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Prevalence of metabolic syndrome and its components among type 2 diabetic mellitus Syrian patients according to NCEP-ATP III and IDF diagnostic criteria

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ABSTRACT: The metabolic syndrome (MetS) is an important group of components responsible of high incidence of cardio-vascular disease (CVD) and stroke among the type 2 diabetic mellitus (DM) patients. Studies on the prevalence of the MetS and its components among DM patients are limited in developing countries and such studies never been done in Syria before. The objectives of current study were two-folds: (a) to investigate the prevalence of MetS in a group of DM Syrian patients as defined by NCEP-ATP III and IDF diagnostic criteria, and (b) to identify the individual MetS associated risk factors components in the studied group. A cross-sectional study carried out at one of the diabetic clinics of the health ministry in Damascus, Syria between 2016–2017. A random sample of 424 patients (209 males, 215 females) DM patients aged 40–79 years were participated in this study. Anthropometric indices, blood pressure (BP), fasting blood sugar (FBS), total cholesterol, high density lipoprotein cholesterol (HDL-C), triglycerides (TG) were determined. The overall prevalence of the MetS was 67% and 69.3% according to the NCEP-ATP III and IDF criteria, respectively. The prevalence was higher in females and increased with age. According to NCEP/ATP III criteria and for the overall group, high TG was the most prevalent component of the MetS. However, when an IDF criterion was applied, central obesity was the commonest component in the overall group. According to both diagnostic criteria, hypertension was significantly higher in males while central obesity was dominated in females ($p<0.05$, $p<0.001$, respectively). In conclusion, the results revealed high prevalence of the MetS in DM Syrian patients using both diagnostic criteria but slightly higher with IDF criteria. Especial care, health awareness, life style modifications, and proper medications should be directed towards controlling the risk factors components of this syndrome.

KEY WORDS: metabolic syndrome, prevalence, risk factors components, diabetes mellitus, Syrian patients

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Introduction

Type 2 diabetes mellitus (DM) is a chronic, progressive metabolic disease characterized by elevated levels of blood glucose, in which the body becomes insulin resistant and loses the capacity for enough insulin production. DM is one of the most common chronic illness worldwide and the fifth leading cause of death in the developed world. The prevalence of diabetes has been steadily increasing for the past 3 decades and is growing rapidly in low- and middle-income countries (WHO 2016). In 2017, it was estimated that there were 451 million diabetic patients, with an expectation that this number to rise to 693 million by 2045. Also, in 2017, approximately, 5.0 million deaths worldwide were attributable to this disease (Cho et al. 2018). In the Middle Eastern and North African region an estimation of 9.2% (39.9 million) of adults aged 18–99 years old are living with DM in 2017, and it was predicted to rise to 85.9 million by 2045 (Cho et al. 2018). In a recent report by Meo and colleagues (2017), the authors showed high prevalence of DM in Arab world with many countries of the region are among the world's top ranking in terms of DM prevalence. These countries are Saudi Arabia (31.6%), Oman (29%), Kuwait (25.4%), Bahrain (25%), United Arab Emirates (25%), Lebanon (18.9%), Egypt (17%) and Syria (15.6%). Close results were reported by other groups (Badran et al. 2012). However, Syria as Middle Eastern country ranks in the eleventh place in the DM with a prevalence of 15.6%. Moreover, in these countries, with a high DM prevalence, this disease is recognized as an important cause of disability and premature death, mainly, through the increased risk of CVD. It has been reported that one in four deaths adults is due to DM, with mortality of about 280.000 within the age range of 20–79 year, distributed equally in both genders. According to the recent united nation report by world leaders Political Declaration on the Prevention and Control of NCDs, this disease is consider as one of four priority noncommunicable diseases (NCDs) targeted by world leaders (Resolution 66/2United Nations 2011).

