Prevalence of metabolic abnormalities in the Tunisian adults: a population based study


SUMMARY

Aims: To estimate the prevalence of individual metabolic abnormalities and the cluster of metabolic abnormalities in a representative sample of the Tunisian adult population and to identify their relationship with gender, age and residency. The definition used is an adaptation of the NCEP ATP III definition, using total cholesterol $\geq 5.2$ mmol/l instead of HDL-cholesterol.

Materials and methods: We used a sample of the Tunisian National Nutrition Survey (TNNS), a cross-sectional health survey conducted in 1996, to estimate the nutritional status of the population. The TNNS included 2927 adults aged 20 years or older who had measurements of height, body weight, waist circumference, blood pressure, fasting plasma glucose, total cholesterol and triglycerides. The cluster of metabolic abnormalities was defined as the presence of three or more metabolic abnormalities.

Results: The prevalence of abdominal obesity, hypertriglyceridemia, high total cholesterol, high blood pressure and high fasting plasma glucose was, respectively, 9%, 23%, 24%, 45% and 15% in men and 33%, 19%, 29%, 44% and 15% in women. The prevalence of the cluster was more frequent in women than in men (18% versus 13%, P<0.001) and in those living in urban communities (21% in women, 16% in men) rather than rural communities (11% in women, 8% in men) (P<0.001). The prevalence also increased significantly with age (P<0.001).

Conclusion: The cluster of metabolic abnormalities and its components are common in the Tunisian adult population and prevalence increases significantly with female sex, urban residency and age.

Key-words: Epidemiology · Tunisia · Prevalence · Metabolic abnormalities · Cluster of metabolic abnormalities · Urban residency.


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RESUMÉ

Prévalence des anomalies métaboliques chez l’adulte tunisien : étude en population

Objectif : Déterminer la prévalence des anomalies métaboliques et leur association en utilisant les critères de la NCEP ATP III modifiés (cholestérol total $\geq 5.2$ mmol/l à la place du HDL-cholestérol) dans un échantillon représentatif de la population adulte tunisienne et d’estimer leur relation avec le sexe, l’âge et le lieu de résidence.

Matériel et méthodes : L’Enquête Nationale de Nutrition est une étude transversale descriptive réalisée en 1996 pour estimer l’état nutritionnel des tunisiens. Elle a inclus 2927 adultes âgés de 20 ans et plus qui ont bénéficié de mesures anthropométriques, de dosage de la glycémie, du cholestérol total et des triglycérides. Le HDL-cholestérol n’a pas été dosé.

On a considéré l’association d’anomalies métaboliques quand une personne cumulait au moins trois anomalies parmi les cinq anomalies.

Résultats : La prévalence d’une obésité abdominale, de l’hypertriglycéridémie, d’un cholestérol élevé, de l’hypertension artérielle et de l’hyperglycémie est respectivement chez l’homme de 9%, 23%, 24%, 45%, 15% et chez la femme de 33%, 19%, 29%, 44%, 15%. La prévalence de l’association de trois anomalies métaboliques ou plus est significativement plus élevée chez la femme, 18% contre 13% chez l’homme (P<0.001) et augmente avec l’âge (P<0.001). Elle est aussi plus élevée en milieu urbain (21% chez la femme, 16% chez l’homme) qu’en milieu rural (11% chez la femme, 8% chez l’homme) (P<0.001).

Conclusion : Les anomalies métaboliques et leur association sont fréquentes dans la population tunisienne adulte. Leur prévalence augmente significativement avec le sexe féminin, l’âge et le milieu urbain.

Mots-clés : Épidémiologie · Tunisie · Prévalence · Anomalies métaboliques · Association d’anomalie métabolique · Milieu urbain.


