

Prevalence of the Metabolic Syndrome Among Omani Adults

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Adults (Adult Treatment Panel III [ATP III]) of North America (12) to estimate the prevalence of the metabolic syndrome among Omanis.

OBJECTIVE — To estimate the prevalence of the metabolic syndrome by age and sex in the Omani population as defined by the third report of the National Cholesterol Education Program Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel III [ATP III]) of North America.

RESEARCH DESIGN AND METHODS — We analyzed data from a cross-sectional survey conducted in 2001 containing a probability random sample of 1,419 Omani adults aged ≥ 20 years living in the city of Nizwa. The metabolic syndrome, defined by the ATP III, was defined as having three or more of the following abnormalities: waist circumference >102 cm in men and >88 cm in women, serum triglycerides ≥ 150 mg/dl (1.69 mmol/l), HDL cholesterol <40 mg/dl (1.04 mmol/l) in men and <50 mg/dl (1.29 mmol/l) in women, systolic blood pressure ≥ 130 mmHg and/or diastolic ≥ 85 mmHg or on treatment for hypertension, and fasting serum glucose ≥ 110 mg/dl (6.1 mmol/l) or on treatment for diabetes.

RESULTS — The age-adjusted prevalence of the metabolic syndrome was 21.0%. The crude prevalence was slightly lower (17.0%). The age-adjusted prevalence was 19.5% among men and 23.0% among women ($P = 0.236$). Low HDL cholesterol was the most common component (75.4%) of the metabolic syndrome among the study population followed by abdominal obesity (24.6%). Abdominal obesity was markedly higher in women (44.3%) than in men (4.7%).

CONCLUSIONS — The prevalence of the metabolic syndrome in Oman is similar to that in developed countries. Future prevention and control strategies should not overlook the importance of noncommunicable disease risk factors in rapidly developing countries.

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People with abnormal glucose metabolism, hypertension, obesity, and dyslipidemia constitute a major challenge facing health systems in developed and developing countries. Such people are at substantially increased risk of developing diabetes and cardiovascular diseases (CVDs), including coronary artery, cerebrovascular, and peripheral vascular diseases necessitating long-term care (1,2).

Several studies have illustrated a high prevalence of diabetes, impaired glucose

tolerance, obesity, and hypertension among Arab populations of the Middle East, including Omanis (3–10). However, all of these studies focused on estimating the population distribution of major risk factors for CVDs, and only one (11) estimated the clustering of such risk factors in individuals in the form of metabolic syndrome. We used the working definition provided by the third report of the National Cholesterol Education Program Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in

RESEARCH DESIGN AND METHODS

Study population

As part of the initiative to obtain baseline data on CVD risk factors before the implementation of a community-based healthy lifestyle intervention project, a cross-sectional survey was conducted between April and June 2001 in the city of Nizwa (capital of the main Interior Province of Oman with 66,000 inhabitants and 180 km away from the national capital Muscat) (Fig. 1). The target group was all Omanis aged ≥ 20 years who resided in this city for at least 6 months before the date of the survey. The sample size, 1,000 men and women, was calculated for gender-specific analyses based on the estimate of the national prevalence of diabetes (10%), a nonresponse rate of 20%, and an error margin of 20% on each side of the 95% confidence intervals for any point estimate (Epinfo version 6; CDC, Atlanta, GA).

Two-stage cluster sampling was used as the sampling method. Of the 80 Census Enumeration Areas (CEAs) in Nizwa, 16 were randomly selected by the principle of probability proportionate to size. To obtain the sampling frame, a presurvey census was conducted in the 16 CEAs where all eligible residents were listed by household, locality, family name, given name, sex, and age, and field maps were updated simultaneously. The study protocol was seen and approved by the central ethics committee, and informed consent was given by study subjects.