In most people with DM, there is a group of components forming what is called metabolic syndrome (MetS) (Alberti et al. 1998). The MetS is a cluster of risk factors including; high fasting blood sugar (FBS), central obesity, low LDL, high triglycerides (TG), and high blood pressure (BP) (Lorenzo et al. 2003). These components were initially described and introduced by Gerald Reaven (1998). Later, these factors have given a number of names, such as "Syndrome X", dysmetabolic syndrome and, also called insulin resistance syndrome. During the last decade, several criteria have been proposed for identifying the MetS, (Marchesini et al. 2004, Leslie 2006). These include the criteria by the World Health Organization (WHO, 1999), the national Cholesterol Education Program Adult Treatment Panel III (NCEP-ATP III, 2001), and the International Diabetes Federation (IDF 2005). All these criteria take into consideration the abnormalities of glucose metabolism, dyslipidemia, high blood pressure, and obesity as major components of the MetS. However, defining the cut-off values of the abnormalities to define the MetS are considered the major areas of inconsistencies. These inconsistencies lead to undesirable consequences for prioritization of patients for proper treatment.

MetS has become a major health issue worldwide. The published studies indicated that around 20–25% of the world's adult population is suffering from this syndrome and eligible three times to have CVD compared with people without the syndrome (Stern et al. 2004). Prevention, an early diagnosis and a proper intervention of this syndrome components are highly essential for reducing the risk of CVD (Ford 2005). Also, this syndrome has a great link with an important metabolic disorder called insulin resistance which is characterized mainly by insulin function impairment (Dandona et al. 2005). The insulin resistance is mainly developed accordingly with of central obesity and physical inactivity (Bonora et al. 1998). Studies have shown that the people with MetS are at increased risk of DM, regardless of the presence of any glucose metabolism abnormalities (Lorenzo et al. 2003). The published data have shown that patients with MetS have a fivefold greater risk of developing DM in comparison with general populations (Wilson et al. 2005; Stern et al. 2004). Therefore, identifying the MetS in diabetic patients is highly beneficial for the CVD prevention.

The underlying cause and exact mechanisms of the complex pathways of this syndrome are still unknown and under investigation and continues to challenge the experts. However, only partially these mechanisms have been elucidated. However, both insulin resistance and central obesity are considered significant factors (Carr et al. 2004; Nesto 2003). Genetics, physical inactivity, a pro-inflammatory status, diet rich with carbohydrate and lipid, aging may considered as contributing factors, but the role of these factors may vary depending on ethnic group (Andrson et al. 2001; Bonora et al. 1998; Nakamura et al. 1994; Saad 1991). Studies have demonstrated that many inflammatory biomarkers such as C-reactive protein (CRP), Fibrinogen, Interleukin-6 (IL-6) are often increased (Andrson et al. 2001; Saad et al. 1991). Therefore, the management has two goals, first, to reduce the main underlying causes (central obesity and physical inactivity), and secondly, to treat the associated risk factors.

Studies on the prevalence of the metabolic syndrome and its components among DM patients are limited in developing countries and such studies never been done in Syria before. Therefore, the objectives of this study were two-fold: (a) to explore the prevalence of MetS among group of Syrian patients of different age groups with DM as defined by NCEP-ATP III and IDF diagnostic criteria, and (b) and to identify the individual MetS associated risk factors in the studied group.

Materials and Methods

Participants

A cross sectional study was conducted between 2016–2017 at one of the diabetic clinics of the health ministry in Damascus, Syria. The study subjects were recruited by local advertisement and consisted of a sample of 424 subjects (209 males, 215 females) living in Damascus city and surrounding areas aged 40–79 years. Participants were selected based on availability and willingness to take part. The main inclusion criteria were previously known or newly diagnosed type 2 diabetes mellitus (DM) of at least 1 year. Type-1 DM patients, pregnant women, patients with serious metabolic illness, chronic viral and bacterial infections were excluded. The study protocol was

approved by the scientific research and the Ethical Committee of the Atomic Energy Commission of Syria (AECS). This study was performed in accordance with guidelines prescribed by Helsinki Declaration of the World Medical Association. Each participant provided informed consent prior to participation after a detailed explanation of the study protocol. A special questionnaire was prepared for all participants to include personal data such as age, sex, family history of diabetes, other diseases, and all performed measurements. All of the measurements were done by the same person with the same equipment during morning hours. The subjects arrived in the morning after an overnight fast at diabetic clinic of the health ministry in Damascus, Syria. Brief clinical examination was performed by specialized medical doctor. Trained clinical technicians conducted all anthropometric measurements. Systolic and diastolic blood pressure (SBP, DBP) were measured to the nearest 2 mmHg on the right arm with subjects seated, after at least 15 min of rest, using a standard mercury sphygmomanometer. The mean of the three readings was taken for all the measurements.

