Original Article

Prevalence of Metabolic Syndrome and its Components in Nondiabetic Libyan Females

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Abstract

Background: The metabolic syndrome (MS) is defined as a cluster of cardiovascular risk factors, including central obesity, dysglycemia, hypertension (HPN), elevated triglycerides (TGs), and reduced high-density lipoprotein cholesterol (HDL-C). MS increases the risk of cardiovascular disease and all-cause mortality. **Objective:** This study aims to estimate the prevalence of MS and its components among nondiabetic Libyan females using the definition proposed by National Cholesterol Education Program (NCEP) Adult Treatment Panel III (ATP III). **Methods:** A total of 122 randomly selected nondiabetic Libyan females were included in the study. Detailed medical history was obtained from all participants. Blood pressure, weight, height, waist and hip circumference were measured. Body mass index and waist–hip ratio were calculated. Fasting blood glucose (FBG) and lipid profile were collected. Standard oral glucose tolerance test with 75 GM glucose was performed. The MS was defined by ATP III and International Diabetes Federation criteria. **Results:** According to NCEP definition, the prevalence of the MS in the study group was 42.6%. The most common component was abdominal obesity (67.2%). FBG was ≥ 100 mg/dl in 47.5%. The prevalence of both HPN and low HDL-C was 45.9%. About 26.2% of the participants have their TG ≥ 150 mg/dl; all were MS patients. **Conclusions:** The prevalence of MS and cardiovascular risk factors were high among Libyan females. Public health authorities and health-care providers should implement strategies for prevention, screening, and management of cardiovascular risk factors to reduce the burden of its potential complications.

Keywords: Diabetes, Libya, metabolic syndrome, oral glucose tolerance test, women

Introduction

Metabolic syndrome (MS) is defined by a constellation of metabolic, clinical, and biochemical, factors that increases the risk of atherosclerotic cardiovascular disease (CVD), type-2 diabetes mellitus (DM-2), and all-cause mortality.[1,2]

There have been several definitions of MS, but the most commonly used criteria for definition at present are from the National Cholesterol Education Program (NCEP) Adult Treatment Panel III (ATP III),[3] the International Diabetes Federation (IDF),[4,5] and the World Health Organization (WHO).[6]

According to the NCEP ATP III definition, which was updated by the American Heart Association and the National Heart, Lung, and Blood Institute in 2005,[1] MS is present if three or more of the following five criteria are present: abdominal obesity, dysglycemia, elevated blood pressure (BP), elevated triglycerides (TGs), and reduced high-density lipoprotein cholesterol (HDL-C).

Access this article online

Quick Response Code:

Website: http://journal.limu.edu.ly

DOI: 10.4103/LIUJ.LIUJ_9_18

IDF criteria require central obesity as a prerequisite for the diagnosis of MS in addition to any two of the above-listed criteria.[5]

MS increases the risk of type 2 DM by 5-fold and CVD by 2-fold over the next 5–10 years.[7,8]

Furthermore, individuals with MS are more susceptible to fatty liver, cholesterol gallstones, asthma, sleep disturbances, and breast, pancreatic, and colorectal, cancer.[8,9]

MS affects around 20%–25% of the world population and its prevalence has been globally increased, as a result of Westernization of lifestyle with less physical activity and

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How to cite this article: El-Shareif HJ. Prevalence of metabolic syndrome and its components in nondiabetic Libyan females. Libyan Int Med Univ J 2018;3:20-5.

Received: 03-02-2018 **Accepted:** 14-02-2018 **Published:** 05-04-2018

increased obesity.[8,10-12] The prevalence of MS varies widely between populations from 8% to 43% in men and from 7% to 56% in women around the world.[10] Genetic background, socioeconomic status, diet, and lifestyle influence the prevalence of the MS and its components.[10]

In females, menopause and estrogen deficiency appears to be independent predisposing factor for the development of most of the components of the MS.[13,14] Higher frequency of MS among females than among males was reported in studies from Turkey; Iran, Jordan, Saudi Arabia, and Tunisia.[15]

The aim of this study is to determine the prevalence of MS and abnormal glucose regulation among a sample of nondiabetic Libyan females examined in a pilot screening program that was conducted at the endocrine department of the Tripoli medical center.

Methods

This study was carried out in accordance with the principles of the Helsinki Declaration. Formal approval was obtained from institutional authorities. Female visitors to medical wards of the Tripoli Medical Center, during the study period (June 2010 to December 2010), were approached and asked to participate in the study. Only those who agreed to be part of the study were included. The purpose of the study and the procedure involved was explained to all participants and verbal consent was taken. One hundred and twenty-two Libyan women were enrolled in the study, females with a history of diabetes and pregnant individuals were excluded from this study.

