Metabolic syndrome: An emerging public health problem in Iranian Women: Isfahan Healthy Heart Program

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Abstract

Objectives: To determine the gender-specific prevalence of the metabolic syndrome (Met S) in a representative sample of Iranian adults, and to identify some possible related lifestyle factors.

Methods: As the baseline survey of a community-based interventional program entitled Isfahan Healthy Heart Program, we performed this cross-sectional study on 12,514 adults (≥19 years) living in urban and rural areas of 3 cities in Iran. We assessed the prevalence of the Met S (according to the ATP III criteria) as well as dietary intake (based on food frequency questionnaire) and physical activity habits of all of the participants. We also evaluated dietary intake at the micronutrient level by using a one-day food record in a sub-sample of 2000 participants.

Results: The age-adjusted prevalence of Met S was 23.3%, with a higher prevalence in women compared to men (35.1% vs. 10.7%, P<0.05) and in urban residents compared to rural residents (24.2% vs. 19.5%, P<0.05). In all age groups and in both urban and rural areas, the Met S affected a significantly larger number of women than men. Among women, abdominal obesity (71.7%) was more prevalent followed by low HDL-C (60.9%) and hypertriglyceridemia (56.6%), whereas among men, the most frequent components were hypertriglyceridemia (49.1%) and low HDL-C (35.1%), respectively. Abdominal obesity was nearly six times as prevalent in women as in men (71.7% vs. 12%, P<0.05) and had a significant association with metabolic disorders even after adjustment for age, sex and the living area. In general, dietary intake had no effect on the prevalence of Met S. The prevalence of Met S in subjects with a sedentary lifestyle was significantly higher than in active subjects of both genders (25.6% vs. 14.4%, respectively, P<0.05).

Conclusion: The Met S is highly prevalent in the Iranian population, notably in women living in urban areas. Abdominal obesity and dyslipidemia characterize this syndrome. Implementing community-based strategies for lifestyle change is of great significance.

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Keywords: Metabolic syndrome; Gender-specific prevalence; Lifestyle; Living area

1. Introduction

The term metabolic syndrome (Met S) refers to a clustering of risk factors; it is a key feature of the pathogenesis of type 2 diabetes and the progression of many degenerative processes including atherosclerosis. It is widely agreed that the Met S is a growing and pressing problem in developing countries. The prevalence of non-communicable

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diseases (NCDs), especially cardiovascular diseases (CVD) in both genders is escalating much more rapidly in developing countries than in industrialized countries [1].

The prevalence of NCDs may well vary in a single region, not to mention between different populations; we found this to be the case in the Eastern Mediterranean region (EMR) [2].

Although underlying genetic tendencies or early-life adverse events may contribute to insulin resistance, adverse body fat patterning (e.g. abdominal adiposity) and its related complications, lifestyle factors appear to play an important role in this regard [3].

It has been demonstrated that increased physical activity combined with dietary changes may prevent the progression of NCDs, hence there is a growing need for increased awareness and control of risk factors and their clustering. The dramatic global rise in obesity is the major driving force behind the increase in the prevalence of insulin resistance [4].

We conducted the present study in Iran to obtain gender-specific baseline data on NCD risk factors and their associated high-risk behaviors in urban and rural populations before implementing a comprehensive community-based interventional program for NCD prevention and health promotion. Gender-specific understanding of health behaviors is bound to help in more accurate planning of interventional strategies and activities.

2. Methods

We performed this cross-sectional study in 2000–2001 as the baseline survey of an integrated comprehensive community-based national program entitled “Isfahan Healthy Heart Program” (IHHP). This program is jointly conducted by Isfahan Cardiovascular Research Center (ICRC, a WHO Collaborating Center) and Isfahan Provincial Health Office, both affiliated to Isfahan University of Medical Sciences.

2.1. Study participants

We considered two provincial cities of Isfahan and Najaf-Abad with populations of 1,895,856 and 275,084, respectively, as venues of intervention. We considered Arak, a provincial city of 668,531, as the reference area. The populations of the three cities were studied for major NCD risk factors, as well as behaviors, attitudes, skills and knowledge (BASK). Meanwhile, we performed continuous surveillance of disease data registry (myocardial infarction, stroke, cancers, etc) in order to identify appropriate and feasible interventions to be scaled up to the national level. We have previously reported the details of the program elsewhere [5].

By conducting quota sampling, the study population was stratified by their living area (urban vs. rural) according to regional population distribution as per the national population census in 1999. The project team conducted this baseline survey of 12,514 randomly selected adults aged ≥ 19 years via 2-stage random cluster sampling. Initially, they randomly selected census blocks from each city and divided them into clusters, each with approximately 1000 households. They randomly selected approximately 5 to 10 of households within these clusters for enumeration. After enumeration, they randomly selected one of the eligible individuals aged ≥ 19 years per household, providing that he or she had Iranian nationality, was mentally competent and not pregnant. We calculated the sample size and divided it into different age groups (19–25, 25–34, 35–44, 45–54, 55–64 and ≥ 65 years) in both sexes according to the distribution in the community.