Anthropometric measurements

Anthropometric measurements included: weight, height, hip circumference (HC), and waist circumference (WC). Body weight was measured to the nearest 0.1 kg using calibrated an electronic scale (Seca, Model 7671321004; Germany, D=0.05 to 0.1 kg). The accuracy of the scales were assessed using weight of known mass according to the Quality Assurance Office (AECS) procedure. Height was measured to the nearest 0.1 cm using a well-mounted stadiometer (Seca, Model 225 1721009, Germany). Subjects were measured barefoot in light underwear. WC was measured in midway between the lateral lower rib margin and the iliac crest. Measurements were performed to the nearest millimeter using a non-stretchable tape over the unclothed body. Three measurements were made and the mean expressed in cm used for analysis. BMI, as measurement of overall obesity, was identified as weight divided by height squared (kg/m^2). Four categories of BMI were identified according to WHO recommendations as follows: individuals with a BMI ≤18.5 kg/m^2 were classified as underweight, individuals with a BMI 18.5–24.9 were classified as normal, overweight with BMI 25–29.9, and obese BMI≥30.

Biochemical procedures

The major MetS biochemical risk factor components were included in this study. Blood samples were drawn from the antecubital vein for all participants after 12 hours of overnight fasting. The sample was centrifuged to obtain the serum according to the standard methods. The following biochemical parameters were determined using commercial kits; fasting blood glucose (FBS), total cholesterol (Chol), triglycerides (TG) and high density lipoprotein cholesterol (HDL-C). The protocol for the determination of the biochemical parameters was as indicated in the manufacturer's instructions (Human Co.).

Metabolic syndrome definition

The MetS was defined according to the criteria of the National Cholesterol Education Program, Adult Treatment Panel III (NCEP-ATP III). MetS includes in-

dividuals with any three or more of the following five factors: abdominal obesity (waist circumference >102 cm for males or >88 cm for females); high TG ≥ 150 mg/dL; low HDL-C (males <40 mg/dL and female <50 mg/dL); high BP (SBP ≥130 mm Hg and/or diastolic BP ≥85 mm Hg and high FBS≥110 mg/dL, or previously diagnosed type 2 DM, or specific treatment for any of the previous abnormalities. As all the participants were previously diagnosed with type 2 DM, they were classified as hyperglycemic irrespective of the level of blood glucose.

The MetS was also defined according to the criteria of the International Diabetes Federation (IDF) Criteria and include individuals with central obesity (defined as waist circumference with ethnicity specific values). For Eastern Mediterranean and Middle East (Arab) populations the European data are recommended (males ≥94 cm and females ≥80 cm), plus any two of the following four risk factors: high TG ≥150 mg/dL, low HDL-C (males <40 mg/dL and females <50 mg/dL), high BP (SBP ≥130 mm Hg and/or diastolic BP ≥85 mm Hg), and high FBG ≥110 mg/dL, or previously diagnosed type 2 DM, or specific treatment for any of the previous abnormalities.

Statistical analysis

Data were entered into Microsoft Excel 2007 and statistical analyses were performed using the Statistical Package for Social Science SPSS for windows (Version 18, SPSS Inc., Chicago, USA). The results are expressed as means and standard deviations (Mean±SD), whereas categorical variables were represented by frequency and percentage. The level of significance was determined as a p-value<0.05.