Sociodemographic data collected included age, marital status, level of physical activity, fruit and vegetable consumption, and smoking history. Past medical history of hypertension (HPN), hyperlipidemia, and other chronic diseases and family history of diabetes was also recorded. Weight and height were measured in light clothes and no shoes. Body mass index (BMI) was calculated as weight in kilogram divided by height squared in meters. BMI was classified according to the WHO classification.[16] Waist circumference, and hip circumference were measured in centimeters (cm), and waist-to-hip ratio (WHR) were calculated; WHR >0.85 in women indicates central obesity. The BP of each participant was recorded using a standard mercury sphygmomanometer after the participant had been seated for at least 15 min.

Blood sample (after 10–12 h of fasting) was obtained from each participant for fasting blood glucose (FBG) and lipid profile (TG, total cholesterol, HDL-C, and low-density lipoprotein cholesterol [LDL-C]). Standard oral glucose tolerance test (OGTT) with 75 g glucose was performed for all participants. The results of the OGTT were interpreted according to the ADA guidelines:[17]

- Normal fasting glucose <100 mg/dl, impaired fasting glucose ≥100 mg/dl but <126 mg/dl, diabetic fasting glucose ≥126 mg/dl.
- Normal glucose tolerance <140 mg/dl, impaired glucose tolerance ≥140 mg/dl but <200 mg/dl, diabetic glucose tolerance ≥200 mg/dl.

Definitions of the MS and its components

The NCEP and ATP III criteria were used to identify women with MS.[1]

MS is present if three or more of the following five criteria are present: waist circumference ≥88 cm; elevated BP: systolic BP ≥130 mmHg and/or diastolic BP ≥85 mmHg or receiving treatment for HPN; elevated TGs ≥150 mg/dL; reduced HDL-C <50 mg/dL (for women), and elevated fasting glucose ≥100 mg/dL. The IDF criteria require central obesity as a prerequisite for the diagnosis of MS in addition to any two of the above-listed criteria.[5]

Statistical analysis

Statistical analysis was performed using the Statistical Package for the Social Science (SPSS Inc., IBM, US), 19th version. Continuous variables are expressed as mean ± standard deviation. Categorical data are expressed as numbers and percentages. Student's *t*-test or Mann–Whitney test was used to compare continuous variables. Qualitative variables were analyzed with Chi-square test. A $P < 0.05$ was considered statistically significant.

Results

According to NCEP-ATP III criteria, only 11.5% of our participants have no components of MS, 23.0% had two components, and 42.6% have three or more components of MS. According to IDF diagnostic criteria, 45.9% of all participants have MS [Table 1].

The prevalence of each component of MS using the two sets of criteria (NCEP-ATP-III and IDF) are shown in Table 2. It is clear that significantly higher percentage of participants with MS had abdominal obesity, showed lower HDL-C, higher fasting blood sugar, and TGs when compared to non-MS participants.

Table 3 summarizes the clinical and metabolic characteristics of the participants with and without MS. It is clear that there is a significant difference in all measures except for waist circumference and LDL-C levels between participants with and those without MS.

Table 4 displays the prevalence of MS by age group, first-degree family history of diabetes, BMI, blood sugar regulation, and level of physical activity. The prevalence of MS among those <40 years of age was 20% compared to 60% in those ≥50 years. About 30% of those with negative family history of diabetes have MS versus 50% in those with positive family history. None of the normal-BMI participants have MS, while 59.1% of those with higher BMI have MS. Diabetic fasting blood sugar was significantly higher in participants with MS compared to participants without MS (14.5% versus 2.9%, respectively). Most of the participants with MS (42.3%) showed impaired GTT, but none showed diabetic GTT. All

Table 1: Percentage of participants per number of metabolic syndrome components

Number of MS components	NCEP-ATP III (%)	IDF (%)
0	14 (11.5)	10 (8.2)
1	28 (23.0)	28 (23.0)
2	28 (23.0)	28 (23.0)
3	22 (18.0)	24 (19.7)
4	18 (14.8)	20 (16.4)
5	12 (9.8)	12 (9.8)
Total	122 (100)	122 (100)

NCEP-ATP III: National Cholesterol Education Program-Adult Treatment Panel III, IDF: International Diabetes Federation, MS: Metabolic syndrome

