Prevalence of metabolic syndrome in Saudi adult soldiers

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ABSTRACT

Objective: To estimate the prevalence of metabolic syndrome in Saudi male soldiers aged 20 years and above using the criteria of the National Cholesterol Education Program Adult Treatment Panel III (NCEP-ATP III).

Methods: We performed a cross-sectional survey involving a group of 2250 Saudi male soldiers aged 20-60 years residing in a military city in Northern Saudi Arabia in 2004. Participants were recruited from a primary care setting. Anthropometric data together with a brief medical history were obtained from the subjects at initial contact. Laboratory investigations were performed on the following day after fasting for 12 hours. Data on all variables required to define the metabolic syndrome according to NCEP ATP III criteria were available only for 1079 subjects who attended the laboratory for investigations (response rate: 47.9%). Data obtained from these subjects were analyzed excluding the non-respondents from the study sample.

Results: The age-adjusted prevalence of metabolic syndrome was found to be 20.8%. Abdominal obesity was the most common component in the study population (33.1%) closely followed by raised serum triglycerides (32.2%) and elevated systolic blood pressure (29.5%). Over two-thirds of the subjects (71%) exhibited at least one criterion for metabolic syndrome. Prevalence of individual factors and mean values of the components of the syndrome showed a steady increase with increase in age and body fat.

Conclusion: The estimated prevalence conforms to the rates found in other studies performed in the Middle East and elsewhere. High rates of this syndrome predict an increased burden of cardiovascular disease and diabetes among Saudis over the next few years and call for effective healthcare planning to contain this epidemic.

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Metabolic syndrome is commonly defined as a group of risk factors or abnormalities closely associated with insulin resistance that markedly increases the risk for both coronary heart disease and diabetes. Avogaro et al[1] recognized the association of obesity, diabetes, hypertension and dyslipidemias in 1967. Haller,[2] who coined the term "metabolic syndrome", later highlighted the association of atherosclerosis with this constellation of abnormalities. Reaven,[3] in his Banting Lecture in 1987, re-introduced this association and called it "Syndrome X". In 1991, Ferrannini et al[4] postulated that insulin resistance was the basis for the association of these abnormalities and renamed it as "Insulin Resistance syndrome". Meigs et al[5] in the Framingham Offspring Study (1997) turned the clock back when they found that hyperinsulinemia alone was not the underlying cause of this clustering of risk factors and the older term "metabolic syndrome" is now generally used for this group of abnormalities. There is no universal agreement on what this syndrome is or how to define it. Studies on the prevalence of this syndrome have been constrained by the lack of a standard definition. Definitions proposed by the American Heart Association, International Diabetic Federation,

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American Diabetes Association and American Association of Clinical Endocrinologists differ in the number and content of factors used to define the syndrome. The 2 most commonly adopted definitions of the syndrome are those proposed by the World Health Organization (WHO) in 1998 and National Cholesterol Education Program – Adult Treatment Panel III (NCEP-ATPIII) in 2001. The WHO developed a definition in 1998 (revised in 1999)[6] stating that individuals need to show evidence of insulin resistance and at least 2 of 4 other factors (hypertension, dyslipidemia, obesity and microalbuminuria) to be considered as suffering from metabolic syndrome. More recently, 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) NCEP-ATPIII, provided a new working definition of the syndrome in 2001[7] (**Table 1**). The latter definition has been adopted to define the syndrome in the population of this study due to its simplicity and greater clinical applicability. Studies carried out on the prevalence of this syndrome in various parts of the world have found varying rates in the developed and developing nations.[8-12] However, we could find only 2 studies performed in the middle east and none in Saudi Arabia.[13-14]