We doubled the total number owing to our use of the cluster method. Considering the missing rate, we calculated the total number of 12,600 for the 3 cities. The urban-to-rural ratio in Iran is approximately 68/32 , and in the cities of Isfahan, Najaf-Abad and Arak it was 90/10, 60/40 and 66/34, respectively. It should be mentioned that in Iran, all places with a population of at least 10,000 and having municipality are considered as urban area.

2.2. Data collection

After obtaining informed written consent from all participants at the clinic, our team conducted a structured interview using a standardized questionnaire to obtain information on demographic and socioeconomic aspects. A trained team of physicians performed physical examinations using standardized and zero-calibrated instruments. They measured blood pressure (BP) twice in a seated position and recorded the average of two readings for the first and

Table 1

Mean (±SEM) of the components of the metabolic syndrome by gender and living area: IHHP

<table>
<thead>
<tr>
<th>Components</th>
<th>Total Female</th>
<th>Total Male</th>
<th>Total Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td>Male</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Triglyceride (mmol/L)</td>
<td>1.9 ± 0.01</td>
<td>1.7 ± 0.02</td>
<td>1.8 ± 0.01</td>
</tr>
<tr>
<td>HDL-C (mmol/L)</td>
<td>1.2 ± 0.005</td>
<td>1.2 ± 0.007</td>
<td>1.2 ± 0.005</td>
</tr>
<tr>
<td>Fasting blood sugar (mmol/L)</td>
<td>4.6 ± 0.02</td>
<td>4.6 ± 0.03</td>
<td>4.6 ± 0.02</td>
</tr>
<tr>
<td>Systolic blood pressure (mmHg)</td>
<td>114.2 ± 0.3</td>
<td>116.8 ± 0.5</td>
<td>116.2 ± 0.4</td>
</tr>
<tr>
<td>Diastolic blood pressure (mmHg)</td>
<td>74.5 ± 0.2</td>
<td>77.4 ± 0.3</td>
<td>76.7 ± 0.2</td>
</tr>
<tr>
<td>Waist circumference (cm)</td>
<td>92.2 ± 0.1</td>
<td>86.2 ± 0.2</td>
<td>90.2 ± 0.2</td>
</tr>
</tbody>
</table>
fifth Korotkoff sounds as systolic and diastolic pressures, respectively. They measured height barefoot in standing position to the nearest 0.5 cm using a secured metal ruler, and measured weight in light clothing using calibrated scales. In addition, they measured waist circumference (WC) at a level midway between the lower rib margin and the iliac crest to the nearest 0.5 cm using a secured metal ruler, and measured blood pressure (BP) by two times of venous blood sampling (in fasting state and 2 h after drinking a glucose solution) in all participants other than the known cases of diabetes mellitus.

We defined the Met S and its components according to the Third Report of the Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel III, ATP III) [10]. The physical activity habits were assessed by using the Baecke questionnaire [12]. We considered an energy expenditure of 150 kcal for daily leisure time physical activity as cut-off for defining active and inactive lifestyle [13].

2.3. Statistical analysis

All collected data were stored in a computer database. A trained team checked the recorded information for missing data.

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Table 2
Prevalence (%) of different components of the metabolic syndrome among Iranian Adults aged ≥19 years according to gender and the living area in the interventional vs. reference communities: IHHP

<table>
<thead>
<tr>
<th>Component</th>
<th>Interventionsal community</th>
<th>Reference community</th>
<th>Total population</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Urban area</td>
<td>Rural area</td>
<td>Urban area</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>Male</td>
<td>Total</td>
</tr>
<tr>
<td>Abdominal obesity (cm)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(n=2463)</td>
<td>76.4</td>
<td>16.8</td>
<td>48.5</td>
</tr>
<tr>
<td>Hypertglycemia (mg/dL) (%)</td>
<td>45.5</td>
<td>52.5</td>
<td>48.9</td>
</tr>
<tr>
<td>Low HDL-C (%)</td>
<td>61.1</td>
<td>33.9</td>
<td>47.8</td>
</tr>
<tr>
<td>High blood pressure (%)</td>
<td>18.2</td>
<td>18.7</td>
<td>18.5</td>
</tr>
<tr>
<td>High fasting blood sugar (%)</td>
<td>6.5</td>
<td>5.9</td>
<td>6.2</td>
</tr>
</tbody>
</table>

