37
Fasting blood sugar	174.7	130.8	<0.05
HbA1c	8.3	7.1	<0.05
Troponin T (mean µg/L)	0.52	37.4	0.31
Cardiac echocardiogram (%)			
Ejection fraction	33.9	39.8	0.24
Mild LVH	29.4	56.3	<0.05
Moderate-to-severe LVH	41.2	6.3	<0.05

BMI = body mass index; LVH = left-ventricular hypertrophy; MetS = metabolic syndrome.

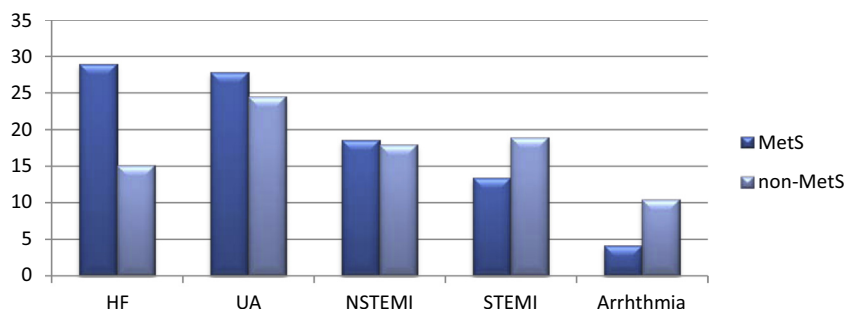


Figure 2. The diagnosis on admission to the cardiac care unit according to the presence or absence of MetS. HF = heart failure; MetS = metabolic syndrome; NSTEMI = Non-ST-segment elevation myocardial infarction; STEMI = ST-segment elevation myocardial infarction.

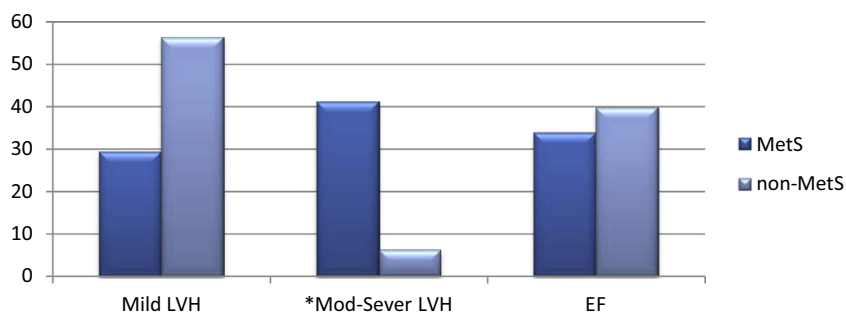


Figure 3. Cardiac echocardiogram results among patients with MetS versus non-MetS patients. *Significant p. EF = ejection fraction; LVH = left-ventricular hypertrophy; MetS = metabolic syndrome.

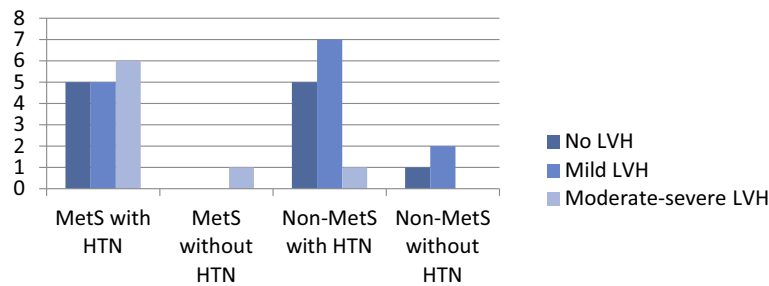


Figure 4. The association of LVH with MetS and HTN. HTN = hypertension; LVH = left-ventricular hypertrophy; MetS = metabolic syndrome.

Table 4. The prevalence of MetS criteria among the MetS group as compared to the non-MetS group.

MetS criteria	MetS group	Non-MetS group	<i>p</i>
Elevated waist circumference (males >94 cm; females >80 cm)	97 (100)	31 (29.5)	<0.05
High fasting blood sugar (100 mg/dL or diagnosed as diabetic/in treatment)	87 (89.7)	56 (52.8)	<0.05
Low HDL (males <40 mg/dL; females <50 mg/dL; or in treatment)	82 (84.5)	62 (58.5)	<0.05
High blood pressure (>130/85 mmHg or in treatment)	62 (39.9)	38 (35.8)	<0.05
High triglyceride (>150 mg/dL or in treatment)	29 (29.9)	23 (21.7)	0.18

Data are presented as *n* (%).