Methods. King Khalid Military City is located about 60 Km away from Hafr Al-Batin, in Saudi Arabia, close to the border of Kuwait. The city has an approximate population of 120,000, of whom, approximately 25,000 are adult male soldiers of Saudi nationality. These soldiers hail from all regions in Saudi Arabia, reflecting a case mix similar to the distribution of Saudi male population in the age group of 20-60 years. Northern Area Armed Forces Hospital with its 9 satellite primary care clinics is the only hospital located within the precincts of the city and caters to all residents in the city. In this cross-sectional survey, physical examination was performed for a total of 2250 Saudi male soldiers aged ≥20 years in the year 2004. All soldiers presenting at the primary care clinics for medical care for themselves or for their family members, were examined. Though all subjects were given laboratory requests for investigations, only 1079 performed laboratory tests (response rate of 47.9%). Hence, complete data was available for 1079 subjects. The remaining 1171 subjects were considered missed and were excluded from the study sample. An analysis of the distribution of body mass index (BMI) categories and age-clusters together with the means of the physical characteristics among the responders and non-responders revealed no statistically significant difference. Anthropometric measurements were obtained at initial contact with the subject. A flexible, non-stretchable plastic measuring tape was used to determine waist circumference. Measurement was made at the mid-point between the costal margin and superior iliac crest to the nearest centimeter. Though BMI is not a component of the NCEP-ATPIII definition of metabolic syndrome, measurements of height and weight were obtained to facilitate analysis of the syndrome and its components with variations in BMI. Height and weight were measured with Healthometer scales manufactured by Continental Scale Corporation, Bridgeview, Illinois, USA. The scales were calibrated daily, before the start of the working day. Height was measured to the nearest centimeter; barefoot and without any headgear. Weight was measured to the nearest 100 grams in light clothing. Body mass index was calculated by dividing weight in kilograms by the square of height in meters. World Health Organization classification of BMI categories was used to segregate the subjects into 6 categories (**Table 2**). Blood pressure was measured after resting for 10-15 minutes. The measurement was made with the subject sitting in an office chair and the arm resting on the table with a standard mercury sphygmomanometer (Diplomat Presameter 660-360 manufactured by Riester GMBH, Germany). Measurements were made to the nearest millimeter of mercury. The mean of 3 readings was recorded in the data.

Each subject was then given a requisition for laboratory investigations. The patient was advised to attend the hospital laboratory after an overnight fast of 12 hours. Tests requested included fasting plasma glucose (FPG), serum high-density lipoprotein cholesterol (HDL-C) and serum triglycerides (TG). The tests were performed on Vitros Ektachem Analyzer manufactured by Ortho-Clinical Diagnostics of Rochester, New York, USA by quantitative colorimetric analysis. The same manufacturer supplied reagents used in the tests. Individuals with self-reported history of diabetes with anti-diabetic medication and those with FPG ≥7 mmol/L were considered diabetic. Data were entered into the statistical software program, Epi Info version 3.3, released by Centers for Disease Control and Prevention (CDC), Atlanta, Georgia, in October 2004. Bivariate and multivariate analysis was performed using ANOVA, a parametric test for inequality of population means, Bartlett's test for inequality of population variances and Kruskal-Wallis test for 2 groups. A p-value of <0.05 was considered statistically significant. The skewing of the age structure of the sample was corrected by adjustment of age against the standard Saudi population enumerated in 1992 census. Online software provided by the US Bureau of Census on its International Database website was used to calculate age-adjusted rates.

Results. The mean age of the subjects was 36.15 ± 7.2 years (mean ± SD) (range 20-60). For age-specific analysis, the subjects were divided into 4 clusters of 10 years each. Just over a half of the subjects (50.9%) were aged 31-40 years while those aged 51-60 years formed only 2.7% of the surveyed population. Subjects in the age ranges 20-30 and 41-50 formed about a quarter each of the study population (**Table 2**). Two hundred and one subjects were found to have ≥3 of the criteria for metabolic syndrome (crude rate of prevalence: 18.6%; age-adjusted prevalence: 20.8%). The prevalence of the syndrome was found to show a steady increase with rising age and BMI (**Table 2**). While the youngest age group (20-30 years old) had the lowest rate (8.9%), the oldest age group (51-60 years old) had the highest prevalence (37.9%). An analysis of the prevalence rates of the syndrome among the 6 BMI categories showed a steady increase with rise in BMI. While no case of metabolic syndrome was detected among the underweight subjects. The "normal" BMI subjects showed a prevalence of 3.9% and the overweight 10.4%. Over a quarter of class 1 obese and more than two-thirds of class 3 obese were found to conform to the definition of metabolic syndrome. Overall, 311 (28.8%) of the subjects did not have any of the criteria for metabolic syndrome. Among the rest, 298 (27.6%) had one factor and 269 (24.9%) had 2 factors. Of the remaining 201 subjects that qualified for the diagnosis of metabolic syndrome, 144 (13.4%) had 3 factors while 49 (4.5%) had 4 and 8 (0.7%) had all 5 criteria. Only 3 among the underweight subjects had a single factor while none exhibited more than one factor.

