Prevalence of Metabolic Syndrome in Saudi Population

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Abstract

Background and Objective: Metabolic syndrome (MetS) is a cluster of metabolic factors. The prevalence of MetS are increasing worldwide. The aim of this study was to determine the prevalence as well as the individual components of MetS in Saudi population.

Methods: We analyzed 2810 participants who are equal to or older than 18 years old. All cases were from the population of the primary health at King Fahad Armed Forces Hospital. All data were collected by personal interview and based on a review of electronic medical records. Physician and nurse interviewers measured and recorded weight (kg) and height (cm). Metabolic risk factors were defined using the 2006 International Diabetes Federation criteria that define elevated triglyceride (TG) as ≥150 mg/dL (≥1.7 mmol/L) and reduced HDL as <40 mg/dL (<1.03 mmol/L) for male and as <50 mg/dL (<1.29 mmol/L) for female. Hypertension (HTN) was defined when the systolic blood pressure was ≥130 mm Hg and/or diastolic blood pressure was ≥85 mm Hg in addition to receiving any medication for HTN. Abnormal glucose metabolism was considered when HbA1c (≥5.7) or when patients were known to have type 2 diabetes (T2DM). A combination of two or more of these risk factors was used to assess cutoff values for BMI. Body mass index (BMI) values classified as lean (BMI <18.5), normal weight (BMI=18.5-24.9 kg/m²), overweight (BMI=25.0-29.9 kg/m²), obese (BMI≥30 kg/m²). The total number of females were separated on basis of age values into 5 groups: <30 years, 30-39 years, 40-49 years, 50-59 years and ≥60 years.

Main results: Of the 2810 participants analyzed, 1060 (37.7%) were male and 1750 (62.3%) were female with female to male ratio 1.7:1. Age was 42.7±15.8 (minimum 18 years and maximum 105 years). MetS was present in 1815 cases (64.4%) where 692 cases (38.1%) were male and 1123 cases (61.9%) were female with female to male ratio 1.6:1, P=0.6. Males were significantly older than females in MetS patients (56.4±12.9 vs. 53.6±12.4 respectively, p<0.0001). BMI was significantly higher in females than males with MetS patients (33.0±7.2 vs. 30.1±5.0 respectively, p<0.0001). Female patients with metabolic syndrome were significantly younger; had higher except TG mean BMI and HbA1c>5.6 or Type 2 diabetes mellitus. Patients with T2DM or having HbA1c>5.6 were 3-fold to possess MetS (OR=3.3; 95% confidence interval [CI]=3.0, 3.8, or had been diagnosed with HTN (OR=2.1; 95% CI=2.0, 2.2), (p<0.0001), have low levels of HDL-cholesterol (OR=3.6; 95% CI=2.7, 4.9) and were also more likely to have elevated plasma triglyceride levels (OR=1.9; 95% CI=1.8, 2.0). MetS prevalence is consistently statistically significant with increasing age (p<0.0001). Moreover, the frequency of MetS is consistently statistically significant with increasing BMI (p<0.0001) and higher among older age group ≥60 years of age in all patients and both genders. Moreover, MetS prevalence was higher among BMI≥30 group in all patients and both genders. Thus, the mean of BMI among MetS is statistically significant correlated with increasing with advanced age, (r=-0.1, p<0.0001).

Conclusion: The prevalence of metabolic syndrome among Saudis is relatively high. Female gender, old age and obesity can be regarded as related factors.

