Int Cardiovasc Res J.2015;**9**(2):94-99.

International Cardiovascular Research Journal
www.ircrj.com

The Prevalence of Metabolic Syndrome and Its Components among Adults in a Rural Community, Fars, Iran

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ARTICLE INFO

Article Type:
Research Article

Article History:
Received: 23 May 2014
Revised: 24 Sep 2014
Accepted: 19 Nov 2014

Keywords:
Metabolic Syndrome
Rural Population
HDL-C

ABSTRACT

Background: Metabolic Syndrome (MetS) is prevalent in Asian countries, but there is limited information about its distribution in rural communities.
Objectives: This study aimed to determine the prevalence of MetS and its components in a rural population in southern Iran.
Patients and Methods: This cross-sectional study was conducted on 13304 adults living in Kavar, southern Iran. The participants aged ≥ 20 years (67.4% female and 32.6% male) and were selected from a larger survey including 20000 subjects. MetS was diagnosed by the National Cholesterol Education program-Adult Treatment Panel III (ATP III) and its prevalence was compared to the rates estimated by modified ATPIII and International Diabetes Federation (IDF) definitions. The data were collected through a structured questionnaire. Anthropometric, clinical, and biochemical parameters including blood pressure, Body Mass Index (BMI), waist circumference, Fasting Plasma Glucose (FPG), and lipid profile were recorded. Then, the data were entered into the SPSS statistical software (v. 15) and analyzed using student's t-test, Chi-square test, and logistic regression analysis. P < 0.05 was considered as statistically significant.
Results: The prevalence of ATP III-defined-MetS was 25.1% compared to 27.7% and 28.3% using the modified ATP III and IDF definitions, respectively. Yet, the prevalence rate was higher among the females compared to the males by all the definitions (e.g. 28.4% in females and 18.9% in males by ATP III criteria, P < 0.001). Also, the prevalence of Mets increased with age (P < 0.001). The most and least common components were low serum High Density Lipoprotein Cholesterol (HDL-C) and impaired FPG, respectively.
Conclusions: MetS was prevalent in this rural area and dyslipidemia was its major component. These findings make it critical to plan further healthcare interventions in order to prevent the adverse consequences of the disease.

►*Implication for health policy/practice/research/medical education:*
The results of this study confirmed the high prevalence of MetS in rural as well as urban population, emphasizing the importance of early detection and control of its modifiable risk factors to prevent its adverse health consequences.

1. Background

Metabolic Syndrome (MetS) which is characterized by insulin resistance consists of several cardio metabolic risk factors, including dyslipidemia, hypertension, glucose intolerance, central obesity, and endothelial dysfunction. It has been estimated that one fourth of the adults around the world have this syndrome and many more are prone to it (1, 2). MetS has widely gained attention worldwide because of its association with increased risk of type 2 diabetes, atherosclerosis, and mortality. The risk of cardiovascular disease is approximately doubled compared to the risk in the absence of the syndrome and the individuals with MetS have a 30 - 40% probability of developing diabetes (3-5). The prevalence of MetS is increasing as a result of complex

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interactions of genetic, metabolic, and environmental risk factors, such as lifestyle and dietary changes, which have occurred with industrialization and urbanization (6-8).

From the first working definition by World Health Organization (WHO) in 1998 until now, several criteria have evolved in defining the syndrome. The National Cholesterol Education Program (NCEP) Adult treatment Panel III (ATP III) criteria in 2001 and the modified NCEP ATPIII definition in 2003 refocused on insulin resistance as the primary cause of MetS and its associated risk factors. In 2005, the International Diabetes Federation (IDF) provided a clinical definition to accommodate different diagnostic criteria and ethnic differences (9, 10). In general, many metabolic risk factors, such as obesity, diabetes, and hypertension, are commonly found in urban and rural populations, but it is not clear how different are their distribution in rural versus urban societies.