On the other hand, all subjects among class 3 obese exhibited at least one criterion for the syndrome. Among the 30 subjects in this group, 10% exhibited all 5 criteria, 20% showed 4 while 36% showed 3 criteria. Among the subjects with BMI in the normal range, approximately 4% could be defined with metabolic syndrome. Over three-fifths of these "normal" subjects had no factor for the syndrome while a fifth had a single factor. Approximately 15% had 2 factors. Among the overweight subjects, over one-third of the subjects lacked any of the criteria for the syndrome. About 29% exhibited a single factor while 22% showed 2 factors. Over 10% could be defined with metabolic

Table 1 - Definition of metabolic syndrome in adult males by the National Cholesterol Education Program Adult Treatment Panel III.

Presence of any 3 of the following 5 factors	
Waist circumference	>102 cm
Fasting plasma glucose	≥110 mg/dL (6.1 mmol/L)
Serum high density lipoprotein-cholesterol	≤40 mg/dL (1.04 mmol/L)
Serum triglycerides	≥150 mg/dL (1.69 mmol/L)
Blood pressure	Systolic pressure ≥ 130 mm Hg Diastolic pressure ≥ 85 mm Hg Use of medication for hypertension

Table 2 - Prevalence of criteria for metabolic syndrome (percentage prevalence with 95% confidence intervals within brackets) (N=1079).

Characteristics	≥1 (n=768)	≥2 (n=470)	≥3 (n=201)	≥4 (n=57)	5 (n=8)
Age clusters					
20-30 (n=257)	58 (54.4-61.6)	28.4 (26.6-30.2)	8.9 (8.4-9.5)	1.9 (1.8-2.1)	0.4 (0.36-0.41)
31-40 (n=549)	70.7 (67.7-73.7)	43.5 (41.7-45.4)	17.7 (16.9-18.4)	4.9 (4.7-5.1)	0.9 (0.87-0.95)
41-50 (n=244)	84 (78.6-89.4)	57 (53.3-60.6)	28.7 (26.9-30.5)	9.4 (8.8-10.0)	0.8 (0.77-0.87)
51-60 (n=29)	89.7 (73-96.3)	65.5 (53.4-77.7)	37.9 (30.9-45.0)	6.9 (5.6-8.2)	0
BMI categories					
Underweight (BMI <18.5) (n=10)	30 (20.5-39.5)	0	0	0	0
Normal (BMI=18.5-24.9) (n=181)	42 (38.9-45.1)	19.3 (17.8-20.7)	3.9 (3.6-4.2)	0.5 (0.46-0.54)	0
Overweight (BMI=25-29.9) (n=405)	62.5 (59.4-65.6)	40.5 (38.5-42.5)	10.4 (9.9-10.9)	2.5 (2.38-2.62)	0
Obese 1 (BMI= 30-34.9) (n=343)	86.6 (81.9-91.3)	57.4 (54.3-60.5)	26.2 (24.8-27.6)	8.2 (7.8-8.6)	1.2 (1.1-1.3)
Obese 2 (BMI=35-39.9) (n=110)	99.1 (98.7-99.7)	69.1 (62.5-75.7)	38.2 (34.6-41.8)	8.2 (7.4-8.9)	0.9 (0.8-1.0)
Obese 3 (BMI ≥40) (n=30)	100 (81.7-118.3)	93.3 (76.3-110.3)	66.7 (54.5-78.9)	30 (24.5-35.5)	10 (8.2-11.8)
Diabetes mellitus					
Non-diabetics (n=972)	68.0 (63.2 –72.8)	39.1 (35.6-42.6)	13.8 (11.9-15.7)	2.7 (2.0-3.4)	0.1 (0.03-0.17)
Diabetics (n=107)	100 (92.9-107.1)	84.1 (76.5-91.7)	62.6 (54.0-71.2)	28.9 (21.5-36.3)	6.5 (2.0-11.0)
Total (n=1079)	71.2 (66.2-76.2)	43.6 (39.7-47.5)	18.6 (16.0-21.2)	5.3 (3.9-6.7)	0.7 (0.21-1.19)
Age adjusted rates	73.5 (68.3-78.7)	45.9 (41.8-58.1)	20.8 (17.9-23.7)	6.0 (4.4-7.6)	0.7 (0.21-1.19)

