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ORIGINAL ARTICLE

Prevalence of Metabolic Syndrome among Hospital Staff of Khalili Hospital, Shiraz, Iran

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ABSTRACT

Background: Metabolic syndrome (MetS) is considered to be a cluster of metabolic risk factors. The purpose of the current study was to determine the prevalence of MetS using 4 different definitions, including the modified Adult Treatment Panel III (ATP-III) for Asians, the American Association of Clinical Endocrinologists (AACE), the International Diabetes Federation (IDF), and Harmonized criteria, its 5 interrelated components, and their association with socio-demographic and anthropometric factors among Khalili Hospital's personnel, Shiraz, Iran.

Methods: Eighty six females and 73 males from Khalili Hospital staff with the mean age of 37.5±8.5 years and 39.2±8.2 years, respectively were recruited and completed the course of the study. Socio-demographic, anthropometric, and biochemical parameters were collected. Data were analyzed using SPSS version 19.

Results: The prevalence of MetS in the study population was 27.7%, 7.5%, 24.5%, and 27.7% based on modified ATP III for Asians, AACE, IDF, and Harmonized definitions, respectively. The mean value of body mass index (BMI) and waist to hip ratio (W/H) was 25.3±4.0 kg/m² and 0.9±0.1, respectively. The prevalence of MetS was only significantly higher in males than in females according to IDF criteria (30.1% vs. 19.8%; *p*=0.027). Neither educational status nor familial history of chronic diseases had a significant association with the prevalence of MetS (*p*>0.05).

Conclusion: Applying definitions with ethnicity-specific abdominal obesity cut-points seems to be better for diagnosis of the syndrome.

Introduction

Metabolic syndrome (MetS) is characterized by a cluster of metabolic conditions including central obesity, glucose intolerance (impaired fasting glucose (IFG), impaired glucose tolerance (IGT), type 2 diabetes), dyslipidemia (low HDL cholesterol (HDL-C), high triglyceride levels), and hypertension which increases the long term risk of cardiovascular disease (CVD), as the major clinical outcome (1), diabetes mellitus (DM) and all-cause mortality (2, 3). Although the pathogenesis of the syndrome remains to be further elucidated, central obesity and insulin resistance is believed to be the prominent risk factor of MetS (4-6).

Since 1998, several definitions have been proposed for MetS, the most commonly used of which are the World Health Organization (WHO, 1998), the Adult Treatment Panel III (ATP-III) by the National Cholesterol Education Program (NCEP/ATP III, 2001), the American Association of Clinical Endocrinologists (AACE, 2003), and the International Diabetes Federation (IDF, 2005) criteria (7, 8). In an effort to harmonize MetS, a scientific statement was provided 4 years later, in 2009, by a collaboration team composed of the International Diabetes Federation Task Force on Epidemiology and Prevention, National Heart, Lung, and Blood Institute, American Heart Association, World Heart Federation, International Atherosclerosis Society, and International Association for the Study of Obesity (Harmonized, 2009) (9).

The syndrome seems to deserve further clinical attention since the existing data suggest that the prevalence of MetS is increasing dramatically in developed and developing countries, not only in adult population, but also among youth and children (10-12). Based on the IDF criteria, one in four adults globally suffers from MetS (13). Besides, nearly one-quarter of western population was reported to have MetS (14). Tehran Lipid and Glucose Study (TLGS) assessing the data collected between 1999 and 2001, showed an estimated prevalence of 30% in adult population according to NCEP/ATP III criteria (15), which is significantly higher than the estimated value reported in most developed countries (16). The prevalence of MetS among urban adults of the west of Iran was also reported to be 23.7% based on the same criteria as applied for TLGS (17). As it is evident, the prevalence of the syndrome varies markedly from one study to another due to the different criteria employed (17).

For reducing the risk of MetS and its components, an update on the prevalence of its individual risk factors as well as the prevalence of the syndrome itself seems to be crucial in different populations. The purpose of the present study was to determine the prevalence of MetS by 4 different definitions including modified ATP III for Asian, AACE, IDF and also Harmonized definitions and its association with socio-demographic and anthropometric factors in Khalili hospital staff, Shiraz, Iran from 2015 to 2016.

Materials and Methods

A total of 159 (64%) healthy personnel, working in Khalili Hospital setting, a teaching hospital affiliated to Shiraz University of Medical Sciences, Shiraz, Iran participated in the study. All the subjects provided a written informed consent following a comprehensive description of the study procedures. No particular inclusion or exclusion criteria were considered. The study protocol was approved by Ethics Committee of Shiraz University of Medical Sciences.