Results

Characteristics of the studied population

This study included 424 type 2 DM patients, 209 males and 215 females. The overall mean age of the group was 59±8 years, whereas the ages of the males and females were 60±8 and 57±8, respectively. The informed consent was provided by all participants. The characteristics of volunteer's sample that enrolled in the study including all the anthropometric and biochemical components are shown in Table 1. The overall mean value of BMI was 31.8±5.7 kg/m^2, and the mean BMI of males and females were 29.7±4.7 and 33.8±5.7, respectively. The overall mean value of BMI of females was significantly higher. The overall mean values of WC were 99.2±11.7 cm, and that of males and females were 97.2±11.5 and 101.2±11.6 cm, respectively. The overall mean value of WC of females was significantly higher. SBP was significantly higher in males, but there was no significant difference in the DBP. Among the biochemical parameters, the total TCH and the HDL were observed to be significantly higher in females compared to males. However, the TG and FBS levels were found to be almost similar in both genders, even, the levels were slightly higher in female gender.

Prevalence of metabolic syndrome

According to the criteria of the NCEP/ATP III, the overall percentage prevalence of MetS was 66.9%. Females had a higher percentage prevalence of 81.9%, compared to a lower percentage prevalence of 51.7% for the males. The corresponding results for the IDF criteria were

Table 1. The characteristics of the participants enrolled in the study including the anthropometric and biochemical metabolic syndrome components

Variable	Male (n= 209)		Female (n=215)		Total (n= 424)		*p*-value
	Mean±SD	n	Mean±SD	n	Mean±SD	n	
Age (years)							
All	60±8	209	57±8	215	59±8	424	0.002
40–49	45±2	22	46±2	36	46±2	58	0.051
50–59	55±3	80	55±3	94	55±3	174	0.149
≥ 60	66±5	107	65±4	85	66±5	192	0.090
BMI (kg/m^2)							
All	29.7±4.7	209	33.8±5.8	215	31.8±5.7	424	0.000
Normal	23.1±1.5	33	23.8±1.1	8	23.2±1.4	41	0.240
Overweight	27.9±1.4	90	27.8±1.2	54	27.8±1.3	144	0.682
Obesity	34.2±3.3	86	36.5±4.7	153	35.7±4.4	239	0.000
WC (cm)	99.2±11.7	424	101.2±11.6	215	97.2±11.5	209	0.000
WC by NCEP-ATPIII							
Normal	91.0±7.5	143	82.7±4.7	25			0.000
Male >102; Female>88	110.4±6.6	66	103.6±9.9	190			0.000
WC by IDF							
Normal	86.5±6.1	86	72.6±4.4	3			0.000
Male >94; Female>80	104.7±7.9	123	101.6±11.1	212			0.003
Blood pressure (mmHg)							
Systolic blood pressure	139±22		133±20		136±21		0.005
Diastolic blood pressure	84±12		82±11		83±11		0.065
FBS (mg/dL)	160±52		165±51		162±51		0.373
TG (mg/dL)	182±89		187±68		184±79		0.516
TCH (mg/dL)	164±35		182±38		173±37		0.000
HDL (mg/dL)	61±6		68±7		65±8		0.000

Abbreviations: BMI – body mass index, WC – waist circumference, NCEP-ATP III – National Cholesterol Education Program, Adult Treatment Panel III, IDF – International Diabetes Federation, FBS – fasting blood glucose, TG – triglycerides, TCH – total cholesterol, HDL – high density lipoprotein; *p* is significant at 0.05.

Table 2. Prevalence of the number of metabolic syndrome components of the type 2 diabetic patients according to NCEP-ATP III and IDF criteria

Number of components	NCEP-ATP III			IDF		
	Male	Female	Total	Male	Female	Total
1	20 (9.6)	4 (1.9)	24 (5.7)	14 (6.7)	1 (0.5)	15 (3.5)
2	81 (38.7)	35 (16.3)	116 (27.4)	58 (27.7)	26 (12.1)	84 (19.8)
3	79 (37.8)	91 (42.3)	170 (40.1)	86 (41.1)	96 (44.6)	182 (42.9)
4	29 (13.9)	85 (39.5)	114 (26.9)	51 (24.4)	92 (42.8)	143 (33.7)
5	0	0	0	0	0	0
MetS*	108 (51.7)	176 (81.9)	284 (66.9)	107 (51.2)	187 (86.9)	294 (69.3)

Percentage values are given in parentheses, NCEP-ATP III - National Cholesterol Education Program, Adult Treatment Panel III, IDF – International Diabetes Federation. 1 (patients with one component), 2 (patients with two components), 3 (patients with three components), 4 (patients with four components); $p<0.001$(*) when compared females to males with metabolic syndrome for both criteria.