syndrome, of whom 8% exhibited 3 factors and 2% showed 4 factors. None showed all 5 factors. Among class 1 obese, a sixth did not exhibit any of the criteria while 29% showed a single factor and 31% showed 2 factors. About a quarter could be defined with metabolic syndrome. Of these, 18% had 3 factors, 7% had 4 and 1% had all 5 factors. Among class 2 obese, 30% had a single factor while 30.9% had 2 factors. Less than 40% could be defined as metabolic syndrome. Among these, 30% had 3 factors, 7% had 4 factors and 1% had 5 factors. An analysis of the criteria among the diabetic and non-diabetic subjects (**Table 2**) showed that among the 8 subjects with all 5 criteria, 7 were diabetic. At least a single factor was found in all diabetics, while a third of the non-diabetics lacked any of the factors. While nearly two-thirds of the diabetic subjects exhibited the syndrome, <14% among the non-diabetic subjects had >3 of the criteria. Age-specific analysis of individual factors for the syndrome (**Table 3**) showed an increasing prevalence of the syndrome and its factors with rising age. The percentage prevalence of the syndrome showed a steady increase from a low of 8.9% among the youngest group to 37.9% among the oldest. The distribution of the individual criteria for the syndrome among the age clusters showed that the older age groups tended to have greater concentration of the factors. While over 40% of the youngest age group lacked any of the criteria for the syndrome, 29% of those aged between 31 and 40 years, 16% of those aged 41 to 50 years and 10% of the oldest group exhibited no factors for the syndrome.

Among the youngest age group, approximately 30% had a single factor, 20% had 2 factors, 7% had 3 factors, 1.5% had 4 factors and <0.5% had 5 factors. In the largest age-cluster of those aged between 31 and 40 years, 27% had a single factor, 26% had 2 factors, 13% had 3 factors, 4% had 2 factors and approximately 1% exhibited all 5 criteria. In the age group 41-50 years, about 27% showed a single factor, 28% had 2 factors, 19% had 3 factors and about 9% had 4 and 1% had 5 factors. Among the oldest group of subjects; however, the distribution of the factors was uneven with 24%

Table 3 - Prevalence of individual components of metabolic syndrome (percentage prevalence with 95% confidence intervals within brackets).