The third national health and nutrition examination (NHANES III) showed that according to ATP III and IDF definitions, the prevalence of MetS in the adult population of the United States (1999 - 2002) was 34.5% and 39%, respectively (9). However, the Bogalusa heart study conducted in the semirural community of New Orleans showed the overall occurrence of MetS to be 12.2% in young adults (14.9% in males and 10% in females) (11). Another study performed in a rural community in eastern Finland reported the prevalence rate of 38% (12). Yet, high prevalence rates of over 40% have been recorded from Portugal, Urban China, Brazil, India, and the United Arab Emirates. Meanwhile, low prevalence rates below 10% have been reported in Spain, Japan, and Hong Kong, which underscore international variations (13-16).

Overall, the prevalence rate of MetS is high among Asians and Middle Eastern countries are expected to show one of the world's greatest increases in the absolute burden of diabetes in the following decades (17). Unfortunately, in spite of its increasing prevalence, the general population has a low level of knowledge about MetS (12). Therefore, further epidemiological studies are necessary to provide adequate information regarding preventive interventions.

Previous studies in Iran reported high prevalence rates of MetS, but these studies were carried out mainly in urban populations (18-20) and no prior study in this regard has been performed in Shiraz, southern Iran.

2. Objectives

The present study was conducted in Kavar, an area with a rural structure in southern Iran, to find out the prevalence of MetS and its components using three sets of criteria.

3. Patients and Methods

This cross-sectional survey was performed on adults aged ≥ 20 years who lived in Kavar, a community with rural structure located 50 Km from Shiraz, southern Iran, in 2010. In order to determine the prevalence of MetS in this rural community, 16500 individuals whose data were available from a previous larger survey carried out on 20000 subjects were selected. The selected residents were invited through phone call or referring to their houses to participate in the study by a team of primary healthcare providers.

The second phase of our study was carried out in the healthcare center by a team composed of two trained physicians, two research nurses, and two laboratory technicians. Pregnant women and the subjects with significant renal and hepatic diseases or chronic inflammatory disorders, recent myocardial infarction, and cerebrovascular accidents were excluded from the study. The participants who were using antihypertensive, antilipid, and antidiabetic medications were considered as hypertensive, hyperlipidemic, and diabetic, respectively. The study protocol was approved by the Ethics Committee of Shiraz University of Medical Sciences.

After explaining the research objectives, written informed consents were obtained from all the participants. Out of the 16500 individuals who were invited, 396 ones were excluded due to having the exclusion criteria and 2800 ones refused to participate. Thus, the final sample included 13304 individuals with better participation rate among women than men in all age groups. The participants' demographic and lifestyle information and history of medications and chronic diseases were obtained by a pre-designed structured proforma and their anthropometric evaluation was performed by trained individuals.

Body weight was measured using a self-zeroing scale. Besides, waist circumference was measured while the subjects wore light clothes at a level midway between the lower rib margins and iliac crest in expiration. In addition, height was measured while the subjects were in upright position using a stadiometer. The height and weight values were rounded to the nearest 0.5 cm and 0.1 Kg, respectively. Body Mass Index (BMI) was calculated for each person as body weight in kilogram divided by height in meters squared.

Blood pressure was measured on the right arm while the subjects were seated after at least 10 minutes, using a standard mercury sphygmomanometer. The mean of two readings was computed and reported. It should be noted that blood samples for measurement of glucose and lipid profile were obtained after an overnight fasting.

Blood glucose level was measured by glucose dehydrogenase method (Biosystems S.A.costa Brava 3; Barcelona) and cholesterol and triglyceride (TG) levels were assessed using cholesterol oxidase/peroxidase and glycerol phosphate oxidase/peroxidase methods, respectively (Biosystems S.A. costa Brava 3; Barcelona). Besides, High Density Lipoprotein Cholesterol (HDL-C) was evaluated using direct enzymatic method (Biosystems S.A. costa Brava 3; Barcelona). All the measurements were performed in the same laboratory with an Autoanalyzer A25.

3.1. Definitions of Metabolic Syndrome

MetS was determined by the definition released by the National Cholesterol Education Program (NCEP) in 2001, Adult Treatment Panel III (ATP III), modified NCEP ATP III in 2003, and the International Diabetes Federation (IDF) criteria.

