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High prevalence of the metabolic syndrome among Northern Jordanians

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Abstract

Background: The prevalence of the metabolic syndrome is rapidly increasing with a considerable ethnic variation within and across populations. This study was conducted to estimate the prevalence of the metabolic syndrome and its individual components using Adult Treatment Panel III (ATP III) criteria among Northern Jordanians. **Methods:** Data were analyzed from a cross-sectional study that included a random sample of 1121 northern Jordanians aged 25 years and above. The metabolic syndrome was defined by ATP III criteria. **Results:** The age-adjusted prevalence of the metabolic syndrome was 36.3% (95% CI 33.6–39.0%) (28.7% among men and 40.9% among women). The prevalence increased significantly with age in men and women. The prevalence of the metabolic syndrome was significantly higher in women than in men in age groups of 40–49 and 60 years and above. Low HDL cholesterol was the most common abnormality in men (62.7%), and abdominal obesity was the most common abnormality in women (69.1%). **Conclusions:** Prevalence of the metabolic syndrome in North Jordan is considerably higher than in developed countries and other Arab populations. An integrated approach is needed for the prevention and treatment of the metabolic syndrome.

Keywords: Metabolic syndrome; Diabetes; Obesity; Prevalence; Jordan

1. Introduction

The metabolic syndrome is essentially a group of interrelated metabolic risk factors that increase the risk of cardiovascular morbidity and mortality and total mortality (Isomaa et al., 2001; Lakka et al., 2002). These factors include obesity, abnormal glucose metabolism, high blood pressure, and dyslipidemia (DeFronzo & Ferrannini, 1991). Although the pathogenesis of the syndrome is not completely understood, it is influenced by a complex interplay between multiple genetic variations interacting with numerous environmental factors (Liese, Mayer-Davis, & Haffner, 1998; Reaven, 1988). The World Health Organization (WHO) initially proposed a definition for the metabolic syndrome in 1998 (Alberti & Zimmet, 1998). More recently, the Cholesterol Education Program Adult Treatment Panel III (ATP III) provided a new working definition of the metabolic syndrome (Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults, 2001).

The prevalence of the metabolic syndrome varies by definition used and population studied (Ford & Giles, 2003). The prevalence of the metabolic syndrome is rapidly increasing (Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults et al., 2001; Ford, Giles, & Dietz, 2002) with a considerable ethnic variation within and across populations (Araneta, Wingard, & Barrett-Connor, 2002). It is present in more than 20% of the US adult population (Park et al., 2003). In the United Kingdom the metabolic syndrome has also been increasingly recognized (The UK HDL-C Consensus Group, 2004) especially in South Asians (Kain, Catto, & Grant, 2003). A considerably high prevalence of the metabolic syndrome was reported in Turkey (Ozsahin et al., 2004), Asian Indian population (Ramachandran, Snehalatha, Satyavani, Sivasankari, & Vijay, 2003), and Iran (Azizi, Salehi, Etemadi, & Zahedi-Asl, 2003).

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The metabolic syndrome is common among Arab populations in Mediterranean countries (Abdul-Rahim et al., 2001; Al-Lawati, Mohammed, Al-Hinai, & Jousilahti, 2003) and among Arab Americans (Jaber, Brown, Hammad, Zhu, & Herman, 2004). In Jordan, several studies (Ajlouni, Jaddou, & Batieha, 1998a, 1998b; Batieha, Jaddou, & Ajlouni, 1997; Jaddou, Batiehah, & Ajlouni, 1996) have focused on estimating the population distribution of major risk factors for cardiovascular diseases and illustrated a high prevalence of hypertension, diabetes, impaired glucose metabolism, obesity, and hyperlipidaemia. However, studies on the clustering of such risk factors in Jordanian population in the form of the metabolic syndrome are not available. Therefore, this study aimed to estimate the prevalence of the metabolic syndrome and its individual components using Adult Treatment Panel III (ATP III) criteria among Northern Jordanians.