Keywords: Metabolic syndrome; Prevalence

Abbreviations: HDL: High Density Lipoprotein; HTN: Hypertension; TG: Triglycerides; WHO: World Health Organization; NCEP: National Cholesterol Education Program; ATP III: Adult Treatment Panel III; IDF: International Diabetes Federation; CVD: Cardiovascular Disease; T2DM: Type 2 Diabetes Mellitus.
Introduction

Metabolic syndrome (MetS) is a cluster of metabolic factors. MetS was initially observed in 1923 by Kyln, who described the clustering of hypertension, hyperglycaemia and gout as the syndrome [1]. Subsequently, several other metabolic abnormalities have been associated with this syndrome, including obesity, microalbuminuria, and abnormalities in fibrinolysis and coagulation [2]. In 1988, Gerald Reaven reintroduced the concept of Syndrome X for the clustering of cardiovascular risk factors like hypertension (HTN), glucose intolerance, high triglycerides (TG) and low high density lipoprotein (HDL) concentration [3]. The first official definition of MetS put forward by a working group of the World Health Organization (WHO) in 1999, a number of different definitions have been proposed. 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), the International Diabetes Federation (IDF), and the World Health Organization (WHO). [4-9]. Risk factor clustering in the MetS cannot be explained by chance alone [10].

Therefore, the syndrome is widely accepted as an important risk factor for cardiovascular disease (CVD) morbidity and mortality and type 2 diabetes mellitus (T2DM) [4,11-14]. MetS increases the risk of developing T2DM by three to five-fold and CVD by two-fold, and it has become a major public health challenge around the world [7,15,16]. As the various abnormalities of MetS may be documented up to 10 years before the detection of T2DM or CVD, there is a potential to prevent both of them in persons identified with MetS [9]. The purpose of identifying people with the MetS is to reduce the long term risk of developing T2DM, CVD, other forms of atherosclerotic disease, chronic renal disease, obstructive sleep apnea, nonalcoholic fatty liver disease, and gout [17]. However, the estimated prevalence of MetS differs between various populations, because variations exist in the frequencies of metabolic risk components [18]. The MetS has gained a great interest worldwide because of its increasing prevalence [9].

MetS affects around 20%-25% of the world population and its prevalence has been globally increased, because of Westernization of lifestyle with less physical activity and increased obesity [16,19-21]. Al-Nozha and colleagues previously reported that MetS was almost 40% among adults in a kingdom-wide sample population taken from 1995-2000 [22]. Since then, other epidemiologic studies conducted within the Arab Peninsula confirmed the same high prevalence [23-25]. The prevalence of MetS varies widely between populations from 8% to 43% in men and from 7% to 56% in women around the world [19]. Genetic background, socioeconomic status, diet, and lifestyle influence the prevalence of the MetS and its components [19]. The differences in prevalence of MetS depend on population characteristics (such as ethnicity, age and sex), geographic location, and the criteria used for the definition [26-28]. Despite the prevalence of MetS is well known in various populations, there is no in-depth information available about the prevalence of MetS and the individual components within particular combined subgroups of sex, BMI and age. However, recent studies on the clustering of the metabolic risk factors in the form of MetS in Saudi population are limited. Therefore, the aim of this study was to determine the prevalence as well as the individual components of MetS in Saudi population.

Methods

We analyzed 2810 participants who are equal or older than 18 years old. All cases were from the population of the primary health at King Fahad Armed Forces Hospital. All data were collected by personal interview and on the basis of a review of electronic medical records. Physician and nurse interviewers measured and recorded weight (kg) and height (cm). Metabolic risk factors were defined using the 2006 IDF criteria that define elevated triglyceride as ≥150 mg/dL (≥1.7 mmol/L) and reduced HDL as <40 mg/dL (<1.03 mmol/L) for male and as <50 mg/dL (<1.29 mmol/L) for female [29]. HTN was defined when the systolic blood pressure was ≥130 mm Hg and/or diastolic blood pressure was ≥85 mm Hg in addition to receiving any medication for hypertension. Abnormal glucose metabolism was considered when HbA1c (≥5.7) or when patients were known to have type 2 diabetes. A combination of two or more of these risk factors was used to assess cutoff values for BMI. Body mass index (BMI) values classified into groups as lean (BMI<18.5), normal weight (BMI=18.5-24.9 kg/m²), overweight (BMI=25.0-29.9 kg/m²), obese (BMI≥30 kg/m²) [30]. The total number of females were separated on basis of age values into 5 groups: <30 years, 30-39 years, 40-49 years, 50-59 years and ≥60 years.