Characteristics	Waist circumference >102 cm	Blood pressure Systolic ≥130 mm Hg	Blood pressure Diastolic ≥85 mm Hg	Serum Triglycerides ≥1.69 mmol/L	Serum HDL-C ≤1.04 mmol/L	Fasting plasma glucose ≥6.1 mmol/L
Age clusters						
20-30 (n=257)	20.6 (15.8-26.1)	22.6 (17.6-28.2)	4.3 (2.2-7.5)	21.0 (16.2-26.5)	27.2 (21.9-33.1)	5.1 (2.7-8.5)
31-40 (n=549)	34.4 (30.5-38.6)	28.6 (24.9-32.6)	11.5 (9.0-14.5)	33.0 (29.1-37.1)	30.1 (26.3-34.1)	10.4 (8.0-13.3)
41-50 (n=244)	43.4 (37.1-49.9)	36.9 (30.8-43.3)	13.1 (9.1-18.0)	41.4 (35.1-47.9)	35.2 (29.3-41.6)	22.5 (17.5-28.3)
51-60 (n=29)	31.0 (15.3-50.8)	44.8 (26.4-64.3)	20.7 (8.0-39.7)	37.9 (20.7-57.7)	34.5 (17.9-54.3)	37.9 (20.7-57.7)
p-value	<0.001	0.0012	0.001	< 0.001	0.248	<0.001
BMI categories						
Underweight (n=10)	0 (0-30.8)	10.0 (0.3-44.5)	0 (0-30.8)	10 (0.3-44.5)	10 (0.3-44.5)	0 (0-30.8)
Normal (n=181)	0 (0-2.0)	14.4 (9.6-20.3)	2.8 (0.9-6.3)	19.9 (14.3-26.5)	23.8 (17.8-30.6)	7.7 (4.3-12.6)
Overweight (n=405)	5.9 (3.9-8.8)	28.1 (23.9-32.8)	7.9 (5.5-11.1)	30.4 (26.0-35.1)	30.6 (26.2-35.4)	12.3 (9.4-16.0)
Obese Class 1 (n=343)	56.6 (51.1-61.9)	34.1 (29.2-39.4)	13.4 (10.1-17.6)	39.1 (33.9-44.5)	33.5 (28.6-38.3)	15.7 (12.1-20.1)
Obese Class 2 (n=110)	99.1 (95.0-100)	39.1 (29.9-48.9)	15.5 (9.3-23.6)	31.8 (23.3-41.4)	30.9 (22.4-40.4)	10 (5.1-17.2)
Obese Class 3 (n=30)	100 (88.4-100)	56.7 (37.4-74.5)	40.0 (22.7-59.4)	60.0 (40.6-77.3)	46.7 (28.3-65.7)	23.3 (9.9-42.3)
p-value	<0.001	<0.001	< 0.001	0.01	0.103	0.032
Diabetes mellitus						
Non-diabetics (n=972)	32.4 (29.5-35.5)	27.6 (24.7-30.4)	8.9 (7.3-11.0)	29.5 (26.7-32.5)	28.9 (26.0-31.8)	4.3 (3.2-5.8)
Diabetics (n=107)	39.3 (30.0-49.2)	47.7 (37.9-57.5)	23.4 (15.7-32.5)	56.1 (46.1-65.7)	47.7 (37.9-57.5)	87.9 (80.1-93.4)
p-value	0.064	<0.001	<0.001	<0.001	<0.001	<0.001
Total (n=1079)	33.1 (30.3-36.0)	29.5 (26.8-32.3)	10.4 (8.7-12.7)	32.2 (29.4-35.1)	30.7 (28.0-33.5)	12.6 (10.7-14.8)

showing a single factor, 27% showing 2 factors, 31% showing 3 factors and about 7% showing 4 factors. None exhibited all 5 factors.

Among the individual components of the syndrome, abdominal obesity (Waist circumference > 102cm) was found to have the highest prevalence (33%), closely followed by raised serum triglycerides (32%), low serum high density lipoprotein-cholesterol (HDL-C) (31%) and raised systolic blood pressure (29%). Raised fasting plasma glucose (13%) and raised diastolic blood pressure (10%) were less common findings. Except for high waist circumference, the other factors showed a higher prevalence among the older age groups. Abdominal obesity was found to be more common among those aged 31-50 years than among the youngest or the oldest age groups. On analysis of the prevalence of these individual factors among the 6 BMI categories (**Table 3**), all factors showed a steady increase with rise in BMI with one exception. The prevalence of high-risk laboratory criteria for the syndrome in class 2 obese was found to drop against the general trend of a steady rise with BMI. While over a half of the subjects with class 1 obesity had abdominal obesity, this factor was universal among those with class 2 and 3 obesity. About half the subjects among class 3 obese and a third among class 1 and 2 obese had either lowered serum HDL-C or raised systolic BP or serum triglycerides. A bivariate analysis of the means of individual components of the syndrome with age and BMI showed a steady increase with increases in age and BMI with 2 exceptions (**Table 4**). Serum HDL-C showed a decline with age and rising BMI. The means for laboratory criteria for class 2 obese were not found consonant with the declining trend for other groups. There was a decline in the means for this group followed by a sharp rise for class 3 obese. The prevalence and means of the individual components of the syndrome were analyzed among the diabetic and non-diabetic subjects (**Tables 3 & 4**). Prevalence of raised blood pressure and high-risk laboratory criteria was significantly higher among the diabetics. Though abdominal obesity was more prevalent among the diabetics, the difference was not statistically significant. An analysis of the

Table 4 - Means of individual components of Metabolic syndrome (means ± standard deviation with range shown within brackets).

