Obesity and cardiovascular risk factors in Saudi adult soldiers

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ABSTRACT

Objective: To examine the relationship between obesity and cardiovascular risk factors among men aged 20 years and above.

Methods: The study involved a cross-sectional survey of 2,250 Saudi male soldiers aged between 20 and 60 years residing in a military city in northern Saudi Arabia conducted in 2004. Anthropometric measurements, blood pressure, and a brief medical history were obtained in a pre-set questionnaire. Serum lipid profile and fasting plasma sugar were requested for all the subjects. A total of 1,079 subjects responded with a response rate of 47.9%. A multivariate analysis was performed to assess the relationship between general obesity, abdominal obesity, and cardiovascular risk factors.

Results: Over 82% of the subjects were either overweight or obese. Abdominal obesity was found in one third, and approximately half were either current or ex-smokers. The means of anthropometric and laboratory measured risk factors for cardiovascular disease showed a progressive rise with increase in age, abdominal, and general obesity.

Conclusion: This study has shown a high prevalence of overweight and obesity positively correlated with the prevalence of cardiovascular risk factors among Saudi adult male soldiers. There is a need for concerted efforts aimed at achieving ideal body-weight together with a reduction in the co-existent risk factors for cardiovascular disease.

Saudi Med J 2005; Vol. 26 (8): 1260-1268

Obesity is an epidemic all around the world, including Saudi Arabia. Globally, it is estimated that there are one billion overweight or obese adults, at least 300 million of them clinically obese.[1] It is the second leading cause of preventable deaths after tobacco.[2] The rapid socioeconomic development during the past 4 decades in Saudi Arabia has been accompanied by drastic lifestyle changes where high-calorie diet and diminished physical activity are the fundamental components of lifestyle contributing to increased prevalence of obesity and associated diseases.[3] The present study was devised to assess the prevalence of obesity and its association with cardiovascular risk factors among Saudi adult male soldiers residing at King Khalid Military City (KKMC), which is located approximately 60 km to the West of Hafr Al-Batin in the north of Saudi Arabia, close to the border with Kuwait. The soldiers hail from all parts of the Kingdom, representing a broad case mix of the normal distribution of the overall Saudi population of this gender and age group. Previous studies conducted in different regions of Saudi Arabia have found widely varying prevalence rates of obesity and overweight among the population. The present study was designed to assess the prevalence of obesity and overweight among the armed forces personnel in active service, together with its association with cardiovascular risk factors

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Received 1st March 2005. Accepted for publication in final form 31st May 2005.

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including hypertension, smoking, and metabolic factors comprising adverse lipid profile and impaired glucose metabolism.