2. Materials and methods

2.1. Study population and data collection

This survey was conducted in the town of Sarih in the north of Jordan to estimate the prevalence of diabetes mellitus, hypertension, hyperlipidaemia, obesity, and metabolic syndrome, and to determine their risk indicators. This town with about 3328 households and 19,227 residents (Department of Statistics 2002—Jordan) was selected because of the presence of a health center in which to perform the study and because of its proximity to the study team. A systematic sample of 550 households (every sixth house) after a random start was selected. One week before the survey, a two-member team (a male and a female) visited the selected households, explained the purpose of the study, and invited all residents aged 25 years and above, who were present at the time of the study, to attend the health centre at a given day after an overnight fast. Subjects on regular medications were asked not to take their medications early at that day and to bring all their medications with them to the survey site. To encourage participation, community and religious leaders, local clubs, schools, and the municipality were contacted to secure subjects' cooperation. The study team offered free transportation to and from the health center upon request and worked during all weekdays including weekends to encourage employed people to participate. The total number of respondents was 1241 and the response rate was 94.0%. Work outside the town was the main reason for nonparticipation.

Participants attended the health centre early in the morning (7:30–10:00 a.m.) with a minimum fasting time of 8 h. A pilot-tested structured questionnaire prepared specifically for the study was administered by trained interviewers to collect information on socio-demographic factors as well as information on diabetes mellitus, hypertension, hyperlipidaemia, and smoking habits, and their risk factors.

2.2. Measurements and laboratory analysis

Anthropometric measurements including weight, height, hip, and waist circumferences were taken with the subjects wearing light clothing and no shoes. Waist circumference was measured to the nearest centimeter using nonstretchable tailors measuring tape at the narrowest point between the umbilicus and the rib cage, and hip circumference was measured at the widest part of the body below the waist (Deen, 2004). Body mass index (BMI) was calculated as the ratio of weight (kilograms) to the square of height (meters). Two readings of systolic (SBP) and diastolic blood pressure (DBP) were taken from the left arm with the subject seated and the arm at heart level, after at least 5 min of rest, using standardized mercury sphygmomanometer. The mean of the two readings was taken as the individual's blood pressure.

For laboratory analysis and all biochemical measurements, two sets of fasting blood samples were drawn from a cannula inserted into the antecubital vein into sodium fluoride potassium oxalate tubes for glucose and lithium heparin vacuum tubes for lipids. Samples were centrifuged within 1 h at the survey site, and plasma was transferred to separate labeled tubes and transferred immediately in cold boxes filled with ice to the central laboratory. All biochemical measurements were carried out by the same team of laboratory technicians and using the same method throughout the study period.

Fasting plasma glucose (FPG), cholesterol, HDL, LDL, and triglyceride were measured by the glucose

Table 1
Demographic characteristics and smoking status of 1121 Northern Jordanians aged ≥25 years

Variable	Male (n=394), n (%)	Female (n=727), n (%)	Total (N=1121), n (%)	P
Age (years)				<.0001
25–29	32 (8.1)	76 (10.5)	108 (9.6)	
30–39	94 (23.9)	192 (26.4)	286 (25.5)	
40–49	106 (26.9)	204 (28.1)	310 (27.7)	
50–59	59 (15.0)	141 (19.4)	200 (17.8)	
≥60	103 (26.1)	114 (15.7)	217 (19.4)	
Education				<.0001
Illiterate	12 (3.0)	177 (24.3)	189 (16.9)	
1–11 years	139 (35.3)	258 (35.5)	397 (35.4)	
≥12 years	243 (61.7)	292 (40.2)	535 (47.7)	
Marital status				<.0001
Married	349 (89.3)	605 (83.2)	954 (85.3)	
Single	39 (10.0)	47 (6.5)	86 (7.7)	
Widow or divorced	3 (0.8)	75 (10.3)	78 (6.9)	
Smoking				<.0001
Current	126 (32.0)	17 (2.3)	143 (12.8)	
Past	69 (17.5)	13 (1.8)	82 (7.3)	
None	199 (50.5)	695 (95.9)	894 (79.9)	

Table 2
Anthropometric and metabolic characteristics of 1121 Northern Jordanians aged ≥25 years