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Introduction

The cluster of certain metabolic abnormalities has been recognized and described within single individuals along with its association with hyperinsulinemia or insulin resistance. The clinical importance of the metabolic syndrome is mainly due to the cluster of simultaneously occurring risk factors in the same individual [1-5]. The metabolic syndrome is thought to predict the future risk of all cause mortality and cardio-vascular disease and has been shown to be predictive of newly onset diabetes [6].

However, the definition of the metabolic syndrome has varied [5,7,8]. The World Health Organisation (WHO) initially suggested that the appropriate name should be “metabolic syndrome” and proposed a set of diagnosis criteria. A further set of criteria was later proposed by the experts of the National Cholesterol Education Programs Adult Treatment Panel III [9]. Estimates of the prevalence of the metabolic syndrome have varied because of the variability of evaluated populations and of diagnosis criteria [10]. In the US population aged over 20 years, the age-adjusted prevalence as defined by ATP III is reported to be 23.7%, with prevalence rates ranging from 4.5% to 35.3% in Europe [8,11,12]. Using the same definition the French DESIR study has reported that 10% of men and 7% of women had the metabolic syndrome [13]. Few studies have dealt with the prevalence the metabolic syndrome in the Arab countries [14,15].

The aims of the present study were to estimate the prevalence of the individual metabolic abnormalities and the prevalence of the cluster of metabolic abnormalities in the Tunisian adult population and to identify its relationship with gender, age and residency.

Materials and methods

The Tunisian National Nutrition Survey (T.N.N.S) was designed to give a national normative estimate of the health and nutritional status of the Tunisian population. It was a cross sectional health study providing a large, nationally representative sample of the Tunisian population and was conducted in 1996 and 1997. The sample of the survey was selected to be representative of the whole country. It was initiated by the National Institute of Statistics and all 23 regions of the country were sampled proportionally. It was a random sample stratified at two levels (by district and then by household), taken from the database of the population and lodging census carried out in 1994. At baseline, 1 800 households situated at 300 districts of 6 households each were included, giving a total of 7 860 subjects. The TNNS included 3 900 adults of 20 years or older for whom anthropometric measurements (body weight, height, waist circumference) blood measurements (fasting plasma glucose, total cholesterol, triglycerides) and blood pressure measurements were recorded. After an initial household census survey, all men, women and children in a given household were invited to take part in an examination which was held at community centres, primary health care centres and hospitals.

The mean response of the household survey was 96.4% (1 735 household responses from 1 800 households). 58.3% of the population studied resided in urban areas as defined by the National Institute of Statistics and this was in accord with the distribution of the whole population in Tunisia.

From the individual testing survey, the mean response rate was 75%. Higher response rates were observed in urban communities (76.9% compared to 72.3% in rural ones) and women (77.1% compared to 70.9% in men). The lowest response rate observed was among men living in rural areas (65.8%). To reduce the bias between the sexes caused by the variation in response rate we chose to analyse the results of the men and women separately.

Height was measured without shoes. Bodyweight was measured with the subject wearing only light underwear without shoes. Waist circumference was measured with a tape measure mid-way between the lower rib margin and the iliac crest.

Resting blood pressure was measured one time on the right arm after the patient had been seated for at least five minutes with an automatic oscillometric blood pressure recorder. Blood samples were collected after a 12-hour overnight fast. Fasting plasma glucose was determined by the glucose oxidase enzymatic method. Serum triglycerides were measured enzymatically after hydrolyzation of glycerol and total cholesterol was measured by the cholesterol oxidase enzymatic method. All biochemical analyses were done using a Beckman reagent Kit on a Beckman SYNCHRON CX7 analyser.

973 adults aged 20 years or older (592 women and 381 men) had missing parameters, such as missing anthropometrics measurements or blood studies. The TNNS therefore included 2 927 adults aged 20 years or older (1 995 women and 932 men) who had all the results of anthropometric measurements, blood pressure, waist circumference, fasting plasma glucose, total cholesterol and triglycerides.