Statistical Analysis

Unpaired t-test analysis and Chi square (X²) test (categorical data comparison) were used between variables to estimate the significance of different between groups for demographic and clinical laboratory. The independent relationship between the stratified BMI and the odds ratio of having MetS were analysed using Chi square (X²). All statistical analyses were performed using SPSS Version 22.0. The difference between groups was considered significant when P<0.05.

Results

Of the 2810 participants analyzed, 1060 (37.7%) were male and 1750 (62.3%) were female with female to male ratio 1.7:1. Age was 42.7±15.8 (minimum 18 years and maximum 105 years), (Table 1). MetS was present in 1815 cases (64.4%) where 692 cases (38.1%) were male and 1123 cases (61.9%) were female with female to male ratio 1.6:1, P=0.6, (Table 2). Males were significantly older than females in MetS patients (56.4±12.9 vs. 53.6±12.4 respectively, p<0.0001). BMI was significantly higher in females than males with MetS patients (33.0±7.2 vs. 30.1±5.0 respectively, p<0.0001). Female patients with metabolic syndrome were significantly younger, had higher except TG mean BMI and HbA1c>5.6 or Type
2 diabetes mellitus (Table 3) shows patients with T2DM or having HbA1c>5.6 were 3-fold to possess MetS (OR=3.3; 95% confidence interval [CI]=3.0, 3.8, or had been diagnosed with HTN (OR=2.1; 95% CI=2.0, 2.2), (p<0.0001), have low levels of HDL-cholesterol (OR=3.6; 95% CI=2.7, 4.9) and were also more likely to have elevated plasma triglyceride levels (OR=1.9; 95% CI=1.8, 2.0). MetS prevalence is consistently statistically significant with increasing age (p<0.0001). Moreover, the frequency of MetS is consistently statistically significant with increasing BMI (p<0.0001) and higher among older age group ≥60 years of age in all patients and both genders, (Figure 1A & C). Moreover, MetS prevalence was higher among BMI≥30 group in all patients and both genders, (Figure 1B & D). Thus, the mean of BMI among MetS is statistically significant correlated with increasing with advanced age, (r=-0.1, p<0.0001).

Figure 1: Percentages of women with metabolic syndrome across different age groups (A) and in relation to gender (C) and body mass index ranges (B) and in relation to gender (D).
Table 1: Basic characteristics of the population under study (means ± SD or number (％)).

<table>
<thead>
<tr>
<th>Parameters</th>
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</tr>
</thead>
<tbody>
<tr>
<td>n (％)</td>
<td>2810</td>
</tr>
<tr>
<td>Age (years)</td>
<td>51.3 ± 15.6</td>
</tr>
<tr>
<td>Gender</td>
<td>Male</td>
</tr>
<tr>
<td></td>
<td>Female</td>
</tr>
<tr>
<td>Body mass index (kg/m²)</td>
<td>31.3 ± 6.7</td>
</tr>
<tr>
<td>HbA1c&gt;5.6 or Type 2 diabetes mellitus</td>
<td>1949 (69.4)</td>
</tr>
<tr>
<td>Hypertension</td>
<td>1131 (40.2)</td>
</tr>
<tr>
<td>Triglyceride (≥1.7 mmol/l)</td>
<td>964 (34.3)</td>
</tr>
<tr>
<td>High density lipoprotein (&lt;1.29 mmol/l)</td>
<td>1473 (52.4)</td>
</tr>
</tbody>
</table>

Table 2: Characteristics of the population with metabolic syndrome under study stratified by gender (means±SD or number (％)).