Variable	Male (n=394), mean±S.D.	Female (n=727), mean±S.D.	Total (N=1121), mean±S.D.	P
Weight (kg)	81.6±14.3	77.4±14.2	78.9±14.4	<.0001
Height (cm)	169.6±7.4	156.4±6.6	161.1±9.3	<.0001
Waist circumference (cm)	93.5±14.4	98.2±13.5	96.6±14.0	<.0001
Hip circumference (cm)	113.9±13.0	117.5±11.7	116.2±12.3	<.0001
Body mass index (kg/m^2)	28.3±4.7	31.6±5.8	30.5±5.6	<.0001
Systolic blood pressure (mm Hg)	125.1±16.0	123.9±19.7	124.3±18.5	.275
Diastolic blood pressure (mm Hg)	78.6±10.2	80.9±12.4	80.1±11.7	.001
Fasting plasma glucose (mg/dl)	109.4±43.9	109.8±50.5	109.7±48.2	.886
Cholesterol (mg/dl)	197.8±42.2	205.0±42.4	202.5±42.4	.007
Triglycerides (mg/dl)	185.7±116.1	152.6±95.5	164.3±104.4	<.0001
Low-density lipoprotein (mg/dl)	122.4±34.7	126.5±37.1	125.1±36.3	.074
High-density lipoprotein (mg/dl)	38.2±8.0	47.1±12.4	44.0±11.8	<.0001

oxidase method, using a Cobas Analyzer (Roche). Glycosylated hemoglobin (HbA_{1c}) was analyzed using a high-performance liquid chromatography method (Bio-Rad).

2.3. Definition of the metabolic syndrome

ATP III criteria for the metabolic syndrome were met if an individual had three or more of the following criteria:

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

2.4. Statistical analysis

Subjects with missing data on various components of the metabolic syndrome were excluded. For the purpose of statistical analysis, age was categorized into five intervals: 25–29, 30–39, 40–49, 50–59, and ≥60 years to estimate age-adjusted prevalence rates by direct method (King & Rewers, 1993) using the World Standard Population (Segi, 1960). Age-adjusted prevalence rates were estimated to facilitate comparisons with other published rates. Chi-square test was performed to compare the crude prevalence rate between men and women, and between age groups. Independent-samples t-test was performed to compare the means of continuous variables between men and women. The analyses reported in this study were done using the Statistical Package for Social Sciences (SPSS), version 11.5. P value of less than .05 was considered statistically significant.

3. Results

3.1. Participant's characteristics

A total of 1121 participants (394 men and 727 women) aged 25 years and above had complete information for all components of the metabolic syndrome. The demographic, anthropometric, and metabolic characteristics of participants are depicted in Tables 1 and 2. Age of the subjects ranged from 25 to 85 years with a mean of 46.2±13.2 (±S.D.). About 52% of the subjects had less than high school

Table 3
Age-adjusted prevalence (95% confidence interval) of individual metabolic abnormalities and overlapping abnormalities of the metabolic syndrome among Northern Jordanian aged ≥25 years

	Men (n=394)	Women (n=727)	Total (N=1121)
Individual components[a]			
Abdominal obesity	12.3 (9.2–15.5)	60.7 (57.0–64.3)	44.1 (41.0–47.1)
Hypertriglyceridemia	48.1 (42.2–54.0)	34.2 (30.6–37.7)	38.6 (35.5–41.6)
Low HDL cholesterol	61.5 (55.3–67.6)	59.2 (55.1–63.4)	59.6 (56.2–63.0)
High BP or medication use	42.2 (36.5–47.9)	46.0 (42.4–49.6)	44.6 (41.5–47.7)
High FPG or medication use	19.8 (16.5–23.0)	19.7 (17.2–22.2)	19.5 (17.5–21.5)
Number of components			
≥1	83.3 (78.2–88.3)	85.6 (82.3–88.9)	84.6 (81.8–87.4)
≥2	58.1 (52.3–64.0)	63.7 (60.0–67.5)	61.6 (58.4–64.8)
≥3	28.7 (24.2–33.3)	40.9 (37.7–44.2)	36.3 (33.6–39.0)
≥4	10.7 (8.1–13.3)	21.8 (19.4–24.2)	17.7 (15.8–19.6)
5	3.1 (1.6–4.6)	7.7 (6.0–9.4)	6.0 (4.8–7.2)

[a] Abdominal obesity, waist circumference >102 cm (40 in.) in men and >88 cm (35 in.) in women. Hypertriglyceridemia, serum triglyceride level ≥150 mg/dl (1.69 mmol/l). Low HDL cholesterol, serum HDL cholesterol <40 mg/dl (1.04 mmol/l) in men and <50 mg/dl (1.29 mmol/l) in women. High BP, systolic blood pressure ≥130 mm Hg and/or diastolic blood pressure ≥85 mm Hg. High FPG, serum glucose level ≥110 mg/dl (6.1 mmol/l).

education. Eighty-five percent (85.3%) were married and 7.7% were single. The average levels of waist and hip circumferences, BMI, HDL, total cholesterol, DBP were significantly higher in women than in men, and those of FPG, SBP, and LDL did not significantly differ between genders. Triglyceride level was significantly higher in men.