Characteristics	Waist Circumference	Blood pressure Systolic	Blood pressure Diastolic	Serum Triglycerides	Serum HDL-C	Fasting plasma glucose
Age-groups						
20-30 (n=257)	91.7 ± 13.04 (64-126)	115.5 ± 11.9 (100-150)	73.7 ± 6.9 (60-100)	1.34 ± 0.8 (0.35-5.12)	1.25 ± 0.3 (0.7-2.61)	4.91 ± 1.32 (3.08-18.9)
31-40 (n=549)	98.7 ± 12.5 (61-163)	118.1 ± 13.3 (90-180)	75.9 ± 8.6 (60-120)	1.6 ± 1.04 (0.11-9.8)	1.26 ± 0.38 (0.6-3.46)	5.45 ± 1.88 (3.1-20.71)
41-50 (n=244)	99.4 ± 11.3 (68-128)	121.3 ± 14.5 (90-170)	77.2 ± 7.8 (60-100)	1.75 ± 0.99 (0.49-6.4)	1.22 ± 0.4 (0.5-3.5)	6.19 ± 2.65 (3.9-18.14)
51-60 (n=29)	99.8 ± 8.1 (87-120)	125.9 ± 19.7 (100-170)	77.6 ± 9.5 (60-100)	1.9 ± 1.65 (0.87-9.9)	1.19 ± 0.26 (0.8-1.6)	7.0 ± 2.39 (4.77-11.85)
p value	<0.001	< 0.001	<0.001	<0.001	0.122	<0.001
BMI categories						
Underweight (n=10)	66.6 ± 3.5 (61-71)	107 ± 12.5 (100-140)	70 ± 4.7 (60-80)	0.92 ± 0.43 (0.35-1.8)	1.33 ± 0.06 (0.9-1.7)	4.7 ± 0.6 (4.08-5.94)
Normal (n=181)	81.1 ± 6.9 (65-100)	112.4 ± 12.1 (90-160)	72.7 ± 6.1 (60-90)	1.33 ± 0.9 (0.43-6.4)	1.32 ± 0.37 (0.5-2.7)	5.2 ± 1.9 (3.7-16.8)
Overweight (n=405)	93.4 ± 5.8 (70-109)	117.5 ± 13.2 (90-170)	75.1 ± 7.9 (60-110)	1.6 ± 1.1 (0.33-9.9)	1.26 ± 0.4 (0.6-3.46)	5.5 ± 1.9 (3.1-18.9)
Obese Class 1 (n=343)	103.8 ± 5.8 (89-120)	120.7 ± 13.5 (98-180)	76.8 ± 8.5 (60-120)	1.7 ± 0.95 (0.45-6.7)	1.22 ± 0.35 (0.69-3.5)	5.7 ± 2.2 (4.2-20.7)
Obese Class 2 (n=110)	113.7 ± 5.4 (102-126)	123.3 ± 13.5 (100-170)	78.2 ± 8.2 (60-110)	1.6 ± 0.82 (0.1-5.3)	1.17 ± 0.26 (0.7-2.1)	5.5 ± 1.5 (3.9-12.9)
Obese Class 3 (n=30)	126.2 ± 11.4 (110-163)	126.7 ± 13.7 (100-150)	82.9 ± 9.2 (70-100)	2.1 ± 1.4 (0.85-6.7)	1.16 ± 0.46 (0.7-3.2)	6.4 ± 3.1 (4.3-18.0)
p value	<0.001	<0.001	<0.001	<0.001	0.0069	0.023
Diabetes						
Non-Diabetic (n=972)	97.03 ± 12.7 (61-163)	117.7 ± 13.0 (90-180)	75.4 ± 8.03 (60-120)	1.5 ± 0.86 (0.1-8.6)	1.26 ± 0.37 (0.6-3.5)	5.0 ± 0.57 (3.2-6.9)
Diabetic (n=107)	100.7 ± 11.6 (75-142)	125.6 ± 16.5 (100-170)	78.9 ± 8.7 (60-104)	2.36 ± 1.7 (0.51-9.9)	1.1 ± 0.4 (0.5-3.5)	10.3 ± 3.7 (4.03-20.7)
p value	0.0147	0.001	0.0016	<0.001	<0.001	<0.001
Total (n=1079)	97.4 ± 12.7 (61-163)	118.4 ± 13.6 (90-180)	75.7 ± 8.2 (60-120)	1.58 ± 1.01 (0.11-9.9)	1.25 ± 0.37 (0.5-3.5)	5.53 ± 2.05 (3.1-20.7)