The 2001 ATP III definition requires the presence of three or more of the following five components: 1) waist circumference > 102 cm in men and > 88 cm in women, 2) TG ≥ 150 mg/dL or drug treatment for elevated TG, 3) HDL-C < 40 mg/dL in men and < 50 mg/dL in women or drug treatment for reduced HDL-C, 4) Blood pressure ≥ 130/85 mmHg or drug treatment for previously diagnosed hypertension, and 5) FPG ≥ 110 mg/dL or drug treatment for elevated glucose (21).

The modified ATP III definition (2005) requires the presence of all the components of ATP III, except for reducing the threshold for hyperglycemia (FPG ≥ 100 mg/dL) or drug treatment for elevated glucose (10).

The IDF definition requires central obesity (measured as ethnic–specific waist circumference for population of European origin ≥ 94 cm for men and ≥ 80 cm for women) plus any two other four components of the revised ATP III (9).

3.2. Statistical Analysis

All the statistical analyses were performed using the SPSS statistical software, version 15 (SPSS Inc, Chicago, IL, USA). Student's t-test was used to compare the subjects' physical and metabolic indices. In addition, logistic regression analysis was performed to determine the association between MetS and sex, age, marital status, and education level. Chi-square test was also used to compare the categorical variables. $P < 0.05$ was considered as statistically significant.

4. Results

This study was conducted on 13304 individuals (67.4% female, 32.6% male) living in a rural area in Fars province, southern Iran. The participants aged ≥ 20 years with the mean age of 40.99 ± 15.02 years. The prevalence of MetS was 25.1% (28.4% in women and 18.9% in men), 27.7%, and 28.3% using ATP III, modified ATP III, and IDF definitions, respectively.

The results of logistic regression analysis showed that after adjusting for sex, age, BMI, marital status, and education level, the prevalence of MetS was higher in females than in males ($P < 0.001$) by all sets of criteria and its prevalence increased with age ($P < 0.001$). The basic characteristics of the participants with and without MetS have been shown in Table 1.

In our study, the most common component of MetS was low serum HDL-C (56.8%), whereas impaired FPG was the least common one (11.9%) in both sexes (11.7% in females and 12.4% in males). The prevalence of MetS components based on different sets of criteria has been presented in Table 2.

Besides low HDL-C, two other most frequent components were abdominal obesity and hypertriglyceridemia in women and hypertension and high TG levels in men. Abdominal obesity was found in 6.5% of the male subjects.

According to ATP III criteria, 21% of the participants had no components of MetS, while 7.8% and 2.5% of them had four and five components, respectively. We also divided our participants into 6 categories based on age (20 - 29, 30 - 39, 40 - 49, 50 - 59, 60 - 69, and ≥ 70 years) and compared the prevalence rates of MetS and its components in different age groups. Our results showed that, by all the definitions, the prevalence of MetS increased with age ($P < 0.001$) and was higher in women than in men (Table 3).

According to the results, 32.8% of the population was overweight and 14.9% was obese. Additionally, the MetS group had a higher BMI. Moreover, we divided our participants into four categories according to their education levels (illiterate, primary school, diploma and A.D., and higher degrees) and into two categories by their marital status (single and married). The results indicated that MetS was positively related to the participants' marital status ($P < 0.001$), but inversely associated with their education level ($P < 0.001$) (Table 4).

5. Discussion

The findings of the present study showed that about one-fourth of the adults aged ≥ 20 years in this rural community suffered from MetS. Besides, the prevalence of this disorder

Table 1. Physical and Metabolic Characteristics of the Participants with and without Metabolic Syndrome

Variables	MetS Present, Mean (± SD) (N = 3346)	MetS absent, Mean (± SD) (N = 9958)	P value
Age (yr)	50.49 ± 13.43	37.89 ± 14.14	P < 0.001
BMI (kg/m^2)	28.69 ± 13.56	24.20 ± 9.07	P < 0.001
Waist Circum (cm)	94.50 ± 15.54	80.81 ± 11.68	P < 0.001
SBP (mmHg)	132.75 ± 35.45	114.43 ± 19.34	P < 0.001
DBP (mmHg)	84.02 ± 12.87	74.43 ± 11.35	P < 0.001
HDL-C (mg/dL)	44.05 ± 11.52	47.87 ± 12.09	P < 0.001
TG (mg//dL)	191.85 ± 120.76	106.36 ± 76.70	P < 0.001
Glucose (mg/dL)	102.57 ± 50.09	84.39 ± 25.11	P < 0.001

Abbreviations: BMI, body mass index; Circum, circumference; SBP, systolic blood pressure; DBP, diastolic blood pressure; HDL-C, high density lipoprotein cholesterol. The values are presented as mean ± SD.