A comparison of baseline characteristics of the responders (subjects who had all the results of parameters) and the non responders (subjects who had missing data) showed no difference for age (44.9±16.5 (m±sd) vs 45.1±16.2 years, P=0.71) while women and people living in urban areas were over-represented in the responders compared to the non responders (68.2% vs 60.8%, P<0.001, and 59.8% vs 53.9%, P<0.0001, respectively). Therefore, the results are reported separately by sex and by area of residence, and the data have then been standardized according to the 1994 Tunisian census data to calculate prevalence in the Tunisian population.

Definition of metabolic abnormalities

The N.C.E.P. (A.T.PIII) clinical definition of the metabolic syndrome requires the presence of 3 or more of the fol-
lowing abnormalities: waist circumference >102 cm in men and >88 cm in women, high fasting plasma glucose (≥26.1 mmol/l), high blood pressure (systolic ≥130 mm Hg or diastolic ≥85 mm Hg), high fasting serum triglycerides level (≥1.70 mmol/l) and low HDL-cholesterol level (<1.03 mmol/l for men and <1.29 mmol/l for women [9]). In the present study HDL-cholesterol was not determined because at the time of the survey the method of dosage was the precipitation method, which was known for its large variability, and serum was not kept to measure it. Since total blood cholesterol has been shown to be directly related to mortality from coronary heart disease, even in populations with low cholesterol concentrations [16,17], we used total cholesterol instead of HDL-cholesterol as reported by the study of Moroccan Sahraoui women [14]. The cut-off point used for total cholesterol was ≥5.2 mmol/l in men and women. The cluster of metabolic abnormalities was defined as a presence of at least three or more of the individual metabolic abnormalities. We counted only participants who reported currently using anti-hypertensive and/or diabetic medication as participants with high blood pressure or diabetes.

Statistical analysis

Statistical analysis was performed using the SPSS version 11.5 software package. We have used the chi-squared test with univariate and multivariate logistic regression analysis. We have computed the prevalence rates of each metabolic abnormality and of the cluster of metabolic abnormalities was evaluated using multivariate logistic regression analysis with univariate and multivariate logistic regression analysis. We have computed the prevalence rates of each metabolic abnormality and the standar dized prevalence according to age, sex and area of residence of the Tunisian population, using the 1994 Tunisian census data.

The predictive value of risk factors of the cluster of metabolic abnormalities was evaluated using multivariate logistic regression analysis that included gender, age and area of residency. Age was divided in two categories of less than forty years of age. Differences were considered as significant if P<0.05.

Results

Table I compares the means of various clinical and biochemical measurements between the rural and the urban communities. Fasting plasma glucose, total cholesterol and triglycerides were significantly higher in urban men and women than in their rural counterparts. Urban residents had significantly higher body mass index and waist circumference than rural residents.

The prevalence of the different individual metabolic abnormalities in men and women are presented in table II. The prevalence of abdominal obesity, hypertriglyceridemia, high total cholesterol, high blood pressure and high fasting plasma glucose was, respectively, 8.8%, 23%, 23.6%, 45.2% and 14.8% in men and 32.6%, 19.5%, 29.4%, 44.4% and 15.2% in women. Women had a significantly higher prevalence of large waist circumference (P<0.001) and hypercholesterolemia (P<0.001) whereas elevated triglyceride level was more prevalent in men than in women (P<0.005). In both sexes, the prevalence rates of most different metabolic abnormalities increased markedly with age.

Prevalence of the different metabolic abnormalities in the urban and rural communities is presented in table III. In both sexes, most of the components measured were
significantly more prevalent among urban populations than rural ones. In particular, women living in urban areas had a significantly higher prevalence of large waist circumference (40%) compared to women living in rural areas (19%).

The overall prevalence of the cluster of metabolic abnormalities was 16.3% with an overall age-standardized prevalence of 13.4%. The prevalence of the cluster was higher in women than in men (17.7% versus 13.2%, \( P = 0.002 \)). When the prevalence was standardized for age and rural/urban structure, the results were 15% in women and 9.8% in men. The prevalence of the cluster metabolic abnormalities increased with increasing age.