means of the components between the 2 groups showed higher values among the diabetics for all criteria with a greater statistical significance for the difference for laboratory criteria than for anthropometric measurements. A separate analysis of the physical components of the syndrome among the subjects who presented for laboratory investigations (responders) and those who did not (non-responders) was performed to determine the presence of any statistical discrepancy between the 2 groups. The mean age of the non-responders was marginally lower than the responders, with a similar age distribution. The youngest age clusters aged 20-40 years formed the largest category in both the groups, contributing to over three-fourths of the subjects. The distribution of the BMI categories was also similar in the 2 groups, with the overweight subjects forming the largest cluster (37.5% among the responders and 39.1% among the non-responders), while underweight subjects formed the smallest group. The means and prevalence rates of the physical characteristics for metabolic syndrome (waist circumference, diastolic blood pressure and systolic blood pressure) were lower for the non-responders. The mean BMI among the responders and non-responders was 29.4 ± 5.1 and 28.1 ± 5.1. Similarly, the mean diastolic blood pressure was 75.7 ± 8.2 mm Hg among the responders and 75.1 ± 7.5 mm Hg among the non-responders while the mean systolic pressure was 118.4 ± 13.6 among the responders and 117.2 ± 12.8 mm Hg among the non-responders. The prevalence rates for these physical characteristics among the 2 groups were also lower for the non-responders.

Discussion. This study estimates the prevalence of metabolic syndrome in Saudi Arabia. Though previous studies have assessed the prevalence of individual components of the syndrome among the Saudis, we could not find any study that assessed the clustering of these components in the form of metabolic syndrome among Saudis. The age-adjusted prevalence of the syndrome (20.8%) in the study population was found to conform to the rates found in other studies, both in the Middle East and elsewhere. Using the NCEP-ATPIII criteria, Ford et al[8] found an age-adjusted prevalence of 23.9% using the data from a nationally representative sample of Americans derived from a cross-sectional health survey. Alexander et al[9] found a prevalence of 43.5% among subjects older than 50 years from the data derived from the same survey. Jaber et al[10] found a prevalence of 23% among Arab Americans in their study performed in 2004. Meigs et al[11] studied a large multi-ethnic cohort demographically representative of the US population and found an overall prevalence of the syndrome in 24% of the general population, with an inter-ethnic variation of 21-31%. Villegas et al[12] found a prevalence of 20.7% among Irish middle-aged men and women. Using the WHO definition of metabolic syndrome, Abdul-Rahim et al[13] found a prevalence of 17% among the Palestinians in the West Bank. Al-Lawati et al,[14] in their study of the prevalence of the syndrome among Omani adults, found a prevalence of 21%. The number of individuals possessing the criteria for the syndrome increased with increasing age and BMI. Abdominal obesity and dyslipidemia were the most common components of the syndrome. Fasting plasma glucose and diastolic blood pressure were the least common. Older individuals and those with higher BMIs were found to have a higher concentration of the factors. More than a half of the subjects did not return for laboratory investigations (non-responders). This high rate of non-responders could be attributed to the nature of duties of the soldiers which demand punctual attendance at their place of work early in the morning at 06.30 hours on every working day of the week. The timing of the hospital laboratory was not convenient for these soldiers for submission of their blood samples. Another possible reason could be the frequent movement of soldiers away from their base for military maneuvers. Finally, the fear of the subjects that abnormal results would reflect badly on their service records would also discourage them from submission of blood samples in the laboratory. The prevalence of metabolic syndrome in the general Saudi population is likely to be higher than the estimated prevalence in the present study since the population studied here was confined to adult male military personnel. Another limitation of the study relates to the recruitment of the subjects. The subjects were chosen from those attending the primary care clinics. However, they were not confined to those seeking medical care for themselves but included visitors escorting patients. Another study is in progress at this institution to assess the prevalence of metabolic syndrome among adult female Saudis residing in King Khalid Military City, Riyadh, Saudi Arabia. It is shown that over a fifth of the Saudi adult male soldiers have the metabolic syndrome and are at high risk for both cardiovascular disease and diabetes mellitus. Similar studies are required among a wider range of subjects to assess the scope of the problem in Saudi Arabia. There is an urgent need to motivate the physicians at the primary care level to identify the problem and implement requisite remedial measures focusing on weight control, increased physical activity and healthy dietary practices. Public health measures to educate the general population on the risks of obesity, unhealthy food and physical inactivity will hopefully contribute to a reduction in the prevalence of this syndrome in the Saudis.

