The metabolic syndrome: Prevalence, main characteristics and association with socio-economic status in adults living in Great Tunis

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Abstract

Aims. – This study aimed to determine the prevalence of the metabolic syndrome (MetS) and its association with socio-economic status in the population of Great Tunis.

Methods. – The study included 2712 subjects (1228 men and 1484 women), aged 35–70 years and living in the Great Tunis region, all of whom were recruited between March 2004 and June 2005. The sample was weighted by using the inverse of the response rate according to governorate, district and gender. The MetS was defined according to the National Cholesterol Education Program–Adult Treatment Panel III.

Results. – In the studied population, the overall prevalence of the MetS was 31.2%, and it was significantly more frequently seen in women than in men (37.3% vs 23.9%, respectively; \( P < 0.001 \)), as were abdominal obesity (69% vs 21.6%, respectively; \( P < 0.001 \)), high blood pressure (50.3% vs 43.1%, respectively; \( P < 0.001 \)) and low HDL cholesterol (40.6% vs 33.6%, respectively; \( P < 0.001 \)), the most common characteristics of the MetS. Also, the prevalence of the MetS increased with age in both genders, but more so in women. In those aged greater than 55 years, the prevalence of MetS was 56.7% in women and 30.7% in men. An inverse relationship was observed between level of education and prevalence of the MetS in women, with the highest prevalence being in illiterate women and the lowest in those who were university graduates.

Conclusion. – The prevalence of the MetS is markedly high within the population of Great Tunis and especially in women. As these findings predict future increases in cardiovascular disease in these populations, substantial efforts need to be made to fight against obesity and sedentary lifestyles to ameliorate the expected poor health outcomes.

Keywords: The metabolic syndrome; Abdominal obesity; Educational level

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Résumé

Le syndrome métabolique : prévalence, principaux traits et association avec le statut socio-économique dans la population adulte du Grand Tunis.

Objectif. – Cette étude avait pour objectif de déterminer la prévalence du syndrome métabolique et son association avec le niveau socio-économique dans une population résidant au grand Tunis.

Matériel et méthodes. – L'étude a porté sur 2712 individus (1228 hommes et 1484 femmes) âgés de 35 à 70 ans, résidant dans la région de Grand Tunis, recrutés entre mars 2004 et juin 2005. L’échantillon a été pondéré en utilisant l'inverse du taux de réponse selon le gouvernorat, le district et le sexe. Le syndrome métabolique a été défini selon les critères NCEP ATP III.

Résultats. – La prévalence du SM était de 31,2 %. Elle était significativement plus élevée chez les femmes que chez les hommes (37,3 % vs 23,9 %, \( P < 0,001 \)). L’obésité abdominale (69 % vs 21,6 %, \( P < 0,001 \)), l’hypertension artérielle (50,3 % vs 43,1 %, \( P < 0,001 \)) et le taux bas de HDL cholestérol (40,6 % vs 33,6 %, \( P < 0,001 \)) étaient les composantes du SM les plus fréquentes, particulièrement chez les femmes. La prévalence du SM augmentait avec l’âge dans les deux sexes, en particulier chez les femmes. Au-delà de 55 ans, la prévalence du SM était de 56,7 % chez les femmes et 30,7 % chez les hommes. Une relation inverse a été observée entre le niveau d’instruction et la prévalence du SM chez les femmes. La prévalence était plus élevée chez les femmes analphabètes et plus faible chez les femmes de niveau universitaire.

Mots clés : Syndrome métabolique ; Obésité abdominale ; Niveau d’instruction

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1. Introduction

The metabolic syndrome (MetS) refers to a cluster of metabolic abnormalities that includes centrally distributed obesity, hypertension, hyperglycaemia, elevated triglycerides and decreases in high-density lipoprotein cholesterol (HDL-C) [1,2]. The MetS promotes atherosclerosis, and increases the risk of developing diabetes [3] and cardiovascular disease (CVD) [4], as well as rates of mortality [5]. Due to changes in the social environment, behaviour and lifestyle, a growing number of people have been diagnosed with the MetS over the past two decades. Thus, the MetS has become a serious public-health problem [6].

As a result of economic growth and its associated sociodemographic changes, the burden of infectious diseases has diminished in Tunisia (North Africa). However, although the accompanying changes in lifestyle and diet have led to a longer life expectancy, they have also brought an increased risk of CVD and other chronic diseases [7]. So far, two studies have investigated the MetS in the Tunisian population [8,9], but both studies are now out of date and have important limitations. Recently, we demonstrated that some of the components of the MetS, such as abdominal obesity, hypertension (HTA) and hyperglycaemia, are particularly prevalent in the Great Tunis population [10]. The objective of the present report is to determine the prevalences of the MetS and its components by gender and age, according to the National Cholesterol Education Program–Adult Treatment Panel III (NCEP–ATPIII) definition. Another objective was to examine the association between the MetS and socio-economic status, as denoted by level of education.

