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Original article

Prevalence and Risk Patterns of Metabolic Syndrome Among Patients with Ischemic Heart Disease in Tripoli, Libya

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A B S T R A C T

Metabolic syndrome (MetS) represents a constellation of cardiometabolic abnormalities that considerably raise the risk of cardiovascular disease and type 2 diabetes. This hospital-based prospective study investigated the frequency, demographic distribution, and determinants of MetS among ischemic heart disease (IHD) patients in Tripoli, Libya. A total of 227 adults were assessed, including 127 individuals with established IHD and 100 without IHD. MetS was identified using the International Diabetes Federation (IDF, 2005) and the revised National Cholesterol Education Program Adult Treatment Panel III (NCEP ATP III, 2005) definitions. Data collection included anthropometric indices, blood pressure, fasting glucose, lipid profile, lifestyle practices, and family history through structured interviews. The occurrence of MetS was significantly higher in the IHD group: 68.5% (IDF) and 65.4% (NCEP ATP III), compared to 41% and 39% among controls ($P<0.001$). Abdominal obesity and hypertension were the most common abnormalities, followed by reduced HDL-C and raised fasting glucose. Prevalence increased with age, and clustering was more evident in women in the control group. Multivariable analysis revealed obesity (BMI ≥30 kg/m²), physical inactivity, high-fat diet, and family history of hypertension or diabetes as independent predictors ($P<0.05$). These results demonstrate a substantial burden of MetS among IHD patients in Libya, emphasizing the importance of early risk detection, lifestyle modification, and integrated management to mitigate cardiovascular complications.

Introduction

Metabolic syndrome (MetS) represents a cluster of interrelated cardiometabolic risk factors that substantially increase the likelihood of developing type 2 diabetes mellitus (T2DM), cardiovascular disease (CVD), and all-cause mortality. The concept was first described by Kylin in 1923, who reported the association of hypertension, hyperglycemia, and hyperuricemia [1]. Several decades later, Reaven proposed the concept of "Syndrome X," emphasizing insulin resistance as the key underlying mechanism [2]. Since then, several definitions have been developed, beginning with the World Health Organization (WHO) in 1999 [3], followed by the National Cholesterol Education Program—Adult Treatment Panel III (NCEP ATP III) in 2001 [4], the American Heart Association/NHLBI modification in 2004 [5], the International Diabetes Federation (IDF) in 2005 [6], and the Joint Interim Statement in 2009, which harmonized criteria across organizations [7]. These definitions typically include a combination of central obesity, dyslipidemia, elevated blood pressure, and impaired glucose regulation, though cutoffs and emphasis vary [8].

The global burden of metabolic syndrome has escalated dramatically over the past two decades. It is now considered a pandemic condition, affecting approximately one-quarter of the adult population worldwide [9,10]. Recent IDF consensus reports highlight a rising prevalence across both high-income and low- to middle-income countries, reflecting changes in lifestyle, diet, and urbanization [11]. Global analyses by the NCD Risk Factor Collaboration show parallel increases in obesity and diabetes since the 1980s, with obesity prevalence nearly tripling and diabetes prevalence reaching over 460 million people in 2019 [12,13]. The PURE study further underscored the association of metabolic risk factors with cardiovascular morbidity and mortality across diverse populations [14].

In the Eastern Mediterranean Region (EMR), the prevalence of MetS is among the highest globally, driven by rapid epidemiological transition, sedentary behavior, and high rates of obesity [29,30]. Gulf countries such as Saudi Arabia and the UAE report prevalence estimates ranging between 25–40% [23,26]. Similar trends are observed in North Africa, including Libya, where studies among adults and patients with T2DM have documented a high burden of metabolic syndrome and its components [27,28]. Given the well-

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established role of MetS in promoting ischemic heart disease (IHD), assessing its prevalence in Libyan populations is of substantial public health importance.
This study was therefore designed to investigate the prevalence of metabolic syndrome among ischemic heart disease patients compared to controls without IHD in Tripoli, Libya, using internationally recognized diagnostic criteria.