References

1. Avogaro P, Crepaldi G, Enzi G, Tiengo A. Associazione di iperlipidemia, diabeto mellito e obesita di medio grado. ***Acta Diabetol Lat*** 1967; 4: 36-41.
2. Haller H. Epidemiologie und assozierte Riskofaktoren der Hyperlipoproteinamie. ***Z Gesante Inn Med*** 1977; 32: 124-128.
3. Reaven GM. Banting Lecture 1988: Role of Insulin resistance in human disease. ***Diabetes*** 1988; 37: 1595-1607.
4. Ferrannini E, Haffner SM, Mitchelli BD, Stern MP. Hyperinsulinemia: the key feature of a cardiovascular and metabolic syndrome. ***Diabetologia*** 1991; 34: 416-422.
5. Meigs JB, D'Agostino RB, Wilson PWF, Cupples LA, Nathan DM, Singer DE. Risk variable clustering in the insulin resistance syndrome: the Framingham Offspring Study. ***Diabetes*** 1997; 46: 1594-1600.
6. World Health Organization. Definition, Diagnosis and Classification of Diabetes Mellitus and its Complications. Part 1: Diagnosis and Classification of Diabetes Mellitus. Geneva; WHO; 1999 (WHO/NCD/99.2).
7. Executive Summary of the Third Report of The National Cholesterol Education Program (NCEP) Expert Panel on Detection, Evaluation and Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel III). ***JAMA*** 2001; 285: 2486-2497.
8. Ford ES, Giles WH, Dietz WH. Prevalence of the metabolic syndrome among US adults: findings from the Third National Health and Nutrition Examination Survey. ***JAMA*** 2002; 287: 356-359.
9. Alexander CM, Landsman PB, Teutsch SM, Haffner SM. NCEP defined metabolic syndrome, diabetes mellitus and prevalence of coronary heart disease among NHANES III participants aged 50 years and older. ***Diabetes*** 2003; 52: 1210-1214.
10. Jaber LA, Brown MB, Hammad A, Zhu Q, Herman WH. The prevalence of the metabolic syndrome among Arab Americans. ***Diabetes Care*** 2004; 27: 234-238.
11. Meigs JB, Wilson PWF, Nathan DM, D'Agostino RB, Williams K, Haffner SM. Prevalence and Characteristics of the metabolic syndrome in the San Antonio Heart and Framingham Offspring Studies. ***Diabetes*** 2003; 52: 2160-2167.
12. Villegas R, Perry IJ, Creagh D, Hinchion R, O'Halloran D. Prevalence of the metabolic syndrome in middle-aged men and women. ***Diabetes Care*** 2003; 26: 3198-3199.
13. Abdul-Rahim HE, Husseini A, Bjertness E, Giacaman R, Gordon NH, Jervell J. The metabolic syndrome in the West Bank population. ***Diabetes Care*** 2001; 24: 275-279.
14. Al-Lawati JA, Ali JM, Al-Hinai HQ, Jousilahti P. Prevalence of the metabolic syndrome among Omani adults. ***Diabetes Care*** 2003: 26: 1781-1785.