Following the completion of socio-demographic details, including age, sex, marital status, education and familial history of CVD, DM and hypertension (HTN), weight, height, and waist- and hip circumferences (WC; HC) of the subjects were measured based on standard protocol at the time they were enrolled in the study (to the nearest of 0.1 kg and 0.5 cm). Both WC and HC were measured using a flexible non-elastic tape above the iliac crest and at the maximal width buttocks, respectively. Two measurements were recorded for each of waist and hip circumference parameters. In the case of observing variation >2 cm in the recorded measurement, a third measurement was made. Body mass index (BMI), defined as weight (kg) divided by squared height (m^2), was then calculated from these measures. Weight-to-height (kg divided by cm) and waist-to-hip (WHR) ratios were also calculated by the means of parameters.

WC was categorized based on accepted WHO Asian WC cut-offs; 90 and 80 cm for men and women, respectively (18). Besides, BMI was classified according to WHO Asian BMI classification as follows: underweight <18.5 kg/m^2, normal weight 18.5-22.9 kg/m^2, overweight (pre-obese) 23-27.4 kg/m^2 or obese ≥27.5 kg/m^2 (19). In order to determine several blood parameters related to the prevalence of MetS, venous blood samples were drawn after an overnight fasting. Serum fasting blood glucose (FBG, mg/dL), triglyceride (TG; mg/dL), total and HDL cholesterol (TC; HDL-C; mg/dL) were calorimetrically measured by Biosystem A-25 auto-analyzer and relevant commercial kits (Pars Azmoon, Tehran, Iran). The other biochemical parameter estimated was LDL-cholesterol (LDL-C; mg/dL), using Friedewald calculation as follows:

LDL cholesterol (mg/dL)=total cholesterol (mg/

dL)–[HDL cholesterol (mg/dL)+triglycerides (mg/dL)/5] in the case the fasting TG was measured to be <400 mg/dL. Besides, other relevant cardiovascular risk factors including LDL-C to HDL-C, and TC to HDL-C ratios were also calculated. Cuff arterial pressure was measured via a mercury sphygmomanometer in the right arm. The subjects were asked to have an at least a 5-minute rest in a seated position before BP measurement. Systolic and diastolic pressures were recorded to the nearest 5 mmHg.

Data was analyzed using IBM SPSS statistical software (version 21.0, IBM Corp., Armonk, NY, USA). Continuous and categorical variables were presented as mean±standard deviation (SD) and number (together with percentage), respectively. Crosstabs Chi-Square as well as Fisher's exact tests (with the two tailed p value) were used to determine the significance of the differences in MetS prevalence in the familial history of chronic disease level. Independent sample t test was also used to determine whether there was a significant difference in anthropometric measurements (weight, BMI, WC, HC, and WHR) between individuals with or without MetS.

Results

Out of 247 hospital staff enrolled, 159 (64%) completed the study. General characteristics of the study population were reported in Table 1. The mean age of the subjects was 38.3±8.4 years. Almost 54% of the participants were female. The majority were married (77.5%) and 46.5% were highly educated (with a BA/BSc or a higher degree). Familial history of CVD, DM, and HTN was recorded to be

positive in 44%, 34%, and 48.4% of the subjects, respectively. The mean value of BMI in male and female subjects was higher than the WHO cut point for Asian population of 23 kg/m² (25.75±4.3 and 25.0±3.7, respectively). The percentage of females who had central obesity (WC≥80 cm) was almost the same as the ones without (WC<80) (42.9% vs 57.1%). The value for male participants was, however, about 2 times the percentage of those with WC<90 (67.8%vs 32.2%; p=0.03).

As revealed in Table 2, the mean values of all biochemical constituents of MetS in the study population were within the relevant reference range. The mean values of LDL-C to HDL-C- and the total to HDL-C-ratios were found to be 2.3±0.8, and 4.3±1.4, respectively. Table 3 demonstrates the prevalence of MetS based on the 4 different definitions. As shown in the Table, both modified ATP III- and Harmonized-criteria define the highest prevalence of MetS in the study population (27.7%), while AACE definition identified the lowest (vs. 7.5%).

The prevalence of MetS was only significantly higher in males than females according to IDF definition (30.1% vs. 19.8%; p=0.027). No significant association was found between the prevalence of MetS (according to the 4 different definitions) and the familial history of chronic diseases, including CVD, DM, and HTN (p>0.05; data not shown). A significant association was observed between all anthropometric factors, (including weight, BMI, WC, HC, and WHR) and MetS prevalence defined by modified ATP III, IDF, and Harmonized criteria. In contrast to the above-mentioned criteria, AACE-defined MetS indicated no significant association with the anthropometric indices.