1. Waist circumference >88 cm in females and >102 cm in males.
2. Triglycerides ≥1.65 mmol/L and or those under treatment.
3. HDL-C <1.04 mmol/L in men, and <1.3 mmol/L in women.
4. Systolic/diastolic blood pressure ≥130/80 mmHg and or those under treatment.
5. Fasting Blood Sugar ≥6.1 mmol/L and or those under treatment.
values and data entry errors. After data management, we performed the statistical analyses using the SPSS statistical package version 12.0 for Windows (SPSS Inc., Chicago, USA). All values were adjusted indirectly. The data are presented as frequencies, percentages and 95% confidence intervals. We compared the prevalence of the different components of the Met S by the chi-square ($\chi^2$) test. We used multiple logistic regression analysis for the association of abdominal obesity and dietary intakes with the Met S. Considering the missing values, we used the multiple imputation method to handle item non-response [14]. Multiple imputation was executed by IVEware software (developed by the Survey Methodology Program at the University of Michigan’s Survey Research Center, Institute for Social research) and SAS version 8.02. The significance level was set at $P<0.05$.

3. Results

Table 1 presents the mean (+SEM) values of different components of the Met S by gender and living area. The most prevalent component of the Met S was low HDL-C (48.9%), followed by hypertriglyceridemia (46.4%) and abdominal obesity (41.4%). Abdominal obesity in women and hypertriglyceridemia in men were the most frequent components of the Met S. Overall, abdominal obesity was nearly six times as prevalent in women as in men (Table 2).

As presented in Table 3, the age-adjusted prevalence of the Met S was 23.3% in the studied subjects, with a higher prevalence in women compared to men (35.1% vs. 10.7%, respectively, $P<0.05$), and in urban areas compared to rural areas (24.2% vs. 19.5%, respectively, $P<0.05$). The prevalence of the Met S increased with age until the age of 65. In addition, in all age groups and in both urban and rural residents, the Met S was significantly more prevalent in women than in men.

Abdominal obesity had a significant association with metabolic disorders even after adjustment for age, sex and living area (Table 4).

Other than the percentage of daily carbohydrate and protein intake in women which slightly increased the prevalence of the Met S, the macronutrients and the type of fatty acids consumed had no association with the prevalence of Met S (Table 5).

Total energy expenditure in women was lower than in men both in urban areas (76.7±0.7 vs. 118.9±0.9 kcal/Kg/day, respectively, $P<0.05$) and rural areas (76.8±1.2 vs. 129.6±1.6 kcal/Kg/day, respectively, $P<0.05$). Fig. 1 demonstrates the prevalence of the Met S in active and inactive individuals and shows a significantly higher prevalence of this syndrome in sedentary subjects of both genders (25.6% vs. 14.4%, respectively, $P<0.05$). This difference between the prevalence of the Met S in inactive and active women (25.6% vs. 14.4%, respectively, $P<0.05$) was higher than the difference between inactive and active men (11.2% vs. 9.5%, respectively, $P<0.05$).

Fig. 1. Prevalence of the metabolic syndrome in population with active lifestyle versus population with sedentary lifestyle. Odds Ratio (95% CI)= 0.59(0.5–0.71)($P<0.001$). [Female: 0.41(0.32–0.49); Male: 0.65 (0.52–0.76)].

4. Discussion

The findings of the present study, the first in its kind to be performed on a large representative sample of Iranian adults living in urban and rural areas, revealed a significantly high prevalence of the Met S. Noteworthy is that the high prevalence of the Met S in the present study was not primarily determined by high glucose as reported in some other studies [1], but rather by central obesity combined with dyslipidemia.

In the current study, the Met S affected 23.3% of the subjects including 35.1% of women and 10.7% of men. This prevalence rate approximates that of Western nations. The age-adjusted prevalence of the Met S in the National Health and Nutrition Examination Survey (NHANES III) in the US was 23.7%, which varied from 19.9 to 35.6% according to race and sex [15]. Pooled data from eight studies in Europe on subjects aged 40–55 years indicate that 7–36% of men and 5–22% of women met the WHO criteria for the Met S [16]. However, since the WHO criteria include the co-existence of impaired glucose tolerance with other components, comparison of this prevalence rate with those based on the ATP III criteria could not be precise.

The limited available data from Asia are in line with the findings of Western countries. South Asians are reported to have a more centralized distribution of body fat, with higher mean waist-to-hip ratios for a given level of BMI compared to Europeans [17].

In our study, the prevalence of Met S in women was significantly higher than in men. In a national survey performed in Korea, the age-adjusted prevalence of the Met S based on ATPIII guidelines was 6.8% (5.2% in males, 9% in females) [18].