HDL = high-density lipoprotein; MetS = metabolic syndrome.

men (0% vs. 25%), but had a higher mean age (64.5 years vs. 58.3 years), mean BMI (30 vs. 28.1), obesity likelihood (49.4% vs. 34.2%), reports of sedentary lifestyle (57.8% vs. 30%), and were more likely to have type 2 diabetes (65.1% vs. 45.8%), and hypertension (83.1% vs. 52.5%; Table 2).

Discussion

Our study indicated high rates of MetS across all segments of patients in the CCU and was not limited to patients with acute coronary syndrome. Our findings showed that women who were admitted to the CCU were more likely to have MetS. MetS patients were also more likely to be obese and physically inactive. Furthermore, we found a strong association between MetS and moderate-to-severe LVH and LVEH. Although the majority of patients in the MetS group, as well as non-MetS patients, had LVH and were also known to be hypertensive as compared to the MetS group, the non-MetS group was more likely to have mild LVH. In our study, hypertension increased the risk of LVH, while MetS may increase the severity of the LVH.

None of the previous studies used the new IDF definition for MetS diagnosis, which included the history of specific treatment for lipid abnormality, history of diabetes, and hypertension as criteria. This could be better based on the variability that may occur in FPG and BP due to acute metabolic stress related to myocardial infarction

or the effect of medications the patient might use [14].

The prevalence of MetS in our study was similar to that reported in 2008 by Agoşton-Coldea et al. [8] and those in the 2010 Gulf RACE study [7,8]. Our study was similar to Agoşton-Coldea et al. [8], except that they included patients with acute coronary syndrome only, and the MetS diagnosis was based on NCEP-ATP III criteria. Our study included all cardiac patients admitted to the CCU, either with or without acute coronary syndrome, and we used population-specific criteria for MetS diagnosis.

Generally, the baseline characteristics of the CCU patients showed that they were older, more likely to be diabetic, and have a higher BMI, waist circumference, and waist-to-hip ratio. Additionally >66% of patients reported having a sedentary lifestyle, and ~25% had UA and then HF.

The relationship between MetS and HF has been studied. In a cohort study, Butler et al. [15] studied the impact of MetS on cardiovascular events in 3035 older adults with a 6-year follow up, finding that HF hospitalization was more common in MetS patients as compared to non-MetS patients (10% vs. 6.1%, $p < 0.001$) [15]. In our study, HF was the most common admission diagnosis in MetS patients as compared to non-MetS patients (28.9% vs. 15.1%, $p < 0.05$).

Women in the CCU were more likely to be passive smokers, diabetic, obese, hypertensive, and physically inactive. Men were more likely to be

active or former smokers than women, and more likely to present with STEMI and NSTEMI. All of these risk factors may help explain the gender difference in the CCU presentation.

Non-MetS patients are more likely to be men, elderly, active smokers, physically inactive, overweight, and diabetics, as well as tending to have high cholesterol, LDL, and troponin T levels and present with UA and STEMI.

Our study had some limitations. It is a cross-sectional study, therefore, we were unable to assess causality. Additionally, some of the behavioral data, such as smoking and physical activity, was self-reported. Our strengths included evaluation of all patients admitted to the CCU, and we used Middle East population-specific criteria.

In the recent American Heart Association 2015 meeting, a paper was presented (oral presentation) studying 6000 patients with myocardial infarction diagnosis, where 707 patients met diagnostic criteria of newly diagnosed diabetes, while only 30% were immediately treated for diabetes. After a 1-year follow up, those who were untreated for the newly diagnosed diabetes were 1.5-fold more likely to experience major adverse cardiac events as compared to those who were treated. This emphasizes on the importance of early diagnosis and treatment of major cardiac-related risk factors, such as diabetes and MetS, when cardiac patients are evaluated. More efforts related to education and awareness should be encouraged among healthcare providers who are caring for those patients. Also, public health education campaigns to educate high-risk populations about MetS and its complications are important. Providing comprehensive care that will address both the admission of cardiac disease, as well as its risk factors, is key to improve patient outcomes.

Larger studies to determine the size and impact of MetS on cardiovascular incidence and complications, relationships between MetS and sex hormones, and the impact of controlling cardiovascular-related risk factors on CCU patient outcomes in Saudi Arabia are needed.

Conclusion

The prevalence of MetS among patients admitted to the CCU based on the new IDF definition

was 47.8%, and was more common among females. MetS patients were more likely to be overweight/obese and diabetic, and more likely to be admitted with HF and suffer from moderate-to-severe LVH.

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