2. Material and methods

2.1. Sampling

The Tunis Risk Factor of Atherosclerosis Study (TUNFAS) was a cross-sectional study based on a stratified, two-stage, clustered sample of households, as reported in the last population census of 2004. The study was conducted between 2004 and 2005 in the Great Tunis region, and targeted adults aged 35–70 years. Great Tunis, located in the northeast of Tunisia, includes four governorates—namely, Ben Arous, Tunis, Ariana and Manouba—with a total population of 2,251,000 inhabitants (including 980,000 adults). The sampling scheme was designed by the Tunisian National Institute of Statistics: stratification was according to the four governorates and urban/rural environments. For each stratum at the first sampling stage, primary sampling units (referred to as ‘census districts’) were selected according to a probability based on the census district’s size, resulting in 110 such districts in all. At the second stage, 20 households were randomly selected from each district, and all individuals aged 35–70 years were recruited into the sample. Those who had acute diseases and women who were pregnant were excluded. Response rates were 99.6%, 95.1% and 74.8% for households, women and men, respectively. A total of 2712 individuals (1228 men and 1484 women) were ultimately included in the study.

2.2. Data collection

Data were collected from the study subjects at home by a physician investigator, using a previously developed and validated questionnaire that included demographic, socio-economic and health characteristics. Participants were stratified by gender and age into eight strata (35–44, 45–54, 55–64 and >64 years), and all answered a detailed questionnaire containing information on their demographic characteristics, habits, and personal and familial medical history. Weight and height were also measured with the subjects barefoot and lightly clothed. Waist circumference was measured with the tape midway between the lowermost rib margin and the iliac crest. Blood pressure was recorded as the average of two measurements after subjects had been resting for 15 min. The protocol for the survey was approved by the ethics committee for human research of Rabta Hospital (Tunis, Tunisia), and all participants gave their informed consent.

Fasting venous blood samples were collected into heparin-containing and sodium-fluoride-containing tubes. These samples were centrifuged at 1500 × g for 20 min, and all analyses were carried out within 4 h. Glycaemia was measured using a glucose-oxidase method, and cholesterol and triglycerides were measured by enzymatic methods. All biochemical analyses were carried out using a Hitachi 912 analyzer (Roche). The MetS was defined according to the NCEP–ATPIII report [11]. Also, as recommended by the report, a cut-off point of 100 mg/dL was used for fasting plasma glucose, as recommended by the American Diabetes Association [12].

Participants who fulfilled three or more of the following criteria were defined as having the MetS:

- waist circumference exceeding 102 cm in men and exceeding 88 cm in women;
- blood pressure greater or equal to 130/85 mmHg;
- fasting plasma glucose greater or equal to 100 mg/dL (≥5.6 mmol/L);
- serum triglycerides greater or equal to 150 mg/dL (≥1.69 mmol/L);
- serum HDL-C < 40 mg/dL (<1.04 mmol/L) in men and less than 50 mg/dL (<1.29 mmol/L) in women.

Participants were also grouped, according to education level as an indicator for socio-economic status, into four cate-
Table 1
Clinical characteristics and levels of education in adults, aged 35–70 years, living in the Great Tunis region and stratified by gender (n = 2712).

<table>
<thead>
<tr>
<th>Level of education</th>
<th>Men (n = 1228)</th>
<th>Women (n = 1484)</th>
<th>P valuea</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>49.2 ± 9.2</td>
<td>47.3 ± 9.1</td>
<td>0.001</td>
</tr>
<tr>
<td>Body mass index (kg/m²)</td>
<td>26.4 ± 6.5</td>
<td>30.0 ± 6.2</td>
<td>0.001</td>
</tr>
<tr>
<td>Waist circumference (cm)</td>
<td>91.8 ± 12.1</td>
<td>94.4 ± 13.4</td>
<td>0.001</td>
</tr>
<tr>
<td>Systolic blood pressure (mmHg)</td>
<td>126.4 ± 16.7</td>
<td>128.4 ± 20.0</td>
<td>0.006</td>
</tr>
<tr>
<td>Diastolic blood pressure (mmHg)</td>
<td>75.9 ± 9.4</td>
<td>77.4 ± 11.1</td>
<td>0.001</td>
</tr>
<tr>
<td>Plasma glucose (mg/dL)</td>
<td>106 ± 46</td>
<td>104 ± 43</td>
<td>NS</td>
</tr>
<tr>
<td>Total cholesterol (mg/dL)</td>
<td>187 ± 31</td>
<td>195 ± 40</td>
<td>0.001</td>
</tr>
<tr>
<td>Triglycerides (mg/dL)</td>
<td>141 ± 95</td>
<td>124 ± 83</td>
<td>0.001</td>
</tr>
<tr>
<td>HDL cholesterol (mg/dL)</td>
<td>45 ± 11</td>
<td>54 ± 13</td>
<td>0.001</td>
</tr>
</tbody>
</table>