3.2. Prevalence of the metabolic syndrome

The age-adjusted prevalence of individual metabolic abnormalities and prevalence of overlapping abnormalities of the metabolic syndrome are presented in Table 3. The age-adjusted prevalence of abdominal obesity was markedly higher among women (60.7%) than among men (12.3%). Low HDL cholesterol was the most common abnormality in the study population (59.6%). About 84.6% of the study population had at least one metabolic abnormality. Age-adjusted prevalence of the metabolic syndrome was 36.3% (95% CI 33.6–39.0) (28.7% among men and 40.9% among women).

Prevalence of the metabolic syndrome in men and women by age is shown in Fig. 1. The prevalence increased significantly with age in men and women (P value for trend <.0001). It rose from 9.4% in men aged 25–29 years to 50.8% in those aged 50–59 and then declined to 45.6% in those aged 60 years and above. On the other hand, the prevalence rose from 11.8% in women aged 25–29 years to 81.6% in women aged 60 years and above. The prevalence of the metabolic syndrome was significantly higher in women than in men in age groups of 40–49 and ≥60 years only.

The relative frequencies of the metabolic syndrome and its individual components by age and sex are shown in Table 4. Low HDL cholesterol was the most common abnormality in men (62.7%), and abdominal obesity was the most common abnormality in women (69.1%). Men had a significantly higher prevalence of hypertriglyceridemia (P<.0001) and lower prevalence of abdominal obesity than women (P<.0001). All other metabolic abnormalities did not significantly differ by gender. The frequencies of the individual components of the metabolic syndrome varied by age in both men and women. Among men, abdominal obesity, high blood pressure, and hyperglycemia were significantly more prevalent in the participants aged 45 years and above than in those aged 25–44 years. Among women, all individual components were significantly more prevalent in those aged 45 years and above than in those aged 25–44 years. Sex-specific prevalence of the metabolic syndrome was 35.0% and 48.4% in men and women, respectively (P<.0001). The prevalence of the metabolic syndrome increased with age in both sexes. Among men, 22.5% of those aged 25–44 years and 45.8% of those aged 45 years and above had metabolic syndrome (P<.0001). The prevalence was 29.0% and 69.2% among women aged 25–44 years and 4 years and above, respectively (P<.0001).

Among those with metabolic syndrome, 57.2% of men and 44.3% of women had three components, 29.7% of men and 35.8% of women had four components, and 13% of men and 19.9% of women had five components. In men with the metabolic syndrome, the most common cluster

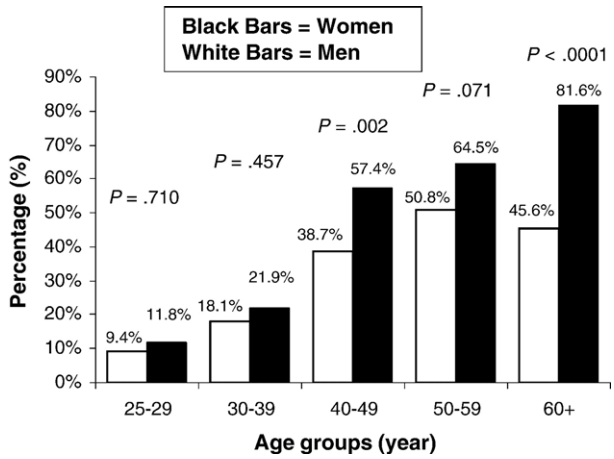

Fig. 1. Age-specific prevalence of the metabolic syndrome among Northern Jordanians aged ≥25 years by sex.