All data were fed into a personal computer, and a random list of 1,000 individuals of each sex was selected from this sampling frame. Selected individuals were visited by the survey teams 1 week before the survey. In addition to verbal instructions, each subject was given a formal written invitation for the survey signed by the head of the local community leader. Subjects on regular medica-

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Abbreviations: ATP III, Adult Treatment Panel III; CEA, Census Enumeration Area; CVD, cardiovascular disease; FPG, fasting plasma glucose.

A table elsewhere in this issue shows conventional and Système International (SI) units and conversion factors for many substances.

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tion were asked to bring all of their medications with them to the survey site.

Of the 2,000 subjects invited for the survey, 1,511 completed the survey, giving an overall response rate of 75.5%. The response rate was higher in women (80.3%) than in men (70.8%). The participants' ages ranged from 20 to 99 years with a mean age \pm SD of 38.2 ± 15.5 years for men and 37.5 ± 15.4 years for women. A total of 72 women reported being pregnant during the survey and 20 subjects with missing data on various components of the metabolic syndrome were excluded from the analysis.

Laboratory analyses and measurements

Participants attended the survey site early in the morning (6:30–9:30 A.M.) after an overnight fast. The mean fasting time was 11 h (minimum 8 and maximum 15.5 h). After identity verification against an on-site register and registration of the subject, two sets of fasting blood samples were collected from each subject in sodium fluoride potassium oxalate tubes (for glucose) and lithium heparin vacuum tubes (for lipids). Samples were centrifuged at the survey site, and plasma was transferred to separate tubes and labeled and transferred immediately in cold boxes filled with ice (at 2–8°C) to the main regional hospital laboratories. There, samples were frozen at –20°C and analyzed later on the same day.

Fasting plasma glucose (FPG) was determined by the glucose oxidase method. Serum triglycerides were measured enzymatically after hydrolyzation of glycerol. HDL cholesterol was measured after the precipitation of other lipoproteins with heparin manganese chloride mixture. All biochemical analyses were done using a Hitachi 911E analyzer (Boehringer Mannheim, Mannheim, Germany). Reagents used were supplied by the same manufacturer. Every 50th sample was tested a second time to assess the coefficient of correlation between duplicate readings, which were as follows: glucose 0.997, triglycerides 0.994, and HDL cholesterol 0.887. The coefficient of variation for the retested samples were as follows: glucose 1.23%, triglycerides 2.02%, and HDL cholesterol 2.18%.

Blood pressure was measured to the nearest 2 mmHg on the right arm with subjects seated, after at least 10 min of rest, using a standard mercury sphygmo-