Values were expressed as means ± SD or percentages. NS, not significant.

a Comparison between genders.

Categories: level 0, illiterate; level 1, low-level education (≤ 7 years of schooling); level 2, medium-level education (7–13 years of schooling); and level 3, higher education (≥ 14 years of schooling).

2.3. Statistical analysis

The statistical analyses were performed using the SPSS version 11.5 software package. In all calculations, the sample was weighted using the inverse of the response rate according to governorate, district, and gender. The prevalence rates of the MetS and its components were computed according to gender, age and education level. All analyses were also performed separately by gender, and the data in all analyses were weighted to adjust for district, age and gender. The differences between groups were compared using t tests for continuous variables and chi-square tests for categorical ones. The statistical level of significance was established at 5%.

3. Results

The main clinical and biochemical characteristics of the study participants are presented in Table 1. According to education level, the proportion of illiterates was higher, and the proportion of those with a medium or high education lower, in women compared with men. The overall prevalence of the MetS was 31.2%, and was significantly higher in women than in men (37.3% vs 23.9%, respectively; P < 0.001). The main features of the MetS were abdominal obesity and hypertension, and nearly one out of every two subjects had either or both signs. The individual prevalence of each characteristic feature of the MetS by gender is shown in Table 2. Abdominal obesity, hypertension and low HDL-C were significantly more frequently seen in women, while hypertriglyceridaemia was more frequently seen in men. The prevalence of hyperglycaemia was similar in both women and men. As for the individual features of the MetS, 106 participants (4%) had all five traits, and more than half exhibited one or two traits, while less than 20% had no associated trait of the MetS (Fig. 1). Also, the prevalence of the MetS increased with age in both men and women up to age 64 years. In the age group 35–44 years, 16.3% of men and 23.2% of women had the MetS. In those exceeding 64 years, the prevalence was 30.7% and 56.7% for men and women, respectively (Fig. 2).

The prevalence of the MetS was inversely related to the level of education in women, but not in men. The rate of prevalence was highest in illiterate women and lowest in those who had graduated from university (Fig. 3). The age-adjusted MetS prevalences were 30.1%, 46.5%, 43.8% and 17.8% for illiterate, low-level education, medium-level education and higher education women, respectively.

Table 2
Prevalences of the metabolic syndrome (MetS) and its components, according to NCEP–ATPIII criteria among adults aged 35–70 years, living in the Great Tunis region and stratified by gender.

<table>
<thead>
<tr>
<th></th>
<th>All subjects [n (%)]</th>
<th>Men [n (%)]</th>
<th>Women [n (%)]</th>
<th>P valuea</th>
</tr>
</thead>
<tbody>
<tr>
<td>High blood pressure</td>
<td>1275 (47.1)</td>
<td>529 (43.1)</td>
<td>746 (50.3)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Hyperglycaemia</td>
<td>768 (28.5)</td>
<td>363 (29.8)</td>
<td>405 (27.5)</td>
<td>0.108</td>
</tr>
<tr>
<td>Hypertriglyceridaemia</td>
<td>764 (28.4)</td>
<td>380 (31.2)</td>
<td>384 (26.0)</td>
<td>0.002</td>
</tr>
<tr>
<td>Low HDL cholesterol</td>
<td>1007 (37.4)</td>
<td>409 (33.6)</td>
<td>598 (40.6)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Large waist circumference</td>
<td>1287 (47.6)</td>
<td>264 (21.6)</td>
<td>1023 (69.0)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>MetS</td>
<td>835 (31.2)</td>
<td>288 (23.9)</td>
<td>547 (37.3)</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

NCEP–ATPIII, National Cholesterol Education Program–Adult Treatment Panel III.

a Comparison between genders.
higher frequency of the MetS. The large waist circumferences in women may be explained by genetic and hormonal differences, the greater number of births, and the general lack of participation in physical and sports activities among adult Tunisian women [19].