Table 2. The Prevalence of Metabolic Syndrome Components Based on Different Sets of Criteria

Components of MetS	ATP III Definition	IDF or Modified ATP III Definitions
Abdominal obesity	27.4% (26.63 - 28.17)	49.2% (48.54 - 50.26)
Low HDL-C	56.8% (55.96 - 57.64)	56.8% (55.96 - 57.64)
Hyper TG	36.3% (35.49 - 37.11)	36.3% (35.49 - 37.11)
Hypertension	34.3% (33.49 - 35.11)	34.3% (33.49 - 35.11)
Impaired FPG	11.9% (11.35 - 12.45)	21.8% (21.10 - 22.50)

Abbreviations: TG, Triglyceride; FPG, fasting plasma glucose; HDL-C, high density lipoprotein cholesterol; Data are presented as percentage (95% CI)

Table 3. Adjusted Values for Odd Ratios and 95% Confidence Interval Using Regression Analysis Model for the Presence of Metabolic Syndrome in Age Categories by Three Sets of Definitions

Age (yr)	ATP-III Definition	Revised ATP-III Definition	IDF Definition
30 - 39	4.20 (3.51 - 5.02)	3.88 (3.30 - 4.57)	3.63 (3.12 - 4.22)
40 - 49	9.34 (7.86 - 11.10)	8.52 (7.28 - 9.98)	7.17 (6.18 - 8.31)
50 - 59	17.62 (14.75 - 21.05)	15.61 (13.25 - 18.40)	11.76 (10.07 - 13.73)
60 - 69	20.85 (17.08 - 25.44)	19.29 (15.99 - 23.28)	12.38 (10.34 - 14.83)
≥ 70	16.33 (13.22 - 20.17)	15.60 (12.78 - 19.05)	9.20 (7.43 - 10.96)

Data have been presented as OR, 95% CI; 20 - 29 years age group was the baseline category.

Table 4. Adjusted Values for Odd Ratios and 95% Confidence Interval Using Regression Analysis Model for the Presence of Metabolic Syndrome in Education Level and Marital Status Categories by Three Sets of Definitions

Marital Status	ATP III Definition	Modified ATP III	IDF Definition
Married	3.90 (3.20 - 4.76)	3.32 (2.77 - 3.96)	4.29 (3.55 - 5.17)
Education level			
Primary school	2.54 (2.09 - 3.09)	2.70 (2.22 - 3.28)	2.50 (2.04 - 3.6)
Diploma and associate	5.10 (3.98 - 6.40)	5.43 (4.25 - 6.89)	5.34 (4.14 - 6.89)
Bachelor or more	4.80 (3.30 - 6.99)	5.15 (3.61 - 7.40)	4.95 (3.34 - 7.29)

Data are OR, 95% CI; Single subjects were the baseline category; Illiterate subjects were the baseline category.

was higher in women and increased with age.

The most common abnormal metabolic risk factor by all definitions was low HDL-C in both sexes. Besides, the most frequent cluster of MetS components included low HDL-C, hypertension, and hypertriglyceridemia in men, but low HDL-C, abdominal obesity, and high TG level in women. This pattern was similar to most population-based surveys in Asia (19-22), but rather different from the western populations where abdominal obesity was the most common factor in both sexes (22). Silva et al. conducted a study in a rural Brazilian community and reported similar clusters of components to ours for males and females (8).

In a study in Oman, the prevalence of MetS was 21%, with low HDL-C (75.4%) and increased waist circumference being the most frequent components (23). Another study in Thailand also compared the prevalence of MetS and its components in rural and urban areas and showed a higher prevalence rate of MetS in women which was higher in rural women. In that study, similar to ours, the most common abnormal metabolic risk factor in females was dyslipidemia (low HDL-C and hypertriglyceridemia) (24).