For the cluster of metabolic abnormalities, results of multivariate logistic regression are summarized in Table IV. In the overall adjusted model (which included gender, areas of residency, age) revealed that three independent significant factors were risk factors for the cluster of metabolic abnormalities: female sex, urban residency and people older than forty years.

### Discussion

#### Prevalence of the metabolic abnormalities

This study reports the prevalence of metabolic disorders in Tunisian adult population and highlights the fact that adult people who have a high prevalence of metabolic abnormalities also have a cluster of metabolic abnormalities. A much higher prevalence of abdominal obesity was observed in women compared to men and this is similar to findings from national surveys in other Arab countries [18]. For example, a study of Moroccan Sahraoui women suggested that the prevalence of central obesity was 75% and was the most common comorbid factor in patients with the metabolic syndrome [14]. In Oman, the prevalence of abdominal obesity was also significantly higher in women 44.3% than in men 4.7% [15]. Prevalence of obesity in Bahrain is high especially in women and diabetes was associated more strongly with abdominal obesity than with body mass index.

**Table II**

Prevalence* of individual metabolic abnormalities and the cluster of three or more metabolic abnormalities with age in Tunisian men and women.

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Large waist % (N=N)</th>
<th>High triglycerides % (N=N)</th>
<th>High total cholesterol % (N=N)</th>
<th>High blood pressure % (N=N)</th>
<th>Hyperglycaemia % (N=N)</th>
<th>The cluster of ≥3 metabolic abnormalities % (N=N)**</th>
</tr>
</thead>
<tbody>
<tr>
<td>Men:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>20-29</td>
<td>7.5 (175)</td>
<td>11.9 (183)</td>
<td>8.8 (183)</td>
<td>31.3 (201)</td>
<td>6.1 (188)</td>
<td>2.8 (152)</td>
</tr>
<tr>
<td>30-39</td>
<td>4.4 (176)</td>
<td>29.1 (236)</td>
<td>21.9 (236)</td>
<td>28.9 (261)</td>
<td>4.8 (252)</td>
<td>7.7 (157)</td>
</tr>
<tr>
<td>40-49</td>
<td>8.5 (230)</td>
<td>29.5 (249)</td>
<td>27.7 (262)</td>
<td>34.4 (283)</td>
<td>17.7 (271)</td>
<td>16.5 (193)</td>
</tr>
<tr>
<td>50-59</td>
<td>7.3 (157)</td>
<td>28.7 (156)</td>
<td>30.6 (156)</td>
<td>52.4 (175)</td>
<td>17.3 (169)</td>
<td>13.7 (127)</td>
</tr>
<tr>
<td>60-69</td>
<td>13.0 (214)</td>
<td>17.2 (200)</td>
<td>26.9 (202)</td>
<td>65.6 (227)</td>
<td>25.4 (218)</td>
<td>14.5 (180)</td>
</tr>
<tr>
<td>≥70</td>
<td>11.5 (148)</td>
<td>21.1 (135)</td>
<td>33.1 (136)</td>
<td>76.1 (155)</td>
<td>23.3 (149)</td>
<td>28.0 (123)</td>
</tr>
<tr>
<td>P value for trend</td>
<td>0.004</td>
<td>0.76</td>
<td>0.00001</td>
<td>0.00001</td>
<td>0.00001</td>
<td>0.00001</td>
</tr>
</tbody>
</table>