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Total</th>
<th>Gender</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>n (％)</td>
<td>1815 (64.6)</td>
<td>692 (38.1)</td>
<td>1123 (61.9)</td>
</tr>
<tr>
<td>Age (years)</td>
<td>54.7±12.6</td>
<td>56.4±2.9</td>
<td>53.6±2.4</td>
</tr>
<tr>
<td>Body mass index (kg/m²)</td>
<td>31.9 ± 6.6</td>
<td>30.1 ± 5.0</td>
<td>33.0 ± 7.2</td>
</tr>
<tr>
<td>HbA1c&gt;5.6 or Type 2 diabetes mellitus</td>
<td>1603 (88.3)</td>
<td>593 (85.7)</td>
<td>1010 (89.9)</td>
</tr>
<tr>
<td>Hypertension</td>
<td>1067 (58.8)</td>
<td>401 (57.9)</td>
<td>666 (59.3)</td>
</tr>
<tr>
<td>Triglyceride (≥1.7 mmol/l)</td>
<td>905 (49.9)</td>
<td>408 (59.0)</td>
<td>497 (44.3)</td>
</tr>
<tr>
<td>High density lipoprotein (&lt;1.29 mmol/l)</td>
<td>1272 (70.1)</td>
<td>468 (67.6)</td>
<td>804 (71.6)</td>
</tr>
</tbody>
</table>

Table 3: The risk of metabolic syndrome phenotype among metabolic syndrome.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Total</th>
<th>Gender</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>n (％)</td>
<td>1815 (64.6)</td>
<td>692 (38.1)</td>
<td>1123 (61.9)</td>
</tr>
<tr>
<td>Age (years)</td>
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<td>56.4±12.9</td>
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<td>Body mass index (kg/m²)</td>
<td>31.9 ± 6.6</td>
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<td>HbA1c&gt;5.6 or Type 2 diabetes mellitus</td>
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Discussion

Proper definition of the causes and risk factors of MetS is mandatory for prevention and/or treatment of MetS. In addition to the well-defined risk factors for MetS, there are diseases and conditions that lead to MetS secondarily (Table 4). Knowing these conditions and defining them as risk factors is of importance in the approach toward patients with MetS. In the present study, in which we aimed to determine the factors that would lead to secondary MetS, the characteristics of 2810 patients with MetS were evaluated. Considering the IDF criteria for MetS diagnosis, we showed that around 64.6 % of the cohort analyzed presented the syndrome, which was more prevalent in female’s individuals (61.9％, p=0.6). Noticeably higher than the estimated global prevalence, which is between 20 and 25% and finding is higher than other national and regional studies [6,22,24,25].
Table 4: Numbers (%) of metabolic syndrome according to HbA1c>5.6 or Type 2 diabetes mellitus, hypertension, Triglyceride (≥1.7 mmol/l) and High-density lipoprotein (<1.29 mmol/l) across different age groups.

<table>
<thead>
<tr>
<th>Age (years)</th>
<th>HbA1c&gt;5.6 or Type 2 diabetes mellitus</th>
<th>Hypertension</th>
<th>Triglyceride (≥1.7 mmol/l)</th>
<th>High density lipoprotein (&lt;1.29 mmol/l)</th>
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<tr>
<td></td>
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</tr>
<tr>
<td>&lt;30</td>
<td>33(76.7)</td>
<td>12(27.9)</td>
<td>22(51.2)</td>
<td>35(81.4)</td>
</tr>
<tr>
<td>30-39</td>
<td>122(73.5)</td>
<td>38(22.9)</td>
<td>109(65.7)</td>
<td>136(81.9)</td>
</tr>
<tr>
<td>40-49</td>
<td>328(83.7)</td>
<td>150(38.3)</td>
<td>200(51.0)</td>
<td>304(77.6)</td>
</tr>
<tr>
<td>50-59</td>
<td>525(90.8)</td>
<td>382(66.1)</td>
<td>278(48.1)</td>
<td>399(69.0)</td>
</tr>
<tr>
<td>≥60</td>
<td>595(93.6)</td>
<td>485(76.3)</td>
<td>296(46.5)</td>
<td>398(62.6)</td>
</tr>
<tr>
<td>Total</td>
<td>1603 (88.3)</td>
<td>1067 (58.8)</td>
<td>905 (49.9)</td>
<td>1272 (70.1)</td>
</tr>
<tr>
<td>P value</td>
<td>&lt;0.0001</td>
<td>&lt;0.0001</td>
<td>&lt;0.0001</td>
<td>&lt;0.0001</td>
</tr>
</tbody>
</table>