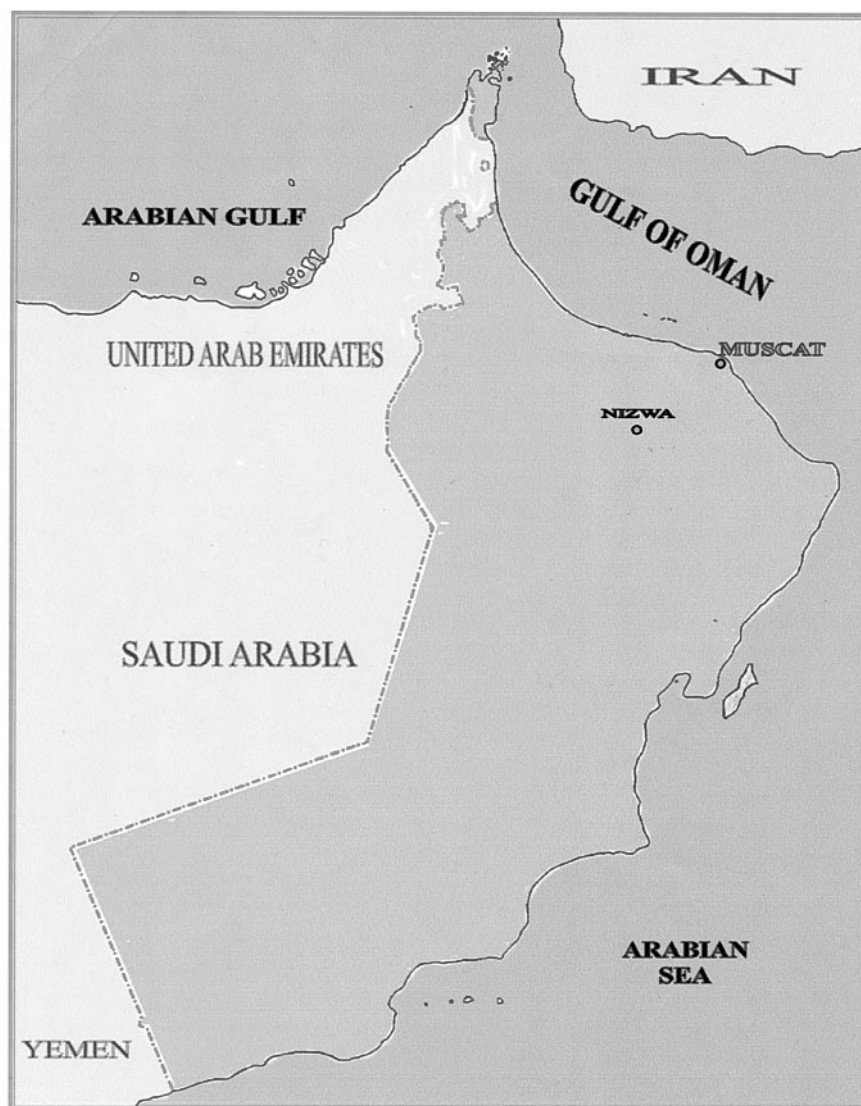


Figure 1—Sultanate of Oman.

manometer. The mean of the two readings was taken as each individual's blood pressure. Waist circumference was measured with subject wearing light clothing (underwear) at a level midway between the lower rib margin and iliac crest to the nearest centimeter using a plastic, non-stretchable tailors measuring tape. The same procedure was applied for men and women. In addition, weight and height were also measured, and BMI was calculated (weight divided by height in meters squared).

Definition of metabolic syndrome

Subjects were considered to have metabolic syndrome if they had any three or more of the following, according to the ATP III:

- Abdominal obesity: waist circumference >102 cm (40 in) in men and >88 cm (35 in) in women
- Hypertriglyceridemia: serum triglycerides level ≥ 150 mg/dl (1.69 mmol/l)
- Low HDL cholesterol: <40 mg/dl (1.04 mmol/l) in men and <50 mg/dl (1.29 mmol/l) in women
- High blood pressure: systolic blood pressure ≥ 130 mmHg and/or diastolic ≥ 85 mmHg or on treatment for hypertension
- High fasting glucose: serum glucose level ≥ 110 mg/dl (6.1 mmol/l) or on treatment for diabetes.

Statistical analysis

All data were entered in Epiinfo software and exported to Intercooled STATA pack-

Table 1—Age-adjusted prevalence of individual metabolic abnormalities of the metabolic syndrome among Omanis aged ≥ 20 years, the Nizwa Healthy Lifestyle Project Survey 2001, Oman

	% Prevalence (95% CI)		
	Men	Women	Total
<i>n</i>	695	724	1419
Abdominal obesity	4.7 (3.0–6.4)	44.3 (40.6–48.0)	24.6 (22.2–26.9)
Hypertriglyceridemia	26.2 (22.8–29.5)	15.9 (13.0–18.8)	20.7 (18.4–22.9)
Low HDL cholesterol	77.2 (74.0–80.4)	74.4 (71.3–77.6)	75.4 (73.2–77.7)
High BP or on medication	27.9 (24.5–31.3)	18.7 (15.7–21.7)	23.1 (20.9–25.4)
High FPG or on medication	19.2 (16.2–22.3)	17.2 (14.3–20.1)	18.0 (15.9–20.1)

BP, blood pressure. See RESEARCH DESIGN AND METHODS for description of the criteria of the metabolic syndrome.

age (Version 7; STATA, Collage Station, TX) to calculate prevalence rates, *P* values, and 95% CIs. To facilitate comparisons with other published rates, all prevalence rates were age-adjusted by direct method (13) within 10-year bands using the World Standard Population (14).