Table 2: Prevalence of individual components of the metabolic syndrome among the study population

Criteria	NCEP-ATP III		IDF		All (%)
	No MS (%)	MS (%)	No MS (%)	MS (%)	
Abdominal obesity[§]	32 (45.7)	50 (96.2)	40 (60)	56 (100)	82 (67.2) ≥88 cm 96 (78.7) ≥80 cm
HPN*	14 (20.0)	42 (80.8)	10 (20)	46 (80)	56 (45.9)
HDL-C <50	16 (22.9)	40 (76.9)	14 (20)	42 (80)	56 (45.9)
FBS ≥100	24 (34.3)	34 (65.4)	22 (30)	36 (60)	58 (47.5)
TG ≥150		32 (61.5)		32 (60)	32 (26.2)

[‡]WC, ≥88 cm (ATP III), ≥80 cm (IDF), *SBP ≥130 mmHg or DBP ≥85 mmHg or known HPN. HDL-C: High-density lipoprotein cholesterol, TG: Triglyceride, FBS: Fasting blood sugar, NCEP-ATP III: National Cholesterol Education Program-Adult Treatment Panel III, IDF: International Diabetes Federation, SBP: Systolic blood pressure, WC: Waist circumference, DBP: Diastolic blood pressure, HPN: Hypertension, MS: Metabolic syndrome

Table 3: Clinical and metabolic characteristics of the study participants

	Mean±SD		*P*	95% CI
	No MS	MS*		
Age	43.1±8.8	48.4±8.9	0.001	−8.5-−2.1
Weight (kg)	66.5±15.9	79.3±11.3	0.001	−17.7-−7.9
BMI	27.4±6.4	33.2±5.1	0.000	−7.8-−3.7
WC (cm)	87.1±16.5	100.9±8	0.000	−18.4-−9.3
WHR	0.9±0.1	0.9±0.1	0.535	−0.04-0.02
SBP (mmHg)	115.1±11.2	137.2±17	0.000	−27.6-−16.6
DBP (mmHg)	73.4±8.3	87.4±9.7	0.000	−17.4-−10.6
FBG (mg/dl)	98.2±12.5	108.4±18.2	0.001	0.001-0.002
2-h blood glucose (mg/dl)[‡]	114.2±42.3	126.6±39	0.0320	0.030-0.037
Total cholesterol (mg/dl)	172.6±39	177.3±35.1	0.3670	0.363-0.382
TG (mg/dl)	83.1±28	162.2±74.9	0.000	0.000-0.000
HDL-C (mg/dl)	52.8±11.4	43.1±12.4	0.000	4.9-14.5
LDL-C (mg/dl)	113.2±36.8	110±30.9	0.3670	0.363-0.382

*NCEP-ATP III, [‡]Post-OGTT. CI: Confidence interval, BMI: Body mass index, WC: Waist circumference, WHR: Waist-to-hip ratio, SBP: Systolic blood pressure, DBP: Diastolic blood pressure, LDL-C: Low-density lipoprotein cholesterol, HDL-C: High-density lipoprotein cholesterol, TG: Triglyceride, FBG: Fasting blood glucose, SD: Standard deviation, NCEP-ATP III: National Cholesterol Education Program-Adult Treatment Panel III, OGTT: Oral glucose tolerance test, MS: Metabolic syndrome

participants with MS showed lower physical activities of more than 3 h/week when compared with participants without MS.

Discussion

Our study showed high prevalence of MS among Libyan females, the percentage of women who had MS was 42.6%, according to NCEP definition and 45.9%, according to IDF definition. This is comparable to other, regional studies using the NCEP criteria. In a study conducted in a family practice clinic at Jordan University Hospital, using NCEP-ATP III criteria, the prevalence of MS among women aged 25–80 years was 41.0%.[18] A similar high prevalence of MS among women (42%) was reported by a large community-based national health survey including 17293 Saudi men and women, aged 30–70 years old.[19] Based on IDF criteria, the prevalence of MS among Emirati women (>20 years old) has been reported to be 45.9%.[20] A retrospective analysis of the files of 820 adult patient at the center of diagnosis of Rabat found that the prevalence of MS among Moroccan female was 40.12%.[21] A lower prevalence of MS has been reported among Omani women (23.0%)[22] and among Egyptian women (26.6%).[23]

Genetic predisposition, age, standards of living, and lifestyle behavior of the studied population influence the prevalence of MS and its components.[1,14,16,21] In our sample, MS was significantly associated with older age, the presence of first degree relative with DM, and low level of physical activity.