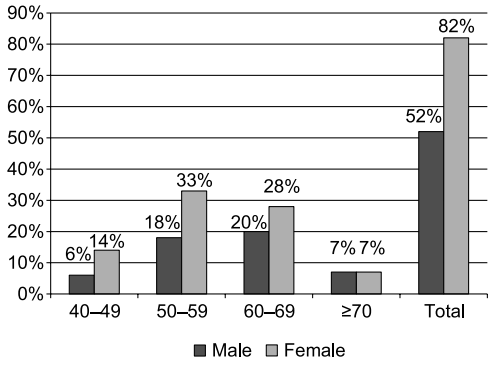

Fig. 1. Prevalence of MetS by sex and age group according to NCEP/ATP III classification
$p<0.001$ when compared females to males with metabolic syndrome for the overall prevalence

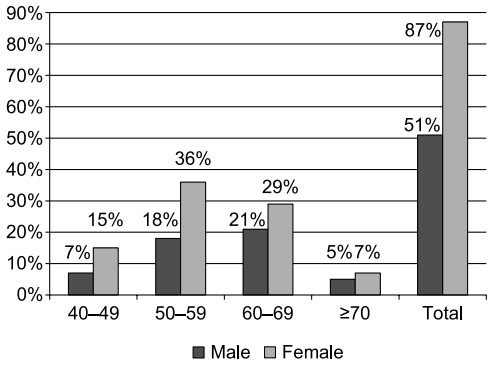

Fig. 2. Prevalence of MetS by sex and age group according to IDF classification
$p<0.001$ when compared females to males with metabolic syndrome for the overall prevalence

69.3%, 86.9%, and 51.2%, respectively. The prevalence was significantly higher in females than in males independently of the criteria used in MetS diagnosis ($p<0.001$) (Table 2).

With respect to age, females patients in the age group of 50–59 years had the highest prevalence of the MetS of 33%, whereas, males in the age group 60–69 years had highest prevalence of Mets of 20%. However, there was no significant

Table 3. Prevalence of the individual components of metabolic syndrome in the type 2 diabetic patients

Variable	Male		Female		Total		*p*-value
	n	%	n	%	n	%	
NCEP-ATP III							
Central obesity	66	31.6	190	88.4	256	60.4	0.000
Elevated BP							
SBP ≥ 130 mm	136	65.1	126	58.6	262	61.8	0.033
DBP ≥ 85 mm	93	44.5	86	40.0	179	42.2	0.101
FBS	180	86.1	185	86.0	365	86.1	0.417
Reduced HDL	0		0		0		
Elevated TG	118	56.5	146	67.9	264	62.3	0.192
IDF							
Central obesity	123	58.8	212	98.6	335	79.0	0.003
Elevated BP							
SBP ≥ 130 mm	136	65.1	126	58.6	262	61.8	0.033
DBP ≥ 85 mm	93	44.5	86	40.0	179	42.2	0.101
FBG	180	86.1	185	86.0	365	86.1	0.417
Elevated HDL	0		0		0		
Elevated TG	118	56.5	146	67.9	264	62.6	0.192

Abbreviations: NCEP-ATP III – National Cholesterol Education Program, Adult Treatment Panel III, IDF – International Diabetes Federation, SBP – systolic blood pressure, DBP – diastolic blood pressure, FBS – fasting blood sugar, FBG – fasting blood glucose, TG – triglycerides, HDL – high density lipoprotein; *p* is significant at 0.05.

difference in these figures when IDF criteria were applied (36%,21%). Whereas, patient of age 70 years and above, had the lowest prevalence (about 5–7% in both criteria and sex) (Figures 1 and 2). The overall prevalence appears slightly higher according to the IDF criteria (66.9% vs 69.3%). However, the trend according to the age groups and sex appears similar.