RESULTS — The age-adjusted prevalence of abdominal obesity was markedly higher among women than men (44.3 vs. 4.7%, respectively) (Table 1). All other components of metabolic syndrome were more common in men. Of all the elements

of the metabolic syndrome, low HDL cholesterol was the most common abnormality in the study population, with 75.4% of individuals having low HDL cholesterol, followed by abdominal obesity (24.6%). Approximately 20% of the population had hypertriglyceridemia, high blood pressure, or high FPG.

The age-specific means and proportions of subjects with abnormal elements of the metabolic syndrome, as well as BMI, are given in Table 2. The mean levels and prevalence of abnormal values increased with increasing age in both sexes, reaching a peak in the 4th and 5th decades.

Nearly 85% of the study population had at least one component (abnormal value) of metabolic syndrome (Table 3). The age-adjusted prevalence of metabolic syndrome (at least three abnormal values) was 21%. Due to the young population, the crude prevalence was slightly lower (17%). Sex-specific prevalences were 19.5 and 23% in men and women, respectively (*P* = 0.236).

The prevalence of the metabolic syndrome increased with age in both sexes, but the increase was steeper in women (Fig. 2). In the age group 20–29 years, 4.7% of men and 2.8% of women had metabolic syndrome. In the age group 60 years and over, the prevalences were 29.8 and 48.7%, respectively.

CONCLUSIONS — This study shows, for the first time, a high prevalence of metabolic syndrome (21.0%) in the Omani population. This estimate is nearly the same as that published from the U.S. (23.7%) using the same clinical definition (15). The only similar study among the Arab populations of the Middle East found that 17% of the West Bank Palestinians had metabolic syndrome using the World Health Organization definition (11).

Table 2—Mean values, SD, and percentage of subjects with abnormal (Abn) components of the metabolic syndrome and BMI by age group and sex among 695 men and 724 women the Nizwa Healthy Lifestyle Project Survey 2001, Oman

	Age group (years)																	
	20–29			30–39			40–49			50–59			60 or over			Total		
	% Abn	Mean	SD	% Abn	Mean	SD	% Abn	Mean	SD	% Abn	Mean	SD	% Abn	Mean	SD	% Abn	Mean	SD
Men																		
Waist circumference	1.6	74.9	10.2	4.0	84.0	9.7	5.7	85.8	11.3	8.4	86.1	12.0	5.8	83.8	13.1	4.2	81.2	12.0
BMI	5.9	23.3	3.9	12.2	25.6	3.7	10.5	25.4	4.2	12.0	25.1	4.3	8.6	24.2	3.8	9.1	24.5	4.0
Triglycerides	14.5	1.1	0.8	31.8	1.5	0.9	33.3	1.6	1.3	31.3	1.5	0.89	25.0	1.2	0.7	24.6	1.3	92.8
HDL	77.2	0.94	0.24	83.8	0.88	0.23	77.1	0.93	0.24	75.9	0.93	0.23	71.1	0.94	0.21	77.5	0.92	0.23
Diastolic BP	4.7	74.5	7.3	12.8	76.0	8.6	18.1	78.1	8.8	19.3	78.0	9.9	23.1	77.4	9.5	12.9	76.2	8.6
Systolic BP	9.8	113	12.5	13.5	112.4	13.5	22.9	118.2	17.5	36.1	122.3	22.5	40.4	122.0	17.1	20.3	116.3	16.0
FPG	6.7	5.3	0.5	13.5	5.6	0.81	24.8	6.1	1.7	26.5	6.3	2.1	31.7	6.5	2.8	17.0	5.7	1.6
Women																		
Waist circumference	18.8	76.7	12.2	42.9	87.0	12.3	59.7	91.3	11.8	59.5	91.4	12.6	53.8	88.5	13.4	39.5	84.4	13.9
BMI	10.6	22.8	5.1	19.2	25.4	4.8	24.1	26.6	5.1	22.8	25.9	4.9	19.2	24.4	6.1	17.1	24.6	5.3
Triglycerides	4.6	0.6	0.4	10.9	0.8	0.7	15.5	1.0	0.74	26.6	1.3	0.7	29.5	1.4	0.7	13.0	0.92	0.6
HDL	63.8	1.23	0.3	69.2	1.16	0.3	72.9	1.15	0.3	89.9	1.03	0.21	84.6	1.05	0.21	71.7	1.16	0.31
Diastolic BP	0.7	69.8	7.0	1.9	69.6	7.4	12.4	73.8	8.7	13.9	77.0	7.8	16.7	77.7	7.4	6.2	72.1	8.1
Systolic BP	0.7	109.6	8.1	3.2	108.8	8.1	11.6	115.1	11.5	31.6	122.9	12.9	32.0	122.4	10.7	9.9	113.2	11.1
FPG	4.3	5.0	0.6	3.2	5.2	1.2	20.2	5.9	2.0	22.8	6.3	2.2	43.6	6.7	2.4	13.1	5.5	1.62