In Saudi Arabia, the prevalence of MetS was found to be 39.8% (34.4% in men and 29.2% in women) and 31.6% (45.0% in men and 35.4% in women), according to the NCEP ATP III and IDF criteria, respectively [31-38]. Another national study found the prevalence to be 39.3% in 2005, using the 2001 ATP III criteria [22]. In the Arab population, the prevalence of MetS also differs between countries. In Lebanon, the overall prevalence of MetS was 31.2% (38.6% in men and 25.8% in women); in Oman, the age-adjusted prevalence was 19.5% among men and 23.0% among women; in United Arab Emirates, the prevalence rate is over 40%; and in the West Bank, the age-adjusted prevalence of MetS was estimated at only 17% [31,39-41]. A study conducted in Baghdad in 2011 showed that the prevalence of metabolic syndrome in females was almost double that in males (34.8 versus 65.2%) [42]. An Indian study revealed that the prevalence of metabolic syndrome was 57.38% in females and 42.63% in males, whereas a study in Tunisia revealed that the prevalence was 45.5%, significantly higher among women [16,43].

This indicates that there might be some changes in the risk factors especially among females that can be explained by the fact that females, most of whom are housewives in our society, are more prone to obesity after child birth, besides, women transition from the premenopausal to the postmenopausal stage with substantial metabolic changes and estrogen deficiency might lead to an increased predisposition to metabolic syndrome. The difference in prevalence of MetS between men and women may be related to differences in body fat distribution: men have more visceral and hepatic fat, whereas women have more total body fat. Differences in distribution of fat with age (total fat and visceral fat) and the cardiometabolic effects of menopause may explain the diminished sex difference in MetS prevalence seen with older age [44,45]. In females, menopause and estrogen deficiency appears to be an independent predisposing factor for the development of most of the components of the MetS [46,47]. The current study showed that the prevalence of metabolic syndrome is significantly increasing with age. The age groups 50 to 59 and ≥60 years had the highest frequencies of metabolic syndrome that can be explained by the aging process.

Figure 2: Mean body mass index kg/m² in patients with metabolic syndrome across different age groups (A) stratified to gender and in relation to gender (B).
This is lower than a study done among US adults and showed that the prevalence increases from 11.5% vs. 18.3% among those 20 to 39 years of age to 35.0 vs. 46.7% among those 60 years or older (Figure 2), and this is also supported by a study in UAE that showed a positive association between the prevalence of metabolic syndrome and age [42,48]. Similar to other observations, we found that the prevalence of MetS increases with age, up to the seventh age decade, and in contrary to others, that it is higher in female than in male [49-53]. Data from NHANES III (1988–1994) showed, however, that prevalence of MetS in women exceeded that of men, when individuals older than 50 years of age were evaluated [53]. In some studies, prevalence estimates for MetS are found to plateau or drop off after the sixth or seventh age decade in both sexes or only in men [54-57]. This observation might be due to a survival effect or participation bias, as individuals prone to obesity-related morbidity and mortality have already died or decline to participate in a study [58]. The observed trend of increasing MetS prevalence with age can be explained by the large number of people developing metabolic complications by the time they are aged ≥60 years (i.e. more than 85% of the individuals have at least one metabolic risk factor).

Due to the age-related rises of blood pressure, obesity and glucose a more similar make-up of MetS was seen in the elderly, whereas in younger people, the MetS profile was more heterogeneous and differed more by sex. While it may also depend on the definition used for MetS even if the same definition was used, different trends were observed between countries [54,59]. This underpins the importance of estimating the country-specific prevalence of MetS. Obesity is an alarming public health challenge of the 21st century. MetS is one of the associated co-morbidities of obesity [60]. We also observed that MetS were more significant and frequent in individuals with higher BMI values, specifically in obese patients compared to those considered overweight. When analyzing the variables associated with insulin resistance, we found significant differences in female groups for all criteria. A higher percentage of females (89.99%), than males (85.7%), presented insulin resistance according to HbA1c>5.6 or T2DM values. HbA1c>5.6 or T2DM was the most frequent of the cardiometabolic parameters, followed by abnormal blood pressure, low HDL and high triglycerides levels.