Prevalence of the metabolic syndrome components

According to the criteria of the NCEP/ATP III and for the overall population, high TG was the commonest component (62.3%) of the MetS, followed by high BP (61.8%), and central obesity (60.4%). However, the differences if any, were meaningless. In females, central obesity was the most common component (88.4%), followed by high TG (67.9%). In males, high BP was the most common component (65.1%), followed by high TG (56.5%). However, when the IDF criteria were applied, central obesity was the commonest component in the overall group of (79%), followed by high TG (62.3%). In female, central obesity was the most common component of (98.6%), followed by TG (67.9%) and BP (58.6%). In males, high BP was the most common component (65.1%), followed by central obesity (58.8%) and TG (56.5%) (Table 3).

Comparison of anthropometric, clinical, and biochemical parameters between diabetic patients with and without Mets

The comparison of anthropometric, clinical, and biochemical parameters between diabetic patients with and without Mets according to NCEP/ATP III and IDF criteria are shown in Table 4. The NCEP/ATP III criteria identified 284(66.9%) participants having MetS while 294(69.3%) patients were positive by IDF criteria. The BMI, WC, BP, and TG were found to be higher in Mets patients in both diagnostic criteria. However, age, HDL, and FBG showed insignificant differences. Also, our results have shown that the majority of the diabetic patients without MetS presented with normal BP (about 70% with normal SBP and 81% with normal DBP), and only small group of those with elevated BP receiving anti hypertension pills, as the majority of those presented with mildly elevated BP.

Discussion

The prevalence of MetS is increasing globally in both developing and developed countries, contributing to rising of noncommunicable diseases such as CVD and DM. Studies on the prevalence of the MetS and its components among DM patients are limited in developing countries and such studies never been done in Syria before. In this study, the prevalence of MetS in Syrian DM patients according to the criteria of the NCEP/ATP III and IDF, and its risk factors components were assessed. These two criteria take into consideration the abnormalities of increased WC, high FBS, high TG, low HDL, and HBP as essential components of the MetS. The IDF has recently provided a criterion more specific in different ethnic populations through providing a range for increased WC, which was lower for certain racial groups.

The main finding of the current study was a high prevalence of the MetS among DM Syrian patients using both diagnostic criteria. The overall percentage prevalence of MetS according to the NCEP/

Table 4. Comparison of clinical and biochemical parameters between diabetic patients with and without Mets

Variable	NCEP-ATP III						IDF					
	Without Mets			Mets			Without Mets			Mets		
	Male (n=101)	Female (n=39)	Total (n=140)	Male (n=108)	Female (n=176)	Total (n=284)	Male (n=102)	Female (n=28)	Total (n=130)	Male (n=107)	Female (n=187)	Total (n=294)
Age	60±8	56±8	59±8	60±9	58±8	59±8	60±8	55±7	59±8	59±8	58±8	58±8
BMI*	28±4	30±4	29±4	31±5	35±6	33±6	27±4	31±5	28±4	32±4	34±6	34±5
WC*	92±10	91±9	92±10	102±11	103±11	103±11	89±10	94±10	90±10	105± 8	102±11	103±10
SBP*	129±20	118±15	126±19	148±20	136±19	141±20	134± 21	112±9	130±21	143±22	136±19	139±20
DBP*	79±10	75±9	78±10	88±11	83±10	85±11	81±11	73±8	80±11	86±12	83±10	84±11
TG*	163±95	149±65	159±88	199±79	195±66	197±71	172± 99	134±28	164±90	191±78	195±69	193±72
FBS	160±56	151±46	157±54	161±47	168±51	165±50	161±53	151±46	159±52	159±50	167±51	164±51
HDL	61±6	67±6	63±6	62±7	69±7	66±8	61± 8	68±6	63±8	61±5	69±7	66±7

BMI: body mass index, WC: waist circumference, SBP: systolic blood pressure, DBP: diastolic blood pressure, FBS: fasting blood sugar, TG: triglycerides, HDL: high density lipoprotein, Mets: metabolic syndrome, $p<0.001$(*) when compared with and without metabolic syndrome subjects for both criteria.