| Women:    |                     |                           |                               |                           |                       |                                               |
| 20-29     | 36.3 (556)          | 8.9 (556)                 | 14.2 (559)                    | 22.2 (614)                | 3.5 (590)             | 5.6 (477)                                      |
| 30-39     | 37.2 (609)          | 16.1 (612)                | 20.7 (813)                    | 29.5 (658)                | 7.3 (641)             | 7.7 (533)                                      |
| 40-49     | 27.6 (441)          | 21.3 (423)                | 25.8 (423)                    | 45.5 (471)                | 16.4 (462)            | 14.6 (366)                                     |
| 50-59     | 28.6 (289)          | 25.3 (295)                | 42.3 (296)                    | 63.1 (325)                | 24.1 (318)            | 28.2 (257)                                     |
| 60-69     | 27.9 (285)          | 31.2 (280)                | 52.9 (291)                    | 75.3 (321)                | 33.8 (308)            | 41.9 (243)                                     |
| ≥70       | 27.9 (153)          | 29.6 (138)                | 53.3 (138)                    | 82.5 (166)                | 28.1 (163)            | 39.5 (119)                                     |
| P value for trend | 0.007 | 0.00001 | 0.00001 | 0.00001 | 0.00001 | 0.00001 |

(N=): the number of people who had the determination of the measurement.
*Prevalence standardised for the urban/rural structure of the Tunisian population from census estimates 1994.
**The cluster of metabolic abnormalities was defined as a presence of at least three or more of the individual metabolic abnormalities and included total cholesterol instead of HDL cholesterol and only treated subjects for diabetes or hypertension were counted as having the corresponding abnormality.
Prevalence of metabolic abnormalities in the Tunisian adults: a population based study

In France, abdominal obesity was observed only in 7.9% of men and 13.3% of women [13]. A common metabolic abnormality is impaired fasting glucose in the metabolic syndrome. The association between elevated plasma glucose and coronary heart disease risk is a continuous variable [20]. The high prevalence of high fasting plasma glucose (15%) in our study is similar to those reported in Omani adults (18%) and in the Moroccan Sahraoui adult women (11.9%). The prevalence of hypertriglyceridemia in our study (20.7%) is comparable to those reported in Omani adults (20%), in Moroccan Sahraoui women (22.4%) and in the West Bank population (22%) [14,15,21]. It is interesting to note that there were considerably more Tunisian women (29.4%) having high total cholesterol levels than Moroccan Sahraoui women (11.6%) [14]. Hypercholesterolemia is prevalent in Europe, a large multinational survey demonstrated prevalence varying from 3% to 53% (total cholesterol ≥ 6.5 mmol/l) [22]. The proportion of adults with desirable levels of total cholesterol (<5.17 mmol/l) was 49% among U.S adults 20 years of age and older [23].

We found the overall prevalence of the cluster of three or more metabolic abnormalities, co-existing in the same individual, to be similar to reported rates in other Arab countries where studies have suggested a prevalence rate of 16% to 23%. Comparison of our data with other reports may be difficult because of different criteria used and different methods adopted. However, using the same diagnostic criteria as our survey, the overall observed prevalence of metabolic syndrome was 16.3% in a sample of 249 Moroccan Sahraoui women [14]. In Omani adults, using the ATP III definition, the age-adjusted prevalence was 19.5% among men and 23.0% among women [15]. The prevalence of the metabolic syndrome as defined by the WHO was 17% in the West Bank population [21]. Among Arab Americans, the prevalence of the metabolic syndrome as defined by the ATP III definition was 23% and was similar to the prevalence observed in the U.S population [24].

### Gender

Prevalence rates of the cluster of three or more of the individual metabolic abnormalities were significantly different between men and women with a higher relative risk in

| Table III |
| Prevalence of different metabolic abnormalities and the cluster of three or more metabolic abnormalities in rural and urban areas in Tunisian men and women. |