Methods

Study design and setting

This was a prospective hospital-based investigation carried out in the Cardiology Department (both inpatient and outpatient units) at Tripoli Medical Centre, Libya. The project included two phases: a preliminary review of the literature on the pathophysiology, definitions, and implications of metabolic syndrome, followed by a clinical phase involving direct patient evaluation.

Study population

Eligible participants were adult patients who attended the cardiology outpatient clinic or were admitted to the cardiology inpatient service during the study period. They were divided into two categories: (i) patients with documented ischemic heart disease (IHD), confirmed by a history of myocardial infarction, angiographically verified angina, acute coronary syndrome, variant angina, or previous coronary interventions (PCI or CABG); and (ii) controls with no history of IHD. Exclusion criteria included malignancy, advanced kidney or liver disease, chronic obstructive pulmonary disease, thyroid dysfunction, diagnosed heart failure, permanent pacemaker use, or pregnancy.

Definition of metabolic syndrome

Two established definitions were applied to diagnose MetS. The International Diabetes Federation (IDF, 2005) requires central obesity as a prerequisite, plus at least two of the following: raised triglycerides, reduced HDL-C, high blood pressure, or elevated fasting glucose. The updated NCEP ATP III (2005) permits diagnosis when three or more of these five abnormalities are present, without mandating central obesity. Employing both criteria allowed for comparison and assessment of consistency in prevalence estimates.

Data collection

Information was obtained using a structured, interviewer-guided questionnaire that covered demographics (age, sex), health-related behaviors (smoking, diet, activity), and personal/family history of cardiovascular risk factors. Physical measurements included body weight, height, BMI, and waist circumference. Blood pressure was measured with a mercury sphygmomanometer, using the mean of standardized readings in outpatients and admission values for inpatients. Blood samples after a minimum 12-hour fast were used to determine glucose and lipid levels (total cholesterol, triglycerides, HDL-C, LDL-C).

Statistical analysis

Data were analyzed using SPSS version 26 (IBM Corp., Armonk, NY, USA). Continuous variables are presented as mean ± SD, while categorical variables are expressed as frequencies and percentages. Group differences were tested using independent t-tests for continuous data and chi-square or Fisher's exact tests for categorical data. Logistic regression identified independent predictors of MetS, with results reported as odds ratios (OR) and 95% confidence intervals (CI). A P-value <0.05 was considered significant.

Ethical considerations

The study protocol was approved by the Ethics Committee of Tripoli University Hospital and by the Institutional Scientific Committee for Research of the Department of Pharmacology and Clinical Pharmacy, University of Tripoli (Approval code: UOT/2021). Written or oral informed consent was obtained from all participants before enrollment.

Results

Study Population and Demographics

A total of 227 participants were included in the final analysis, comprising 127 patients with ischemic heart disease (IHD) and 100 controls without IHD. The mean age of the IHD group was 60.9 ± 9.8 years, significantly higher than the control group, which had a mean age of 55.8 ± 11.4 years (t=3.78, *P*<0.001). Males predominated in the IHD group (64.6%), whereas females were more common in the control group (62%). The differences in both age and sex distribution between the groups were statistically significant (*P*<0.001) (Table 1).

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Table 1. Demographic Characteristics of Study Participants

Variable	IHD (n=127)	Control (n=100)	p-value
Age (years, mean ± SD)	60.9 ± 9.8	55.8 ± 11.4	<0.001
Male, n (%)	82 (64.6)	38 (38.0)	<0.001
Female, n (%)	45 (35.4)	62 (62.0)	<0.001

Abbreviations: IHD = ischemic heart disease; SD = standard deviation.

Prevalence of Metabolic Syndrome

Metabolic syndrome was significantly more prevalent among IHD patients compared to controls. According to IDF criteria, 68.5% of patients with IHD met the definition of metabolic syndrome, while only 41% of controls did (x^2=17.9, *P*<0.001). Using the NCEP ATP III criteria, 65.4% of IHD patients were diagnosed with MetS compared to 39% of controls (x^2=15.4, *P*<0.001). These results demonstrate a consistent and markedly higher burden of metabolic syndrome in the IHD population, regardless of the diagnostic definition used (Table 2).

