Original Article

Metabolic syndrome: Risk factors among adults in Kingdom of Saudi Arabia

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ABSTRACT

Background: Metabolic syndrome (MetS) is a cluster of established cardiovascular risk factors that collectively increase predisposition to major chronic diseases, including heart diseases and diabetes mellitus. Citizens of developing countries such as Saudi Arabia are at risk for MetS as a result of industrialization and accessibility to fast foods. In this epidemiologic study, the kingdom-wide prevalence of MetS is determined. **Materials and Methods:** A total of 4578 Saudis aged 15-64 was randomly selected from 20 regions in Saudi Arabia. Anthropometrics were collected, and fasting blood samples collected to ascertain fasting blood glucose and lipid profile. Components of full MetS as defined by the International Diabetes Federation were used for screening. **Results:** The overall prevalence of MetS is 28.3%. Prevalence was significantly higher in males than in females (31.4 vs. 25.2%; $P = 0.001$). Prevalence of MetS was the highest in the northern and central region, and showed a parallel increase with age, and inversely with educational status. Region was also a significant contributor to MetS. Conclusion: Despite accumulating evidence of an epidemic, MetS remains largely unresolved in the kingdom. Aggressive public campaign should be launched, and policies implemented to control any future damage of MetS in the kingdom.

Key words: Diabetes mellitus, metabolic syndrome, Saudi Arabia

INTRODUCTION

Metabolic syndrome (MetS) is a cluster of cardiometabolic risk factors that include hyperglycemia, hypertension, obesity and dyslipidemia that increase the risk of diabetes mellitus type II and cardiovascular diseases (CVD).[1,2] The prevalence of MetS in the of Kingdom of Saudi Arabia (KSA) and other countries in the region ranges from 18% to about 40% depending on the definition used, population studied and other sociodemographic characteristics.[3-13] In Saudi Arabia, economic and social transformations have brought about a change in a sedentary lifestyle resulting in increasing prevalence of obesity, and an estimated expected rise of MetS. There are serious implications of this trend on morbidity, mortality and health services expenditure. This study attempts to assess the prevalence of MetS in Saudi adults in the whole country and identify significant risk factors and predictors. The information thus generated will be helpful in making suggestions for the implementation of interventions to prevent, make an early diagnosis and control the problem.

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MATERIALS AND METHODS

This was a cross-sectional, community-based study that covered the entire population of KSA in 2005. The WHO STEP wise approach to surveillance (STEPS) of noncommunicable diseases (NCD) risk factors was the basis of the conduct of the survey and collection of the data.[14,15] The STEPS approach focuses on obtaining core data on the established risk factors that determine the major disease burden. It is sufficiently flexible to allow each country to expand on the core variables and risk factors, and incorporate optional modules-related to local or regional interests. The STEPS instrument covers three different levels of "steps" of risk factor assessment. They are:

- Questionnaire
- Physical measurements
- Biochemical measurements.

All Saudis aged 15-64 years from all the 20 health regions of the country made up the study population. A multistage stratified cluster random sampling technique was used to recruit the subjects. Stratification was based on age (five 10-year age groups) and gender (male/female, two groups). All health regions of the country (20 regions) were covered. Based upon the proposed methodology of the WHO STEP wise approach, a sample size of 196 was calculated for each of these categories. A list of all primary health care centers (PHCCs) in each region was prepared; 10% of these PHCCs were randomly chosen and allocated a regional sample proportionate to the size of their catchment population in the sampled PHCCs. To identify the households, a map of the health center coverage area was used to select the houses. Each house was assigned a number, and a simple random draw was made.

Data were collected using the WHO STEP wise approach, a tool used for epidemiologic studies to measure NCD in WHO-member countries.[14,15] It covers three levels of risk factor assessment (steps) which include a questionnaire, physical (anthropometric) and biochemical measurements including fasting serum glucose, lipid profile (triglycerides [TGs], total, [high-density lipoprotein-cholesterol] HDL-C and [low-density lipoprotein-cholesterol] LDL-C), chronic diseases (noncommunicable e.g. hypertension, dyslipidemia, diabetes mellitus, etc.), and risk factors (e.g., obesity, smoking, physical activity, diet). The questionnaire was translated into Arabic by a team of physicians and then translated back to ensure its accuracy. The Arabic instrument was pretested and corrected before being tested on 51 eligible respondents to check the wording and the clarity of the questions. Necessary adjustments were made to the instrument in the light of the pretest. Data was collected by 54 male and 54 female data collectors working in teams. Each field team was made up of four persons: A male data collector, a female data collector, a driver, and a female assistant. The data collection teams were supervised by a hierarchy of a local supervisor, regional coordinators, and national coordinator.