ATP III, and IDF criteria were 66.9% and 69.3%, respectively. This study showed slightly higher prevalence of MetS according to the IDF criteria. This slight higher prevalence reported according to the IDF criteria could be explained by the fact that the two criteria use identical five components apart from WC, where different values of central obesity (main component in IDF) are applied. The almost close agreement between NCEP-ATP III and IDF criteria demonstrated in this study was reported by others. Ahmed and colleagues (2012) reported a similar trend of agreement as observed in our study, where about 10% difference between the two criteria has been shown in his study. Another study conducted in India by Yadav and colleagues (2013) demonstrated the same concordance between the described criteria with prevalence of 45.9%, 57.7% by NCEP-ATP III and IDF, respectively. Also, similar trend of concordance was reported by Kengne and colleagues (2012)with prevalence of 60.4% according to NCEP-ATP III criteria and 71.7% according to the IDF criteria.

There are several studies reported high prevalence of the MetS among DM patients (Azizi et al. 2003; Bonora et al. 1998; Florez et al. 2005; Isezuo et al. 2005). Several studies reported prevalence of MetS in DM patients more than double the prevalence in general people (Azizi et al. 2003; Bonora et al. 1998). Our results indicating that the MetS appears to be highly common among DM Syrian patients. Bhattarai and colleagues (2012) reported prevalence of metabolic syndrome in DM patients using NCEP/ATP III and IDF criteria of 71% and 82%, respectively. Surana and colleagues (2008) reported in a study conducted near Mumbai a high prevalence according to NCEP-ATP III criteria of 77.2%;

and slightly higher prevalence of 79.7% reported by Imam and colleagues (2007) in Pakistan. Another similar study conducted in USA by Bruno and colleagues (2004) reported prevalence of 75.2%, and slightly higher prevalence of 77% was reported by Foucan and colleagues (2006) in diabetic Indian immigrants in the USA. Kengne and colleagues (2012) reported slightly lower observation of prevalence study on MetS of 60.4% according to NCEP-ATP III criteria, and close results of 71.7% according to the IDF criteria in Sub-Saharan Africans. Also, a close results of 69.5% were reported by Bonadnna and colleagues (2006) in a group of Italian diabetic patients. Nsiah and colleagues (2015) demonstrated slightly less prevalence of MetS in Ghnaian population of 58% according to NCEP-ATP III. However, less prevalence of MetS was demonstrated in a study conducted in India by Yadav and colleagues(2013) with an estimated prevalence of 45.9%, 57.7% using NCEP-ATP III and IDF criteria, respectively. Similar prevalence of 47% was also reported in Bangladesh by Hossain and colleagues (2012). Apparently, and as shown in all these studies, the prevalence of MetS varies, the difference most likely due to lack of accepted definition criteria of MetS.

As indicated in the current study, the MetS prevalence rates were significantly higher in females than in males, independently of the criteria used ($p<0.001$). Females had a higher percentage prevalence of 81.9%, compared to a lower percentage prevalence of 51.7% for the males. The corresponding results for the IDF criteria were 86.9%, and 51.2%, respectively. Osuji and colleagues (2012) reported prevalence of MetS dominated in female patients as compared to males among DM Nigerians. Similar finding was reported by Bhattarai and colleagues (2012) where prevalence in females and males were 91% and 72% according to NCEP-ATP III and 95% and 80% according to IDF criteria, respectively. The corresponding results in a study conducted in near Mumbai were 87.7% and 69.3% (Surana et al. 2008). Similar findings were reported in central India by Yadav and colleagues (2013) and by Hossain and colleagues (2012) in Bangladesh. The higher prevalence of MetS in females DM patients may be due to higher WC and higher BMI as compared to males and consequently a higher prevalence of central obesity. The prevalence of central obesity may be due to a relatively sedentary lifestyle in the Middle East region women as the majority of women in this region are house wives. Also, genetic factors might be important factors.

In agreement with prior studies in DM patients (Azizi et al. 2003, Yadav et al. 2013, Hossain et al. 2012), the present study found similarly increasing prevalence of MetS with increasing age in DM patients. The prevalence of MetS in the current study was found to be highest in female age group of 50–59 years with 33% and 36% based on criteria of NCEP-ATP III and IDF. However, in males age group of 60–69 years, the prevalence of MetS was found to be highest of 20% and 21% based on criteria of NCEP-ATP III and IDF, respectively as shown in Figures 1 and 2. These figures indicate that after the age 50 years, more people are likely to have a high prevalence of MetS, irrespective of the sex. Thus, special care and preventive measures should be directed towards controlling the risk factors of this syndrome around this age. The main controlling measures, besides the proper medications, are exercises and watching the diet through eating food contains

less saturated fat and more fibers. The fibers have been shown to lower the FBS, total CHO and TG. This type of diet decreases the gastrointestinal absorption of carbohydrates and cholesterol.