This is in agreement with study from Iraq who showed diabetes mellitus followed by hypertriglyceridemia and hypertension; and disagrees with national study showed the most frequently observed component of metabolic syndrome was found to be low levels of HDL and the Indian study, which showed that the main component was hypertension (98.37%), followed by dyslipidemia (77.05%), hyperglycemia (75.41%), and obesity (59.02%) [16,38]. This disagreement might be due to differences in population characteristics or in the research methodology. When MetS were analyzed in groups stratified by gender, we observed an increased prevalence in females. Approximately 89.9% of females had HbA1c>5.6 or T2DM followed by low HDL levels 71.6% and 59.3% had increased HTN. In males, HbA1c>5.6 or T2DM was the most frequent (85.7%) altered cardiometabolic parameter, followed by low HDL levels (67.6%), and 59.0% had increased TG. In young female, we found that a large proportion had HbA1c>5.6 or T2DM, namely 77.4% vs. 75.0 for male respectively, below the age of 30 years. This finding may suggest that, across the entire lifespan, HbA1c>5.6 or T2DM has a greater relative importance in the development of MetS in female than in male. Regardless of gender, the obese group presented the highest degree of insulin resistance. We found that there is heterogeneity in the metabolic risk status of individuals with normal weight, overweight, or obesity. We observed in our hospital-based sample that 50% of men and women with normal weight who had MetS in consistency with others and modest numbers with obesity (30.5%) but without MetS. [61-68]. Hypertriglyceridemia was present in 49.9% of the sample; this is similar to a study that was carried out among Iraqi adult population (2003–2004), which revealed that the prevalence of hypertriglyceridemia was 41.6% [69]. Reports from neighboring Middle Eastern countries vary from 40.3% in Saudi Arabia to 35.3% in Lebanon, 30.4% in Turkey, and 20.7% in Oman. [70]. In the current study, 70.1% of the sample showed low HDL; this is higher than a study done in Iraq and showed a prevalence of 49.9 and is lower than that in Oman which showed a low HDL in 75.4% [31,42]. MetS is an asymptomatic, pathophysiological state characterized by obesity, insulin resistance, hypertension, dysglycemia, and dyslipidemia. The clinical utility of MetS has been criticized for quite some years [71,72]. Criticism is related to the predictive value of MetS for CVD. MetS is found to have no greater predictive value for CVD compared to the individual components [73]. Furthermore, all MetS components are weighted equally while it is clear that some risk factors are more important for risk prediction. Also, continuous variables are dichotomized and MetS is operationalized as a combination of three or more of the five components, which results in a loss of predictive power [74]. In the current ATPIII definition, only blood pressure and fasting glucose are used for targeted risk factor interventions in clinical practice. Though, interventions are seldom started at the levels proposed by the ATPIII [75].

**Strengths and Limitations**

One of the strength of our study, the large number of participants allowed us to explore trends within detailed clusters of sex, BMI and age, which has not been done before. Our results should be interpreted in light of the study's limitations. First, most of the patients enrolled were already on treatment for hypertension, diabetes and hypertriglyceridemia, which imposed some limitations on the study. We tried to overcome these by obtaining the necessary sample size and by using data documented before treatment. Finally, as this was a hospital-based, retrospective study, the findings do not represent the whole Saudi population or the local community. Further larger population-based studies are necessary to support our findings. Another limitation of the present study was having considered only overall obesity (assessed by BMI).
and not abdominal obesity (measured by waist circumference), which is known to bear a close relationship with the target diseases.

**Conclusion**

It can be concluded from this study that the prevalence of metabolic syndrome among Saudis is relatively high. Female gender, old age and obesity can be regarded as related factors.

**Acknowledgment**

We are grateful to the staffs from the Primary care department at King Fahad Armed Forces Hospital for their valuable contributions in data collection. The authors have no conflict of interest to disclose.

**References**

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