Table 1: General and anthropometric characteristics of hospital staff (N=159).		
Parameter	**Mean±SD**	**Range**
Age (y)	38.3±8.4	22-59
Sex (F/M)	86/73 (54.1/45.9) [a]	-
Weight (kg)	69.4±13.1	43-139
Height (cm)	165.4±8.8	142-184
BMI (kg/m²)	25.3±4.0	15.8-43.9
Underweight (<18.5)	4 (2.5) [a]	-
Normal weight (18.5-22.9)	41 (25.8) [a]	-
Overweight (23-27.4)	70 (44) [a]	-
Obesity (≥27.5)	44 (27.7) [a]	-
WC (cm)	88.3±12.7	60-140
<80 (for female)/90 (for male)	39/20 (24.5/12.6) [a]	-
≥80 (for female)/90 (for male)	47/53 (29.6/33.3) [a]	-
HC (cm)	100.6±8.0	80-135
WHR	0.9±0.1	0.7-1.0
Weight-to-height ratio	0.4±0.1	0.3-0.8

[a]n (%). BMI: body mass index; WC: waist circumference; HC: hip circumference; WHR: waist to hip ratio.

Table 2: Biochemical constituents of MetS and blood pressure in hospital staff (N=159).

Parameter	Mean±SD	Reference range[a]	N (%) Abnormal
FBS (mg/dL)	88.0±20.8	70-99	14 (8.8)
TG (mg/dL)	134.7±84.5	<150	53 (33.3)
TC (mg/dL)	170.4±35.7	<200	33 (20.8)
HDL-C(mg/dL)	46.1±11.1	-	-
Female	49.7±10.5	>50	45 (52.3)
Male	41.8±10.4	>40	31 (42.5)
LDL-C (mg/dL)	97.0±28.8	<130	21 (13.2)
SBP (mmHg)	118.4±18.1	<120	76 (47.8)
DBP (mmHg)	76.4±12.3	<80	53 (33.3)

[a](20). FBS: fasting blood sugar; TG: triglyceride; TC: total cholesterol; HDL-C: HDL cholesterol; LDL-C: LDL cholesterol; SBP: systolic blood pressure; DBP: systolic blood pressure.

Table 3: Definition of MetS risk factors based upon different definitions

Definition	MetS risk factors[a,b]	N (%)
Harmonized, 2009[a]	Any of the 3/5 following risk factors: Increased WC (dependent of ethnicity; WC≥90 (for male)/WC≥80 (for female)); TG≥150; HDL-C<40 (for male) or <50(for females) or HDL-C Rx; SBP≥130 or DBP≥85 or on HTN Rx; FPG≥100 (include DM cases)	44 (27.7)
IDF, 2005[b]	Increased WC (dependent of ethnicity; WC≥90 (for male)/WC≥80 (for female)) plus ≥2 risk factors: TG≥150; HDL-C<40 (for male)/<50(for females) or HDL-C Rx; SBP≥130 or DBP≥85 or on HTN Rx; FPG≥100 (include DM cases)	39 (24.5)
AACE, 2003[b]	IGT or IFG (exclude DM cases) plus any of the following risk factors:BMI≥25; TG≥150; HDL-C<40 (for male) or <50(for females); BP≥130/85	12 (7.5)
Modified ATP III for Asian, 2001[c]	Any of the 3/5 following risk factors: WC≥90 (for male)/WC≥80 (for female); TG≥150; HDL-C<40 (for male) or <50(for females); SBP≥130 or DBP≥85 or on HTN Rx; FPG≥110 (include DM cases)	44 (27.7)

[a](21), [b](22), [c](23), IDF: International Diabetes Foundation; ATP III: Adult Treatment Panel III (ATP III); AACE: the American Association of Clinical Endocrinologists; FPG: fasting plasma sugar; TG: triglyceride; HDL-C: HDL cholesterol; WC: waist circumference; BMI: body mass index; BP: blood pressure; SBP: systolic blood pressure; DBP: diastolic blood pressure; DM: diabetes mellitus; HTN: hypertension; OGTT: oral glucose tolerance test; Rx: medical prescriptions.