BP, blood pressure. Units for waist circumference in cm, BMI in kg/m², and triglycerides, HDL, and FPG in mmol/l. Figures for systolic or diastolic blood pressure or FPG include those on medication for these conditions. See RESEARCH DESIGN AND METHODS for description of the criteria of the each component of the metabolic syndrome.

Table 3—Age-adjusted prevalence of one or more abnormalities of the metabolic syndrome among Omanis aged ≥ 20 years, the Nizwa Healthy Lifestyle Project Survey 2001, Oman

n	% (95% CI)		
	Men	Females	Total
Metabolic abnormalities (n)	695	724	419
≥ 1	85.7 (82.8–88.1)	84.2 (81.2–86.7)	84.8 (82.8–86.6)
≥ 2	44.2 (40.4–47.9)	49.5 (45.7–53.1)	46.6 (44.0–49.9)
≥ 3	19.5 (16.7–22.7)	23.0 (19.9–26.1)	21.0 (18.8–23.1)
≥ 4	5.2 (3.6–7.1)	10.5 (8.4–13.0)	7.6 (6.3–9.1)
5	0.5 (0.1–1.5)	3.5 (2.2–5.0)	1.8 (1.2–2.7)

See RESEARCH DESIGN AND METHODS for description of the criteria of the metabolic syndrome.

Our figures are likely to be an underestimate of the true prevalence of the metabolic syndrome in the national Omani population because the population studied in Nizwa is more representative of semirural communities where the society consists of tribal people living together with high levels of social networking. However, since the early 1970s and soon after the discovery and exportation of oil, the per capita gross domestic product has increased drastically in Oman (from U.S. \$410 in 1970 to U.S. \$8,231 in 2000) (16), leading to personal income growth, better housing, and universal improvements in the population's socioeconomic conditions (17). Nonetheless, this was also coupled with rapid urbanization and subsequent transformation of purely rural communities to semiurban, like the city of Nizwa.

The prevalence of abdominal obesity was remarkably higher among women than men. This was partially explained by the difference in cut-points adopted for men and women, 102 and 88 cm, respectively. However, the actual waist circumferences were also higher in women than

men. Cultural and social restrictions in Oman often imply requirements for the segregation of men and women, especially outside the capitol Muscat. As a result, women-only exercise facilities tend to be rare and expensive, and even where mixed facilities exist, training and coaching is mostly provided by men, making it less favorable for women to exercise (18). In addition, cultural norms in Nizwa make it unacceptable for women to be seen walking or exercising alone without the company of a close family member.