MetS associated risk factors were assessed in the current study. According to both used diagnostic criteria hypertension was significantly higher in males as compared to females while central obesity was dominated in females group. These findings are almost in agreement with other studies (Unadike et al. 2009; Nsiah et al. 2015). High BP is identified as an independent cardiovascular risk factor and together with DM will have a synergistic effect which result in severe cardiovascular events (Unadike et al. 2009). Central obesity is accompanied with high amount of metabolically active visceral fat which produce wide range of inflammatory cytokines leading through many mechanisms to atherosclerosis and consequently CVD (Johnson et al. 2006). However, the female subgroup participated in the current study had significantly higher average of anthropometric indices such as BMI and WC than males subgroup (BMI 33.8 vs 29.7 and WC 101.2 vs 97.2, respectively) as shown in Table 1. Consequently, the leading risk factor of MetS among females subgroup with DM was central obesity. This finding is consistent with a number of previous studies, where a significantly higher prevalence of central obesity was recorded among females with DM compared to their males counterparts (Shin et al. 2013). High level of TG as one of the MetS risk factors has been demonstrated in the current study group (62.3%). Slightly higher prevalence was reported in other studies (Hossain et al. 2012). The results indicated that level of TG was insignificantly higher among females. The increased level of such lipid is associated with atherosclerosis and CVD. However, the exact mechanism of dyslipidaemia in DM patients is not fully understood. Among the proposed effects in DM patients, one proposed mechanism is that the reduced suppression of lipolysis in adipose tissue leads to a high free fatty acid influx and increased hepatic very low density lipoprotein (VLDL) secretion, which leads to hyperglyceridemia and reduce level of HDL cholesterol in plasma. So, and as the obesity, a major risk factor for MetS, this component needs to be well controlled in order to minimize or slow down the development of many complications. In general, the components of MetS continue to be present in many DM patients despite treatment for high glucose levels and other CVD risk factors. Therefore, it is recommended to apply an aggressive intervention therapy in the management of CVD risk factors such as high level of central obesity, dyslipidemia and hypertension in DM patients.

The current study shows some limitations. Firstly, the relatively small sample size makes this study less representative of the diabetes population of the country, and thus a comprehensive prevalence study is essential among Syrian diabetic patients. Secondly, the cross sectional study cannot allow to establish a cause-effect relationship. However, it provides a basis for the future studies. Thirdly, the study sample consists of routinely followed diabetic outpatients and therefore the effects of the given therapy such as antidiabetes or antihypertensive could not be included in the study. Also, health behaviour factors such as smoking, coffee and alcohol consumptions affecting the MetS are limited in the current study.

Conclusions

Our study provides the first estimates of the prevalence of MetS and its components among DM patients in Syria. The results revealed high prevalence of the MetS using both diagnostic criteria of the NCEP/ATP III and IDF but slightly higher with IDF criteria. The prevalence was higher in females than in males and increased with age. According to both used diagnostic criteria hypertension was significantly higher in males while central obesity was dominated in females group. In overall group, TG (NCEP/ATP III) and central obesity (IDF) were the predominant risk factors components of 62.3% and 79%, respectively. The majority of the participants had uncontrolled DM. This study suggests that especial care and primary prevention strategies should be directed towards health awareness, life style modifications, and controlling the risk factors of this syndrome through proper medications.

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Authors' contributions

MAB proposed the objectives and workplan of the paper, supervised the work, and was the major contributor in the statistical analysis and writing the manuscript; KH participated in performing the anthropometric measurements, collecting the required patient´s data and participated in statistical analysis and computing. All participants read and approved the final manuscript.

Conflict of interest

The Authors declare that they have no competing interests to the present article.

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