Table 4
The relative frequencies of individual metabolic abnormalities overlapping abnormalities of the metabolic syndrome by age and sex among Jordanian adults aged ≥25 years

		Men			Women					
Components	Total	25–44 (n=182)	>44 (n=212)	P (age)	25–44 (n=376)	>44 (n=351)	P (age)	Men (n=394)	Women (n=727)	P (sex)
Abdominal obesity	50.6	9.3	22.6	<.0001	50.8	88.6	<.0001	16.5	69.1	<.0001
Hypertriglyceridemia	43.6	50.5	53.8	.523	28.5	50.1	<.0001	52.3	38.9	<.0001
Low HDL cholesterol	62.9	64.8	60.8	.415	59.3	67.0	.033	62.7	63.0	.919
High BP or medication use	51.1	33.0	63.7	<.0001	32.2	73.2	<.0001	49.5	52.0	.424
High FPG or medication use	24.8	11.0	39.6	<.0001	9.0	39.9	<.0001	26.4	23.9	.362
Number of components										
≥1	89.3	80.2	92.5	<.0001	83.2	98.6	<.0001	86.8	90.6	.047
≥2	69.4	56.6	74.1	<.0001	54.3	89.5	<.0001	66.0	71.3	.068
≥3	43.7	22.5	45.8	<.0001	29.0	69.2	<.0001	35.0	48.4	<.0001
≥4	22.7	7.1	21.7	<.0001	10.6	44.4	<.0001	15.0	27.0	<.0001
5	7.9	2.2	6.6	.037	2.7	17.1	<.0001	4.6	9.6	.003

of the metabolic syndrome components was the cluster of the three components (28.3%): low HDL, high blood pressure, and hypertriglyceridemia. On the other hand, the clustering of abdominal obesity, low HDL, and high blood pressure was the most common in women with metabolic syndrome (16.5%).

4. Discussion

This study reported an estimate of the prevalence of the metabolic syndrome among Northern Jordanians aged 25 years and above. Using the ATP III diagnostic criteria, we found that the age-standardized prevalence of the metabolic syndrome was 36.3% (28.7% among men and 40.9% among women). This estimate was considerably higher than that reported in the US population (24%, ATP III criteria) (Park et al., 2003) and Arab populations including Arab Americans (23%, ATP III criteria and 28%, WHO criteria) (Jaber et al., 2004), Palestinians in the West Bank (17%, WHO criteria) (Abdul-Rahim et al., 2001), and Omanis (21%, ATP III criteria) (Al-Lawati et al., 2003). However, this prevalence approximated other estimates reported in a Turkish adult population (33.4%, ATP III criteria) (Ozsahin et al., 2004), Iran (33.7%, ATP III criteria) (Azizi et al., 2003), and urban Asian Indian adults (41.0%, ATP III criteria) (Ramachandran et al., 2003). The considerable variations in the prevalence of the metabolic syndrome within and across populations may be due to the combination of genetics and environmental factors such as obesity and diminished physical activity in its causation. The high prevalence of the metabolic syndrome reported in this study may reflect a relatively better survival with cardiovascular disease risk factors and earlier adoption of a sedentary lifestyle.

The prevalence of the metabolic syndrome increased with age in both men and women, with sharp increase after the third decade of life especially among women. Age-related changes in body size, fat distribution, and insulin sensitivity contribute to the increased prevalence of this syndrome with age (Carr et al., 2004). However, the prevalence declined in men after the fifth decade by 10% while it increased among women by 27% after the fifth decade. Leveling off the prevalence in men is likely because of survival bias, such that people affected by the syndrome die at a relatively young age, depleting the older age categories of affected individuals. On the contrary, continuously increasing prevalence in women with age could in part be an effect of menopause. Menopause was reported in a study to be associated with visceral fat accumulation and acute increase of insulin resistance (Fujimoto et al., 2000). However, menopausal status was not studied in this survey.

The finding that low HDL cholesterol was the most common abnormality in men (62.7%) agrees with that reported among Arab Americans, Palestinians, and Omani adults (Abdul-Rahim et al., 2001; Al-Lawati et al., 2003; Jaber et al., 2004), while the finding that abdominal obesity was the most common abnormality in women disagrees with the finding of these studies. Increased prevalence of obesity among females could be explained by the fact that Jordanian women are less likely to exercise because of cultural and social restrictions. The high prevalence of low HDL cholesterol in this study is of prognostic significance. The atherogenic lipoprotein profile characterized by high triglyceride and low HDL cholesterol in the presence of obesity greatly increases the risk of coronary heart disease.

Clearly, the prevalence of the metabolic syndrome and its individual components is high in this group. Therefore, they are likely to benefit from programs aimed at encouraging healthy weight and physical activity behaviors. In addition, an integrated approach is needed for the prevention and treatment of the metabolic syndrome.

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