Delavari et al. conducted a study to compare the prevalence of MetS in urban and rural populations of all the 30 provinces of Iran. According to the results, the prevalence of MetS by ATP III, IDF, and modified ATP III definitions was respectively 42.1%, 28.1%, and 43% in urban areas and 30.9%, 49.5%, and 33.8% in rural populations. Besides, the most common component of MetS by all sets of criteria was low HDL-C found in 80% of the population (19).

Consistent with our results, low HDL-C was found to be the most frequent metabolic risk factor in many previous studies in Asian countries (18-20, 24, 25). This supports an ethnic predisposition to this type of dyslipidemia and its association with hypertriglyceridemia in the majority of surveys, especially in rural communities, may be explained by different dietary patterns where people consume higher proportions of carbohydrates. Concerning women, the high prevalence of dyslipidemia (low HDL-C and high TG) might be partly attributed to obesity.

The higher prevalence of MetS among women in the present study was in line with many prior studies (15, 24, 26-29), emphasizing the necessity to pay more attention to this part of the community as a group contributing greatly to societies' dietary and healthy lifestyle behaviors. However, a few reports from Turkey and Africa have shown no gender differences in the prevalence of MetS (25, 30, 31).

Several studies, similar to ours, have reported increased prevalence of MetS with aging which can be explained by decrease in physical activity and increase in every component of MetS by advancing age (12, 15, 18, 19, 24-26).

The findings of the current research revealed an inverse relationship between MetS and education level, which was consistent with other reports, such as those performed in the United State, China, Thailand, and Finland (12, 22, 24, 30). Australian researchers also reported that educational barriers compromised prevention of diabetes in rural communities (32). Therefore, more attention should be paid to this barrier which can compromise preventive measures, especially in rural communities. Additionally, it must be emphasized that promotion of health literacy from childhood leads to lifelong healthy behaviors. On the other hand, MetS does not have any symptoms and can be prevented by making changes in lifestyle with regular exercise, following a healthy diet, losing weight, quitting smoking, and medical therapy if necessary. However, the SHIELD population study (study to help improve early evaluation and management of risk factors leading to diabetes) demonstrated that the individuals who were most at risk of MetS were not concerned about their diet and fitness (32). In this regard, Orchard TJ et al. conducted a study in a group of participants with impaired glucose tolerance in 2005 and showed how appropriate lifestyle changes could prevent MetS. After three years, the subjects in the lifestyle group were 41% less likely to have MetS compared to those who underwent no treatment. In addition, the lifestyle changes were about twice as effective as using Metformin (33).

In the current study, the causal relationship between the independent risk factors and development of MetS could not be determined because of its cross-sectional design. Also, detailed information about the participants' dietary pattern was not available and the participation rate was lower among men. Yet, the main strength of this study was its wide coverage of a single community and its large sample size.

The high prevalence of MetS in this study also confirmed that it affects rural as well as urban populations. Therefore, it is important to orient the health systems toward recognizing the health views behind MetS and to empower them for prevention and early control of its modifiable risk factors.

Acknowledgements

This study was extracted from a research proposal (No. 87-4010) approved by the Research Vice-Chancellor of Shiraz University of Medical Sciences. The authors would like to thank all the colleagues working on the project, especially staff of the Endocrinology and Metabolism Research Center of Shiraz University of Medical Sciences, for their cooperation.

Authors' Contribution

Fariba Karimi: Collection and analysis of data, preparation and writing of the article. Driush Jahandideh: Data collection. Mohammadhossein Dabbaghmanesh: Preparation of the proposal and data collection. Mohammadreza Fattahi: Preparation of the proposal and data collection. Gholamhossein Ranjbar Omrani: Final revision of the article.

Financial disclosure

The authors declare that there is no competing financial or other conflict of interests that could be perceived as prejudicing the impartiality of the research reported.

Funding/Support

This study was funded by Shiraz University of Medical Sciences.

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