The most common features of the MetS in our present population were abdominal obesity and hypertension. The prevalences of hyperglycaemia and hypertriglyceridaemia, although less common, were also high. Although the precise causes of the high prevalences of these traits have not been entirely elucidated, factors related to lifestyle, such as dietary habits and lack of physical activity, are incriminated [7,19]. In Tunisia, there has been a shift from traditional eating habits, with a diet rich in cereals, fruits and vegetables, to foods rich in animal products, with high amounts of saturated fat and hydrocarbons. In addition, over the past 20 years, the daily food intake has increased by an average of 140 calories per person, rising from 2294 kcal/day in 1975 to 2434 kcal/day in 1995 [20]. Furthermore, urbanisation has had negative consequences on various aspects of Tunisian life and, in particular, on physical activity. It has been reported that the regular practice of sports involves less than 10% of the adult population and the percentage is even smaller among women [7].

Level of education is considered a good indicator of socio-economic status, as it forms the basis of other indicators, such as income and social position, and it applies equally to women and men, does not usually change in adulthood, and shapes health and lifestyle behaviours through attitudes, values and knowledge [21]. Our present results show that lower levels of education are significantly associated with the MetS in women. These findings are in agreement with other studies involving different international populations [22–26]. Björntorp [27] argues that unfavourable socio-economic circumstances coupled with psychosocial stress can lead to a physiological ‘defeat’ reaction, thereby activating the hypothalamus–pituitary–adrenocortical axis, as indicated by increases in the major components of the MetS, such as the waist-to-hip ratio. Indeed, a previous study found a strong association between low socio-economic status and obesity in the population of Great Tunis [10], and both low socio-economic status and work stress are associated with an atherogenic lipid profile [24].

Human biological functioning is sensitive to a wide array of socially determined forces from the earliest moments of life. Women with less education experience a set of conditions over the course of life that, in combination with any background predisposing factors, increases the risk of the clustering of biological risk factors known as the MetS. In addition, there are two reasons that may explain why the MetS was related to education level in women, but not in men. First, women of higher socio-economic status are more aware of the importance of health and fitness and, therefore, tend to consume a healthy diet, and regularly practise sports and exercise. In contrast, men of higher socio-economic status lead a more sedentary lifestyle and have a greater opportunity to consume rich foods. Second, in Tunisia 50 years ago, women had less access to education and schooling than did men and, thus, older women had less opportunity to be educated. However, as the prevalence of the MetS increases

4. Discussion

According to the NCEP–ATPIII criteria, the prevalence of the MetS was high (31.2%) in this Tunisian population, especially in women vs men (37.3% vs 23.9%, respectively). Two previous studies in the Tunisian population reported MetS prevalences in the range of 15–25%. However, both these studies were carried out more than 10 years ago (in 1994 and in 1996). The survey by Harzallah et al. included only 863 subjects and, in the study by Bouguerra et al., the definition of the MetS did not correspond to NCEP criteria, as HDL-C was not determined in their study patients [8]. The present study’s prevalence is similar to those reported in other populations in the US (32.3%) [13], Oman (21%) [14], India (31.6%) [15] and Iran (33.1%) [16]. A higher rate of the MetS in women has also been reported in several previous studies [8,14,16–18]. In the present study, abdominal obesity was three times more frequent in women than in men (69% vs 21.6%, respectively) and explains their
with age, this factor may be influencing the relationship between the MetS and education level in women. It might be speculated that Tunisian women with lower education levels show a higher prevalence of the MetS because they are older. Indeed, after adjusting for age, the prevalence of the MetS dropped from 42.3% to 30.1% in illiterate women. Nevertheless, the inverse relationship between the MetS and level of education remained applicable to the other three education categories.

In conclusion, the prevalence of the MetS is high in the adult Tunisian population and especially in women, which is consistent with the greater number of women with abdominal obesity and hypertension. While the exact causes are not yet fully understood, lifestyle factors such as a high-calorie and high-fat diet, low levels of physical activity and low levels of education in women may explain part of the phenomenon. Also, because the MetS and its complications are hazardous to health and comprise a costly healthcare burden, the early identification and treatment of the MetS traits represent a major public-health challenge for the physicians and public-health systems that are now facing growing levels of obesity and sedentariness. The major causes of the MetS are unhealthy lifestyles and eating habits. Therefore, for the general population, the optimal approach towards decreasing the prevalence of this syndrome is through weight control, increased physical activity and higher intakes of HDL-raising nutrients.

Conflict of interest

None.

References