Discussion

MetS or insulin resistance syndrome is a combination of risk factors for various diseases such as CVD, DM, ovarian cysts, fatty liver, and various types of cancers (24). Investigating the prevalence of MetS and its individual components appears to be an effective clinical tool for earlier identification of those in high risk of developing CVD and type 2DM (25) in different populations.

The current study, conducted on a group of healthy staff working in Khalili Hospital of Shiraz University of Medical Sciences, Shiraz, Iran showed the prevalence of 27.7% (CI 95%: 21.7-33.7), 7.5% (CI 95%: 3.4-11.6), 24.5% (CI95%: 17.8-31.2), and 27.7% (CI 95%: 21.7-33.7) based on the diagnostic criteria defined by the modified ATP III, AACE, IDF, and Harmonized definitions, respectively. The 2013-2014 prevalence of MetS among the nurses of Shahid-Mohammadi hospital, Bandar Abbas, Iran was reported to be lower than the present results (11.7%, 19.8%, 16.2%, and 12.7% using NCEP/

ATP III, AHA/ NHLBI, IDF and Iranian criteria, respectively) (26). The discrepancy among the present ATP III-defined prevalence of MetS and those of the above-mentioned authors can be attributed to the WC criterion used, since definition of visceral obesity in 2001 NCEP/ATP III criteria (WC≥102 for male and WC≥88 for females) was modified later, based on the 2000 WHO Asia Pacific Guidelines (WC≥90 for male and WC≥80 for females).

In 2017, a systematic review and meta-analysis on the prevalence of MetS among Iranian population revealed the overall weighted prevalence of 31% (95% CI: 28-35). Moreover, according to ATP III criteria, the most popular diagnostic criteria (27), total and gender-stratified prevalence of MetS in females and males were 29% (95% CI: 22-36), 37% (95% CI: 26-48) and 29% (95% CI: 23-36), respectively (28). Although it was anticipated that higher levels of knowledge and education of paramedical personnel about the risk factors of chronic diseases and their side effects would result in lower prevalence of the

syndrome, a similar value was observed in our study population (27.7% vs. 31%). Results from different Asian population-based studies, however, reported that the prevalence of MetS ranged from 10 to 35% (23,29-30).

Based on the diagnostic criteria, the highest prevalence of MetS among hospital staff was obtained via modified ATP III and Harmonized definitions. Following the modification of abdominal obesity indices of ATP III, variation of glycaemia index might be the only cause of probable minor difference of the definitions. The lowest prevalence was, however, obtained via the AACE criteria. This might be, at least partially, associated with the narrow spectrum for glycaemia, which included only pre-diabetic but not diabetic cases, while patients with DM are those with the majority of MetS risk factors. Furthermore, due to unspecified particular number of criteria for MetS diagnosis, the role of clinical judgments is highlighted (8).

Results of several studies have reported a higher prevalence of MetS based upon IDF criteria compared to others (7, 29, 31, 32). The reason for high prevalence of the MetS by the IDF criteria seemed to be due to lower WC cutoff points (31, 33, 34). Moreover, unlike others, central obesity was considered as the major cause of MetS in IDF definition (35). This might be at least partially due to the key roles of metabolically-active visceral fat in inflammatory responses (36). The MetS prevalence was significantly higher in men than women according to IDF definition. A higher rate of the MetS in males might be ascribed to increasing of abdominal obesity due to a lower physical activity in this sex group.

There are some limitations in the present study. There are a few more definitions of MetS including WHO and European Group for the Study of Insulin Resistance Definition (EGIR) definitions. It would be better to estimate the MetS prevalence with the mentioned definitions as well. The financial limitations of measuring urinary albumin excretion and plasma insulin level, however, prevented a more comprehensive result. Moreover, since there is no single universally accepted anatomic site for WC (37), the reported data might be influenced by the protocol applied for WC measurement.

It has been recently hypothesized that a low-grade chronic inflammation, through several inflammatory mediators, induces oxidative stress and insulin resistance, both in youths and adults with MetS (6, 38, 39). It is, therefore, suggested that inflammatory markers such as C-reactive protein should be evaluated as well. Finally, applying definitions with ethnicity-specific abdominal obesity cut-points is suggested by the present study to be utilized for diagnosis of the syndrome.

Conclusion

In general, since the ethnic-specific WC is the factor mostly considered in the definition, IDF, modified ATPIII, and Harmonized criteria can better diagnose the prevalence of MetS than others. Moreover, due to the direct association of MetS with different chronic diseases, awareness about the prevalence of the syndrome for applying preventive strategies in large scope is recommended.

Acknowledgment

Conflict of Interest

None declared.

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