All individuals involved in data collection attended a comprehensive training workshop of interview techniques, data collection tools, practical applications, and field guidelines.

Blood (5 ml) was collected, from the participants in the morning after an overnight fast. Sodium heparin was used as an anticoagulant, and the samples were centrifuged at 3,000 × *g* for 15 min at 20°C to separate plasma. Aliquots were prepared for storage (−20°C or − 80°C) until further analysis. Total cholesterol (TC), TGs, and glucose were measured with commercially available enzymatic colorimetric kits from QCA (Amposta, Spain). Seriscann normal (ref 994148) (QCA, Amposta, Spain) was used for quality control. Serum HDL-C levels were analyzed by an enzymatic method after precipitating serum reagents with phosphotungstic acid and magnesium. LDL-C was calculated according to the friedewald formula (LDL-C = TC − HDL − [TG/5]).

Height, weight, and waist and hip circumferences were measured using standard instruments, according to the STEP wise approach.[14,15] Body weight and height were measured without shoes, using electronic measuring scale. Body mass index (BMI) was calculated as weight in kilogram divided by height in m^2. Waist circumference (WC) was measured, in cm, midway between the lower costal margin and iliac crest during the end-expiratory phase.

For the definition of MetS, the International Diabetes Federation (IDF) for MetS was used in this study as follows:[16]

Central obesity (defined as WC ≥ 94 cm for Europid men and ≥ 80 cm for Europid women, with ethnicity specific values for other groups).

Plus any two of the following four factors:

- Raised TG level: ≥150 mg/dL (1.7 mmol/L),
- Reduced HDL-C: <40 mg/dL (1.03 mmol/L*) in males and <50 mg/dL (1.29 mmol/L*) in females
- Raised blood pressure (BP): Systolic BP ≥ 130 or diastolic BP ≥85 mm Hg
- Raised fasting plasma glucose ≥100 mg/dL (5.6 mmol/L).

The case definition of MetS was generated using statistical analysis system statistical package.

Questionnaires collected from the field were reviewed by the team leaders assigned to each team before submission to headquarters for data entry. A double entry of the questionnaires was done using Epi-Info 2000 software and EpiData software developed by the Menzes center for validation. After entry, the data, was cleaned. New variables were defined by adopting the standard STEPS variables (STEPS data management manual, draft version v1.5, October 2003). The statistical analysis was done using SPSS for Windows, version 17.0 (Chicago, IL, USA). The data were given as mean and standard deviation for continuous variables and as frequencies (percentages) for categorical variables. Association between categorical variables was assessed using a Chi-square test. Univariate regression analysis was used with Mets as the dependent variable and the associated risk factors as independent variables. The level of significance was set at <0.05 throughout the study. Total counts may vary because of missing data from certain variables.

The protocol and the survey instrument were approved by the ministry of health, center of biomedical ethics, and the appropriate authorities in KSA. Informed consent of all subjects was obtained. Participants were assured of confidentiality of data, and that they would be used only for the stated purpose of the survey. The survey was conducted in 2005 and the final report archived without any intension of publishing the results. At the beginning of 2013, however, the principal investigators (authors) of the study decided to have the results published to serve as baseline data for comparison with future studies. None of the contents of this 2005 survey had been published previously.

RESULTS

Of the 4758 subjects in the study, 4406 (92.6%) were included in the final statistical analysis as there were major deficiencies in the remaining records. Females constituted just above half (50.9%); about two-thirds of the subjects were in the age group 24-55 years, with less than secondary school education and an income of 3000 Saudi Riyals (SR) or more (1 SR = 3.75 US$). The prevalence of MetS was 28.3% (1245 cases out of 4406 subjects). Table 1 shows the distribution of MetS cases according to subjects' sociodemographic characteristics. MetS was significantly higher in males, subjects of advancing age, the less educated, house-keepers and in northern and central regions of the country. MetS was significantly associated with those who had been smokers, had lower levels of physical activity at work, transport and recreation. It was more among subjects who consumed more fruits, but was not related to vegetable consumption.