The baseline survey of a recent cohort in Turkey, neighbor to Iran, showed that based on the ATPIII criteria, 32.2% of men and 45% of women had the Met S [19]. Consistent with this study, we found that the high prevalence of the Met S was primarily determined by central obesity combined with dyslipidemia (low HDL-C, high TG) and hypertension. The high prevalence of hypertriglyceridemia in our population, notably in women, might be due their sedentary lifestyle.

We suggest that the higher prevalence of the Met S in women in our study, as well as those in Turkey, compared to Western countries is because of an underlying ethnic predisposition that contribute to insulin resistance and adverse body fat patterning in non-European populations [20]. Our findings highlighted the very low levels of physical activity in women than in men. Physical activity is a complex behavior which consists of different components, including leisure time transportation, hours of work and household activities. Physical inactivity could well be a major contributor to unhealthy weight gain.

Middle-Eastern data in this field are very limited. In the study of Al-Lawati and colleagues in Oman, neighbor to Iran, the age-adjusted prevalence of the Met S was 19.5% in men and 23% in women. Its most common component (75.4%) in Omani adults was dyslipidemia followed by abdominal obesity with a markedly higher prevalence of abdominal obesity in women (44.3%) compared to men (4.7%) [21].

Most other surveys in this region were performed on urban samples and did not assess all the components of the Met S according to the ATPIII criteria. Our previous study in Iran found that nearly three-fourths of adults have at least one cardiovascular risk factor [22]. The only previous population-based study about the prevalence of the Met S in Iran was performed in an urban area of Tehran and found a prevalence of 30.7% with a higher prevalence in women than men [23]. Similar to our study, dyslipidemia and abdominal obesity were the most frequent components of this syndrome, the latter being nearly 6 times more prevalent in women as compared to men.

Little data exists on the Met S in rural areas. In our study, the Met S was more prevalent in urban areas than in rural areas. This finding is in line with recent national surveys in China and Greece showing a higher prevalence of the Met S in urban, compared to rural residents [24,25]. Contrary to these findings, a study in Turkey found a significant difference between women, but not men, living in urban and rural areas [26]. However, a recent review confirmed the high prevalence of the Met S in Asian Indians irrespective of their geographic locations [27].

Asians have a tendency to develop insulin resistance, but the etiology is still unknown and is suggested to be related to complex interactions between genetic, metabolic and environmental factors including diet and physical activity [28]. In the current study, only the higher percentage of daily carbohydrate and protein intake slightly increased the prevalence of the Met S in women.

In our previous work, although we found gender differences for the association of dietary habits with CVD, we suggested that ethnic differences might play a role since we did not find any association between dietary fat intake and the prevalence of CVD in Iranian women [29]. Consistent with the current study, the Framingham Offspring Cohorts did not show any association between dietary pattern and the Met S [30], while the study in Greece, showed a higher prevalence of the Met S in those subjects consuming saturated fats [25].

Previous studies demonstrated a strong inverse association between physical activity and Met S, notably in unfit individuals [31,32]. We found energy expenditure to be lower and the Met S to be considerably higher in women compared to men, in urban residents compared to rural residents, and in sedentary individuals compared to active individuals of both genders in urban and rural areas.

As the Middle-East has the highest dietary energy surplus of the developing countries, and in light of the epidemiologic transition, a rapid rise in NCD risk factors is occurring in this region [33].

Experiencing a transition from traditional to Western lifestyle, Iran has undergone a rapid nutritional shift [34].
Based on the extrapolation of our findings, we estimate that over 12 million out of approximately 50 million Iranian adults may currently have the Met S, and that the syndrome is significantly more prevalent in women. This illustrates the notion that environmental factors, especially a sedentary lifestyle can substantially impact on disease rates in women living in developing countries.

From a public health perspective, unhealthy life habits are the major causes of the Met S, thus the best approach to favorably modifying the syndrome in the general public, notably in those with an ethnic predisposition, is through lifestyle change.

4.1. Limitations of the study

Certain factors might have influenced the findings of the present study, such as the presumptions on the few missing data and the recall bias for the process of recalling and recording the daily food intake and the physical activity habits which requires attention and involves perception; however, the magnitude of these factors is estimated to be low, not acting systematically, and may have exerted rather a dilution bias. We should also acknowledge that the findings of the analysis of factors associated with the Met S should be interpreted with caution, given the cross-sectional nature of the associations. In addition, our data are collected from the central part of the country, and the data of other areas might have some differences with ours.

5. Conclusion

The Met S is highly prevalent in the Iranian population, especially in women. It is primarily characterized by abdominal obesity combined with dyslipidemia. In spite of a suggested ethnic predisposition to the Met S, as we found this syndrome to be more prevalent in women, urban residents and sedentary individuals, we propose the implementation of public health recommendations for lifestyle change in a bid to reduce the increasing prevalence of NCDs, especially in women.

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