The prevalence of obesity is high among our study sample, as 45% were obese. This might explain the high rate of MS in our study, where significant association between BMI and presence of MS were found. On the other hand, none of the normal-BMI participants had MS, while 59.1% of those with higher BMI had MS.

The STEPWISE surveillance for chronic diseases conducted in Libya by the WHO in 2009 showed a 40.1% rate of obesity (≥30 BMI) among Libyan nationals (age 25–64 years).[24] There is good evidence that abdominal obesity is important in the development of insulin resistance and the MS.[9,10,25] The most common component of MS in our study sample was abdominal obesity, 67.2% of our sample had a waist circumference ≥88 cm, this is similar to the reported rate by a cross-sectional community-based study included 124 Egyptian females, aged ≥35 years where 66.1% of the studied group had a waist circumference ≥88 cm.[23] Lower prevalence rate of abdominal obesity has been recorded among Omani females (44.3%), and Saudi females (44%).[19,22,26] while higher rate was reported among Jordanian female (73.5%).[18]

The second most prevalent component in the present study was HPN. About 45.9% were either known hypertensive or have BP ≥140/90 mmHg. HPN is an important CV risk factor worldwide, and its prevalence is estimated to be 25% in 2000 and projected to increase by almost 40% in 2025.[27] In the US National Health and Nutrition Examination Survey, the prevalence of HPN (BP ≥140/90 mmHg) in American women

Table 4: Prevalence of the metabolic syndrome by age group, first-degree family history of diabetes, body mass index, glucose tolerance test, and level of physical activity

	No MS* (%)	MS* (%)	χ^2	*P*
Age				
30-30.9	30 (80)	8 (20)	11.4	0.003
40-49.9	24 (50)	22 (50)		
≥50	16 (40)	22 (60)		
Family history of diabetes†				
No	31 (70)	14 (30)	3.9	0.049
Yes	39 (50)	38 (50)		
BMI**				
18.5-24.9	32 (47.1)	0	37.7	0.000
25-29.9	18 (26.5)	16 (30.8)		
30-39.9	14 (20.6)	32 (61.5)		
≥40	4 (5.9)	4 (7.7)		
FBS**				
NFG	44 (64.7)	18 (34.6)	12.9	0.002
IFG	22 (32.4)	26 (50.0)		
DFG	2 (2.9)	8 (15.4)		
2 h postglucose load (OGTT)‡				
NGT	58 (87.9)	30 (57.7)	24.1	0.000
IGT	4 (6.1)	22 (42.3)		
DGT	4 (6.1)	0 (0.0)		
Level of physical activity				
No	26 (37.1)	14 (26.9)	9.8	0.020
≤3 h	8 (11.4)	18 (34.6)		
3-6 h	12 (17.1)	8 (15.4)		
≥6 h	24 (34.3)	12 (23.1)		

†First-degree relative (offspring, sibling, or parent), **Data were available for 120 participants, *NCEP-ATP III, ‡Post-OGTT (data was available for 118 participants). BMI: Body mass index, FBS: Fasting blood sugar, NFG: Normal fasting glucose, IFG: Impaired fasting glucose, NGT: Normal glucose tolerance, DFG: Diabetic fasting glucose, IGT: Impaired glucose tolerance, DGT: Diabetic glucose tolerance, OGTT: Oral glucose tolerance test, NCEP-ATP III: National Cholesterol Education Program-Adult Treatment Panel III, MS: Metabolic syndrome

was 30.1%.[28] In a systematic review of 61 published articles related to the prevalence of CVD risk among women in Saudi Arabia, the average prevalence of HPN (BP ≥140/90 mmHg) was 21.8%.[29] Moreover, in a systematic review of the 13 studies, the estimated prevalence of HPN among ten Arab countries was 29.5%.[30] In Libya, a surveillance by the WHO showed 35.6% prevalence rate of HPN among 1666 Libyan females aged 25–64 years.[24] HPN is a silent disease and our results showed that only one-third of those with high BP were previously diagnosed.