Table 2 shows the univariate regression analyses between certain habits and the risk of MetS. Those who were more physically active (answered "no" in sedentary activity) (odds ratio [OR] 0.77 [confidence interval (CI) 0.65–91]), did not use any means of transportation (OR 0.73 [CI 0.54-0.84]) did not engage in social (recreational) activities (OR 0.72 [0.58-0.90]) had decreased risk of MetS than those who were less active, used transportation and participated in social activities (*P* values 0.002, 0.001, and 0.002, respectively). Subjects who had never smoked were also at increased risk for MetS (OR 1.34 [1.11-1.962]). Consequently, subjects who consumed more than 5 servings of fruits/day had less risk for Mets than those who ate less ($P = 0.002$). This observation was not true for those subjects who consumed more than 5 servings of vegetables/day.

Table 3 shows selected demographic variables and risk for MetS. Being female, older, living in urban area, earning <SAR 7000 and being illiterate, were considered as significant risk factors for MetS.

DISCUSSION

This study revealed that the prevalence of (MetS) in Saudi adults is more than 28% which is comparable to other national, regional and international studies.[3-13] This prevalence is lower than the previously adjusted prevalence reported by a community-based study of adults aged 18-55 years of age which using ATP III criteria gave a prevalence of 37%. The different age groups and definitions used may partly explain the differences in the prevalence. MetS affects approximately one-quarter of adults in many developed countries.[17,18] It represents a group of risk factors that are linked to the accelerated development of atherosclerosis and CVD. Though the exact pathogenesis is not known many risk factors have been identified.[19] The significant risk factors identified by our study included males, increasing age, lower education, higher income, smokers and housekeepers. The prevalence of MetS was higher with age and male gender, which was consistent with other studies.[4,20-22] Poor lifestyle practices were significantly associated with MetS in this study, which was again in accord with many studies.[23-27] Physical inactivity is strongly and inversely associated with MetS, which reduces with weight loss and regular physical activity.[23,24] MetS Bhas has been significantly associated with smoking in some studies. In agreement with our study, exposure to tobacco has been implicated in the pathogenesis of insulin resistance,[25] as smoking acutely impairs the action of insulin and induces insulin resistance.[26,27] Smoking was associated with MetS despite the fact that smokers had lower BMI than nonsmokers.[28] People at increased risk were those in households with lower levels of education. Education is a good indicator of social position in epidemiological studies and is often seen as the easy means of measuring present socioeconomic status because it precedes other indicators, such as income or occupation based on social position. It is comparable between women and men, does not usually change in adulthood, and shapes health behaviors through attitudes, values and

Table 1: Distribution of MetS among participants according to their demographic characteristics

Characteristics	N (%)			χ^2	*P*
	Total	MetS	No MetS		
Gender					
Male	2164 (49.1)	680 (31.4)	1484 (68.6)	21.0	<0.001
Female	2242 (50.9)	565 (25.2)	1677 (74.8)		
Age (years)					
15-24	951 (21.6)	82 (8.6)	869 (91.4)	484.9	<0.001
25-34	1032 (23.4)	181 (17.5)	851 (82.5)		
35-44	1094 (24.8)	361 (33.0)	733 (67.0)		
45-54	807 (18.3)	352 (43.6)	455 (56.4)		
55-64	522 (11.8)	269 (51.5)	253 (48.5)		
Region					
Central	985 (22.4)	336 (34.1)	649 (65.9)	422.0	<0.001
Eastern	633 (14.4)	158 (25.0)	475 (75.0)		
Northern	397 (9.0)	158 (39.8)	239 (60.2)		
Southern	957 (24.9)	238 (24.9)	719 (75.1)		
Western	1434 (24.8)	355 (24.8)	107 (75.2)		
Education					
Illiterate	1200 (27.3)	438 (36.5)	762 (63.5)	84.2	<0.001
Primary	1131 (25.7)	344 (30.4)	787 (69.6)		
Intermediate	684 (15.6)	135 (19.7)	549 (80.3)		
Secondary	704 (16.0)	164 (23.3)	540 (76.7)		
University+	567 (12.9)	140 (24.7)	427 (75.3)		
Vocational	111 (2.5)	21 (18.9)	90 (81.1)		
Occupation					
Government employee	1298 (29.5)	437 (33.7)	861 (66.3)	225.7	<0.001
Nongovernment employee	410 (9.3)	113 (27.6)	297 (72.4)		
Self employed	575 (13.1)	37 (6.4)	538 (93.6)		
Student	1633 (37.1)	473 (29.0)	1160 (71.0)		
Housekeeping	298 (6.8)	147 (49.3)	151 (50.7)		
Retired	189 (4.3)	38 (20.1)	151 (79.9)		
Income (Saudi riyals)					
<3000	1399 (33.4)	379 (27.1)	1019 (72.9)	8.73	0.07
<7000	948 (22.6)	254 (26.8)	694 (73.2)		
<10,000	1211 (28.9)	351 (29.0)	860 (71.0)		
<15,000	422 (10.1)	139 (32.9)	283 (67.1)		
15,000+	211 (5.0)	69 (32.7)	142 (67.3)		