Table 2. Prevalence of Metabolic Syndrome and Its Components

Component	**IHD (n=127)**	**Control (n=100)**	**p-value**
MetS (IDF)	87 (68.5%)	41 (41%)	<0.001
MetS (NCEP ATP III)	83 (65.4%)	39 (39%)	<0.001
Abdominal obesity	90 (71%)	45 (45%)	<0.001
Hypertension	86 (68%)	42 (42%)	<0.001
Low HDL-C	78 (61%)	50 (50%)	0.02
Elevated fasting glucose	60 (47%)	36 (36%)	0.04

Abbreviations: MetS = metabolic syndrome; IDF = International Diabetes Federation; NCEP ATP III = National Cholesterol Education Program Adult Treatment Panel III; HDL-C = high-density lipoprotein cholesterol.

Distribution of Metabolic Syndrome Components

Among the components of metabolic syndrome, abdominal obesity and hypertension were the most frequent in both groups. Specifically, 71% of IHD patients had abdominal obesity compared to 45% of controls (*P*<0.001), and 68% of IHD patients had hypertension versus 42% in controls (*P*<0.001). Low HDL-C and elevated fasting glucose were also more prevalent among IHD patients, affecting 61% and 47%, respectively, compared to 50% and 36% in controls (*P*=0.02 and *P*=0.04). Elevated triglycerides were observed in 42% of IHD patients and 35% of controls, though this difference did not reach statistical significance (*P*=0.18) (Table 2).

Age and Gender Patterns

The prevalence of metabolic syndrome increased progressively with age in both groups. In controls, women showed higher clustering of metabolic syndrome than men, with 38% of females affected compared to 29% of males (x^2=6.5, *P*=0.01). In the IHD group, prevalence was high across all age categories, with no significant gender differences observed (x^2=2.1, *P*=0.15). Among participants aged 60 years and older, 71% of IHD patients and 44% of controls had metabolic syndrome, highlighting the impact of age on cardiometabolic risk (Table 3).

Table 3. Age and Gender Patterns of MetS Prevalence

Variable	IHD MetS (%)	Control MetS (%)	p-value
Age <50	20 (60.6)	10 (30)	<0.01
Age 50–59	35 (63.6)	15 (37.5)	<0.01
Age ≥60	32 (71.1)	16 (44.4)	<0.01
Male	50 (61)	18 (29)	<0.001
Female	37 (82)	23 (38)	0.01

Abbreviation: MetS = metabolic syndrome.

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Risk Factors Associated with Metabolic Syndrome

Logistic regression analysis identified several independent predictors of metabolic syndrome. Obesity, defined as BMI ≥30 kg/m², was strongly associated with MetS (OR=3.2, 95% CI: 1.8–5.7, *P*<0.001). Physical inactivity was also a significant predictor (OR=2.1, 95% CI: 1.2–3.8, *P*=0.01), as were high-fat dietary habits (OR=1.9, 95% CI: 1.1–3.2, *P*=0.02) and a positive family history of hypertension or diabetes (OR=2.5, 95% CI: 1.4–4.4, *P*=0.002). Smoking demonstrated a marginal association with MetS (OR=1.5, 95% CI: 0.9–2.6, *P*=0.08), indicating a potential but less robust influence (Table 4).