Educational level was also shown to be inversely related to obesity, especially among women (19). In our survey, the majority of women were illiterate (72%) or did not work outside the home (92%), as compared with 28 and 20% of men, respectively. In addition, 77% of obese women in Nizwa were illiterate or could barely read and write.

Over two-thirds of Omanis had low HDL cholesterol levels. This may have several causes, such as elevated triglycerides, overweight and obesity, diabetes, and physical inactivity, many of which are associated with insulin resistance (12).

Moderate alcohol consumption is known to increase HDL levels (20), and alcohol drinking is rare among the traditional Islamic populations (<5% of men in Nizwa drink alcohol). Low HDL levels were also reported by Abdul-Rahim et al. (11) among Palestinians of the West Bank (70% in men and 56% in women). It is not known, however, whether this similarity is due to a genetic predisposition of Arabs of Middle Eastern origin or similar lifestyle factors.

The prevention and control of obesity play a central role in the prevention of the metabolic syndrome. The risk of developing abnormal glucose metabolism, dyslipidemia, and hypertension is markedly higher among obese people compared with people with normal weight (21). In contrast, weight reduction through dietary modification and regular physical activity are shown to be effective in improving insulin sensitivity (22,23), correcting metabolic abnormalities, and reducing blood pressure in obese people (21).

Although the main emphasis in the management of metabolic syndrome-related abnormalities must target the underlying causes, such as obesity and physical inactivity, pharmacotherapy may also be needed for treatment of dyslipidemia, hyperglycemia, and hypertension (12). Recent studies have demonstrated the crucial role of lifestyle changes and pharmacological agents in preventing type 2 diabetes (by 46–58% and by 25–31%, respectively) (24–27); both could be implemented in prevention and treatment strategies among high-risk groups. Thus, an integrated approach is needed for the prevention and treatment of metabolic syndrome.

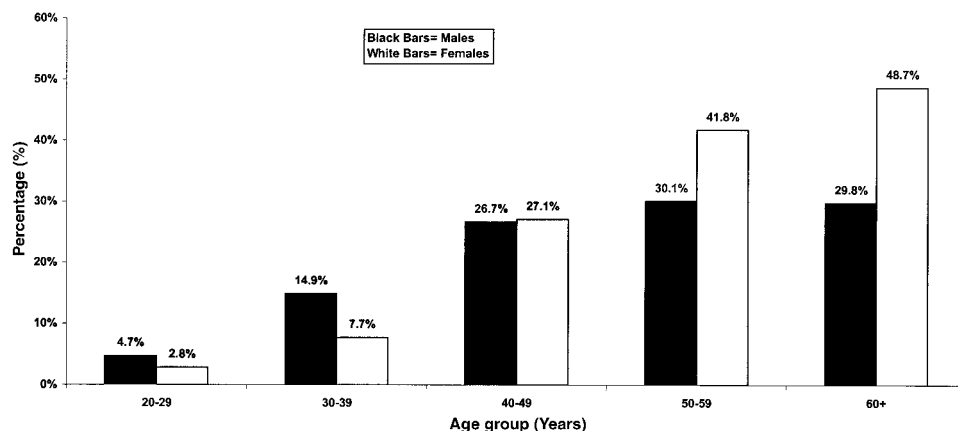


Figure 2—Age-specific prevalence of the metabolic syndrome among 1,419 Omanis aged at least 20 years, by sex, the Nizwa Healthy Lifestyle Project Survey 2001, Oman.

In conclusion, this study documents evidence that the epidemic of non-communicable disease risk factors, including metabolic syndrome, is not limited to industrialized countries. Thus, an increasing number of rapidly developing countries should expect a significant burden from noncommunicable diseases, particularly heart disease, strokes, and diabetes, in the future. Such findings should be taken into account when planning for new or expansion of existing health services and when implementing future non-communicable disease prevention and control programs.

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