Data presented as frequencies (%); *P* value significant at <0.05. MetS: Metabolic syndrome

knowledge.[29] Many studies have reported a higher prevalence of MetS among the less educated subjects, which is in agreement with our findings.[28-31] In the results of studies in other countries the association of income with MetS was inconsistent.[30,32-34] The accuracy of data on income is usually difficult to assess, which may explain inconsistencies of association of income with health problems. Occupation was significantly associated with MetS in this study in which prevalence rates among housekeepers and government employees were higher. Other studies reported significant association of MetS with the occupation, but there was no consistency with the nature of the occupations. The prevalence of MetS was higher in manual workers than in nonmanual workers.[33,35,36] Other studies reported a greater risk for MetS for food service workers, farm managers, machine operators and supervisors and transportation and material moving workers, and was lowest in writers, athletes, engineers, and scientists.[37-39] Other factors such as age, gender, education and income could have confounded the association of occupation with MetS.

The authors acknowledge some limitations. The study is cross-sectional in nature and hence causal relationships could not be ascertained. Some of the significant risk factors for MetS in bivariate analysis (smoking, physical activity, and occupation) were not detected as predictors in multivariate analysis. Self-reporting bias in lifestyle practices such as diet, smoking habits and physical activity may have affected the results. Genetic factors were not addressed in this study.

Table 2: Univariate regression analysis of selected habits in MetS risk

Habits	*n* (%)			OR (95% CI)	*P*
	Total	MetS	No MetS		
Sedentary activity					
Yes	891 (20.5)	216 (24.2)	175 (75.8)	1.0	0.002
No	3453 (79.5)	1016 (29.4)	2437 (70.6)	0.77 (0.65-0.91)	
Transportation					
Yes	2125 (46.3)	505 (24.9)	1520 (48.5)	1.0	0.001
No	2347 (53.7)	733 (31.2)	1614 (68.8)	0.73 (0.54-0.84)	
Recreation (social)					
Yes	518 (11.9)	119 (23.0)	399 (77.0)	1.0	0.002
No	3843 (88.1)	1120 (29.1)	2723 (70.9)	0.72 (0.58-0.90)	
Ever smoking					
Yes	539 (12.6)	182 (33.8)	357 (66.2)	1.0	0.002
No	3734 (87.4)	1029 (27.6)	2705 (72.4)	1.34 (1.11-1.62)	
Dietary habit fruit consumption					
<5 serving/day	4186 (98.7)	1199 (28.6)	2987 (71.4)	1.0	0.002
5+servings/day	54 (1.3)	26 (48.1)	28 (51.9)	0.43 (0.25-0.74)	
Vegetable consumption					
<5 serving/day	4197 (98.7)	1212 (28.9)	2985 (71.1)	1.0	0.547
5+servings/day	56 (1.3)	16 (28.6)	40 (71.4)	1.02 (0.57-1.82)	

P value significant at *P*<0.05. MetS: Metabolic syndrome; CI: Confidence interval; OR: Odds ratio

Table 3: Univariate regression analysis for selected demographic characteristics and MetS risk

Predictor	Category	β	SE	*P*	OR	95% CI for OR	
						Lower	Upper
Sex	Male	0.29	0.10	0.002	1.0	1.11	1.62
	Females				1.34		
Age	<35	−0.59	0.04	0.0001	1.0	0.52	0.59
	≥35				0.55		
Region	Urban	−0.67	0.12	0.0001	1.0	0.41	0.64
	Rural				0.51		
Education	Primary and above illiterate	0.08	0.04	0.02	1.09	1.01	1.16
Income	≥7000	−0.12	0.04	0.002	1.0	0.82	0.96
	<7000				0.89		

P value significant at *P*<0.05. MetS: Metabolic syndrome; CI: Confidence interval; SE: Standard error; OR: Odds ratio

In summary, the prevalence of MetS in the kingdom is still alarmingly high. Major policies should be made and aggressive campaigns launched to control and/or minimize the potential economic burden of MetS and the predisposition of the Saudi people to disease.

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