Nearly 45.9% of the study sample have HDL-C <50 mg/dl, comparable results were reported by a cross-sectional community-based study of 124 Egyptian females, aged ≥35 years old in a rural area where 44.4% of the study participants had low HDL.[23] On the other hand, higher prevalence of low HDL-C reported among Omani female (75.4%),[22] Palestinian women (56%),[31] Jordanian women (56.1%),[18] Emirati females (48.8%),[20] and Saudi women (81.8%).[19]

The prevalence of hypertriglyceridemia in our study (26.2%) is comparable to the reported rates from other regional studies.[19,21,23,31]

About 47.5% of our study population had FBG ≥100 mg/dl. Type 2 diabetes and abnormal glucose regulation are closely associated with the MS. Clustering of the cardiovascular risk factors associated with MS predicts the development of diabetes and CVD. In a cross-sectional study involved 99 randomly selected Libyan adult patients with type-2 DM, 92% of the patients had the MS according to the ATP III criteria.[32]

The MS can be prevented by interventions that modify diet and physical activity and control weight.

We found a higher frequency of MS among those with low level of physical activity. The low rates of physical activity reported by our participants is comparable to reports from other Arab countries.[15,18,22,29,31] Social restraints and lack of open spaces for outdoor activities such as walking are among the factors that contribute to the low level of physical activities among Libyan females. Moreover, the risk of MS increased by sedentary behavior such as watching television, especially in older patients.[33,34] The results of Finnish and American prevention of diabetes studies have shown the marked clinical benefits associated with weight reduction and increased physical activity in terms of prevention of type 2 DM.[35,36] Therefore, the risk of MS can be reduced by increasing physical activity, especially higher intensity activities such as fast walking.

Conclusions

MS is highly prevalent among the studied Libyan females, affecting 42.6%, where abdominal obesity was the most frequent component of the syndrome. MS is associated with increased morbidity and mortality and early detection and treatment of its components are important for the prevention of CVD. Promotion of healthy lifestyle and education about the risks associated with sedentary behavior and active or passive smoking should be part of any management strategy for persons with or at risk for MS. Moreover, public health education is crucial to raise the public awareness of the risk factors for MS and its components.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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ملخص المقال باللغة العربية

انتشار متلازمة الأيض ومكوناته في الإناث الليبيات غير المصابات بداء السكري

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الخلفية: يتم تعريف متلازمة الأيض على أنها مجموعة من عوامل الخطر القلبية الوعائية، بما في ذلك السمنة المركزية، خلل السكر، ارتفاع ضغط الدم، ارتفاع الدهون الثلاثية، وانخفاض الكولسترول الدهني عالي الكثافة. ولهذا فإن متلازمة الأيض تزيد من خطر الإصابة بأمراض القلب والأوعية الدموية وزيادة الوفيات.

الهدف: تهدف هذه الدراسة إلى تقدير مدى انتشار متلازمة الأيض ومكوناتها بين الإناث الليبيات غير المصابات بالسكري باستخدام التعريف المقترح من قبل البرنامج الوطني لتعليم الكوليسترول الأمريكي.

الطريقة: شملت الدراسة 122 امرأة ليبية غير مصابة بالسكري تم اختيارهن عشوائيا. تم الحصول على التاريخ الطبي مفصل من جميع المشاركين. لكل من المشاركين تم الآتي: قياس ضغط الدم والوزن والطول والخصر ومحيط الورك، حساب مؤشر كتلة الجسم ومحيط الخصر أو الورك، تعيين نسبة الجلوكوز والدهون، اختبار تحمُّل الغلوكوز عن طريق الفم. تم تعريف مرض متلازمة الأيض بناء على معايير الاتحاد الدولي للسكري.

النتائج: وفقا لتعريف الاتحاد الدولي للسكري، كان انتشار متلازمة الأيض في مجموعة الدراسة (42.6٪). كان العنصر الأكثر شيوعا السمنة في منطقة البطن (67.2٪). وكان (47.5%) من النساء يعانين من ارتفاع معدل السكر في الدم لأكثر من 100 ملغ/لتر، ونسبة (45.9%) منهن يعانين من ارتفاع ضغط الدم وتدني تركيز نسبة الشحوم العالية الكثافة. كما أن 26.2% منهن يعانين من ارتفاع الدهون الثلاثية.

الاستنتاج: انتشار متلازمة الأيض وعوامل الخطر القلبية الوعائية كبيرا بين الإناث الليبيات. وينبغي لسلطات الصحة العامة ومقدمي الرعاية الصحية تنفيذ استراتيجيات للوقاية من عوامل الخطر القلبية الوعائية وفحصها وإدارتها من أجل تخفيف عبء مضاعفاتها المحتملة.

الكلمات المفتاحية: مرض السكري، ليبيا، متلازمة الأيض، اختبار تحمُّل الغلوكوز، النساء.