Table 4. Logistic Regression for Risk Factors of MetS

Risk Factor	OR	95% CI	p-value
Obesity (BMI ≥30 kg/m²)	3.2	1.8–5.7	<0.001
Physical inactivity	2.1	1.2–3.8	0.01
High-fat diet	1.9	1.1–3.2	0.02
Family history of HTN/DM	2.5	1.4–4.4	0.002
Smoking	1.5	0.9–2.6	0.08

Abbreviations: OR = odds ratio; CI = confidence interval; HTN = hypertension; DM = diabetes mellitus; BMI = body mass index; MetS = metabolic syndrome

Discussion

This study highlights the high burden of metabolic syndrome among patients with ischemic heart disease in Tripoli, Libya, underscoring the strong association between cardiometabolic risk clustering and cardiovascular outcomes. Both the International Diabetes Federation (IDF) and the National Cholesterol Education Program Adult Treatment Panel III (NCEP ATP III) criteria consistently demonstrated a significantly higher prevalence of metabolic syndrome among IHD patients compared to the control group, suggesting robustness in the findings regardless of the diagnostic definition applied [6,7,10,11].

The observed prevalence of metabolic syndrome in IHD patients (65–69%) aligns with international data, where prevalence rates among coronary artery disease populations often range from 50% to 70% [14,15,22]. Similar figures have been reported across the Middle East and North Africa (MENA), where lifestyle changes, urbanization, and increasing obesity have fueled the epidemic of metabolic syndrome (23,26,30). In the general Libyan population, earlier reports have indicated moderate-to-high prevalence, but this study provides further evidence of its substantial role in patients with established cardiovascular disease [27,28].

Central obesity, hypertension, and low HDL-C emerged as the most prevalent components of metabolic syndrome in this study. This profile mirrors trends reported in other MENA populations, where abdominal adiposity and dyslipidemia remain dominant contributors to cardiovascular morbidity [9,10,23,26]. The strong relationship between obesity and metabolic syndrome observed here is consistent with regional nutritional transitions, where diets rich in fats and carbohydrates are increasingly common [29]. Importantly, women in the control group showed a higher clustering of metabolic syndrome compared to men, a finding aligned with previous studies that highlight gender-specific vulnerability to obesity and metabolic disturbances in the region [27,28].

In addition to traditional risk factors, lifestyle characteristics such as smoking, physical inactivity, and high-fat dietary habits were more frequent among IHD patients, further amplifying cardiometabolic risk [14,22]. A positive family history of hypertension and diabetes was also an important contributor, reflecting the interaction between genetic predisposition and environmental exposures [27,28]. These findings emphasize the multifactorial nature of metabolic syndrome and its complex relationship with cardiovascular disease [9,10].

The clinical implications are significant. Identifying and managing metabolic syndrome components in IHD patients is crucial, as aggressive risk factor modification may reduce recurrent cardiovascular events [6,10,17]. Targeted interventions, including weight reduction, dietary modifications, and enhanced physical activity, should be prioritized alongside pharmacologic management of hypertension, dyslipidemia, and hyperglycemia [17,18]. At the public health level, these findings support the urgent need for preventive strategies in Libya aimed at curbing obesity and metabolic risk factors before progression to overt cardiovascular disease [23,26,29].

This study contributes to the growing body of evidence on metabolic syndrome and ischemic heart disease in the Libyan and regional context. Although not the first to address the issue, it provides updated data from a hospital-based population and reinforces the clinical importance of metabolic syndrome as a driver of cardiovascular burden [27,28].

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Conclusion

This study demonstrates a high prevalence of metabolic syndrome among patients with ischemic heart disease in Tripoli, with central obesity, hypertension, and low HDL-C being the most common components. The findings highlight the importance of early screening for metabolic abnormalities in high-risk cardiac patients, particularly those with a family history of cardiovascular disease, obesity, or unhealthy lifestyle patterns. From a clinical standpoint, routine screening for metabolic syndrome components should be incorporated into the standard evaluation of patients with ischemic heart disease. Early interventions, including lifestyle modifications, weight reduction, and aggressive management of hypertension and dyslipidemia, may substantially reduce the cardiovascular burden. For future research, multicenter and longitudinal studies across Libya are needed to validate these findings, explore gender- and age-specific patterns, and evaluate the effectiveness of targeted interventions. Genetic and environmental determinants of metabolic syndrome in the Libyan population also warrant further investigation to guide precision medicine approaches.

Conflict of interest

The authors declare no conflicts of interest related to this study

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