<table>
<thead>
<tr>
<th></th>
<th>Rural areas % (N=)</th>
<th>Urban areas % (N=)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Men:</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Large waist (&gt;102 cm)</td>
<td>3.1 (476)</td>
<td>12.3 (624)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>High triglycerides</td>
<td>18.7 (506)</td>
<td>25.9 (653)</td>
<td>0.001</td>
</tr>
<tr>
<td>High total cholesterol</td>
<td>14.9 (507)</td>
<td>29.4 (657)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>High blood pressure</td>
<td>43.3 (585)</td>
<td>46.4 (717)</td>
<td>0.53</td>
</tr>
<tr>
<td>Hyperglycaemia</td>
<td>10.5 (566)</td>
<td>17.8 (681)</td>
<td>&lt;0.0004</td>
</tr>
<tr>
<td><strong>The cluster of ≥3 metabolic abnormalities</strong></td>
<td>8.2 (389)</td>
<td>16.2 (543)</td>
<td>0.002</td>
</tr>
<tr>
<td><strong>Age standardised of the cluster of ≥3 metabolic abnormalities</strong></td>
<td>5.9 (389)</td>
<td>12.1 (543)</td>
<td>0.001</td>
</tr>
</tbody>
</table>

| **Women:**           |                   |                    |         |
| Large waist (>88 cm) | 19.0 (936)        | 40.0 (1397)        | <0.0001 |
| High triglycerides  | 14.9 (911)        | 22.1 (1403)        | <0.0001 |
| High total cholesterol| 21.9 (913)       | 33.6 (1407)        | <0.0001 |
| High blood pressure | 41.1 (1029)       | 46.3 (1526)        | 0.01    |
| Hyperglycaemia       | 11.5 (998)        | 17.3 (1484)        | 0.001   |
| **The cluster of ≥3 metabolic abnormalities** | 10.6 (787) | 21.5 (1208) | <0.0001 |
| **Age standardised of the cluster of ≥3 metabolic abnormalities** | 9.6 (787) | 18.8 (1208) | 0.001   |

(N=): the number of people who had the determination of the measurement.
*The cluster of metabolic abnormalities was defined as a presence of at least three or more of the individual metabolic abnormalities and included total cholesterol instead of HDL cholesterol and only treated subjects for diabetes or hypertension were counted as having the corresponding abnormality.
**Prevalence standardised for age and urban/rural structure of the Tunisian population from census estimates 1994.
adult population.

Area of residency

In contrast, a higher prevalence of metabolic syndrome has been reported in men than in women in Europe using WHO criteria (14% in men and 4% in women under 40 years of age) whereas the rates are similar in men and women in U.S.A [8,11]. Using the ATP III definition, the prevalence of abdominal obesity and hyperglycaemia. Global estimates predict that the ratio of people with diabetes in urban versus rural areas in the developing world will rise from 1.5 fold at present to more than 3 fold in 2025 [27,28]. Socio-economic and demographic changes have taken place in countries of the Eastern Mediterranean regions and in North Africa over the past decades. Considerable changes have occurred such as increasing urbanisation, improved life expectancy and reduced child mortality. The public health challenge in Arab countries now includes wide disparities between urban and rural areas of disease burden from non-communicable diseases [29].

Age

As expected, an increase of the prevalence of metabolic abnormalities with increasing age was observed; the prevalence rose significantly over the age of 40 years in our study, which is in accordance with previous studies [11,15,30].

Limitations of our study

Our study had several limitations, the principal limitation being our lack of the measurement of HDL-cholesterol as explained above. A second limitation is the poor response rate of men, a classic difficulty in large epidemiological surveys which explains most of the differences observed between the crude prevalence and the standardized ones. However, the overall response rate of the survey is high.

Conclusion

The prevalence of a cluster of metabolic abnormalities and its components is common in the Tunisian adult population and female sex, urban residency and increasing age are all independent risk factors.

The westernisation of lifestyle and increasing urbanisation of cities are factors that confront public health in developing countries [18]. Changing eating behaviour and the decrease of physical activity with the increasing urbanisation in many developing countries is leading to an increased prevalence of obesity, hypertension and diabetes [27,28]. Public health measures are required to reduce the increasing burden of metabolic abnormalities and other non-communicable diseases in developing nations such as ours [31].

References