Methods. In this cross-sectional survey, out of approximately 25,000 male Saudi soldiers residing in this city, 2,250 were examined in the year 2004 in all the primary care clinics in KKMC. All soldiers presenting at the primary care clinics for medical care for themselves or for their family members were included in the study. Out of a total of 2,250 individuals surveyed in the study, only 1,079 submitted for laboratory investigations with a response rate of 47.9%. The non-responders were excluded from the study. The nature of duties and the frequent movement on official duty by the subject population together with a fear of adverse effect of abnormal results on their service records could be the possible reasons for a poor response rate in this study. To improve the response rate, non-responders were contacted individually by telephone and requested to present themselves at the hospital laboratory for collection of blood samples. However, this failed to improve the response rate beyond the rate achieved. Anthropometric measurements were obtained at initial contact with the subject. 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 gms in light clothing. Body Mass Index (BMI) was calculated by dividing weight in kilograms by the square of height in meters. A flexible, non-stretchable plastic measuring tape was used to determine waist and hip circumferences to the nearest centimeter. Waist circumference was measured at a level midway between the superior iliac crest and the costal margin in the mid-axillary line. Hip circumference was measured at the maximal gluteal protuberance from the lateral view over undergarments. Waist-Hip Ratio (WHR) was calculated by dividing waist circumference by hip circumference. A waist circumference greater than 102 cm or a WHR greater than one were defined as abdominal obesity. Blood pressure was measured after resting in the waiting room 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). An appropriate cuff size was used for the obese subjects. The point of appearance of the first Korotkoff sound was considered systolic blood pressure (SBP) while the point of disappearance of last Korotkoff sound marked diastolic blood pressure (DBP). Measurements were made to the nearest millimeter of mercury. The mean of 3 readings was recorded in the data-sheet. The subjects were categorized into 4 groups based upon the classification of blood pressure by the Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation and Treatment of High Blood Pressure (The JNC 7 Report).[4] Those with a self-reported history of hypertension with current anti-hypertensive medication and those with a DBP ≥ 90 mm Hg or a SBP ≥ 140 mm Hg were considered hypertensive. The hypertensive subjects were further categorized into stage 1 (DBP: 90-99 mm Hg or SBP: 140-159 mm Hg), and stage 2 (DBP ≥ 100 or SBP ≥ 160 mm Hg). Those with a DBP < 80 mm Hg, and a SBP < 120 mm Hg were considered normotensive. The remaining subjects with blood pressure falling in the range between normotension and hypertension were classified as prehypertensive. Simultaneously, a brief medical history was obtained in a pre-set questionnaire seeking details of other co-morbid conditions including diabetes mellitus, cholelithiasis, osteoarthrosis, and depression. History of smoking and daily physical activity was recorded. The subject was then supplied with a requisition for laboratory investigations with advice to attend the hospital laboratory after an overnight fast of 12 hours. Laboratory tests requested included fasting plasma glucose (FPG), serum total cholesterol (TC), low-density lipoprotein cholesterol (LDL-C), triglycerides (TG) and high-density lipoprotein-cholesterol (HDL-C). These tests were performed with 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. Data were entered into the statistical software program, Epi Info, version 3.3, released by the Centers for Disease Control and Prevention (CDC), Atlanta, Georgia, USA in October 2004. The skewing of the age structure of the study population was corrected by adjustment of age against the standard Saudi population. All baseline characteristics were presented as percentages for discrete variables or as mean ± SD for continuous variables. The groups were compared with the use of chi-square test for discrete variables and analysis of variance for continuous variables.

Statistical analysis was performed by 2-factor ANOVA test to obtain the *p*-value. A *p*-value < 0.05 was considered significant.

Results. The mean age of the subjects was 36.1 ± 7.2 years (mean ± SD) (range 20-60). The population was divided into 4 clusters of age groups of 10 years each. More than half of the subjects (50.9%) were aged between 31 and 40 years, while the oldest age group of 51-60 year olds formed only

2.7% of the study population. The youngest group formed the second largest group (23.8%) while the group aged 41-50 years made up the rest (22.6%). The study subjects had a mean BMI of 29.4 ± 5.06 (range 16.12-55.36). The World Health Organization (WHO) classification of BMI categories[5] was used to segregate the subjects into 6 categories. While overweight subjects formed the largest group (37.5%), underweight subjects were the least common (less than 1%). Class 1 obese formed a sizable group of 31.6% while class 2 and 3 obesity were present in 10.2% and 2.1% of the subjects. Subjects with BMI within the normal range formed only 18.1% of the study population. In other words, more than 80% of the study subjects were either overweight or obese. Age-wise distribution of the BMI categories revealed that the youngest age cluster had the lowest prevalence of overweight and obesity (71.9%) while the oldest group had the highest prevalence (89.7%). The subjects had a mean waist circumference (WC) of 97.4 ± 12.7 cm (61-163), and a mean WHR of 0.97 ± 0.07 (0.72-1.23). The means of both these indices of abdominal obesity showed an incremental rise with age and BMI category **(Tables 1 and 2)**. Abdominal obesity based upon WC greater than 102 cm was present in 33.1% of the subjects while WHR greater than one was found in 32.9% of the subjects. Though overall prevalence of high-risk WC and WHR was approximately equal, age specific prevalence of abdominal obesity defined by each of these markers differed markedly. While there was a steady rise in the prevalence of WHR-defined abdominal obesity with increasing age, prevalence of high-risk WC among the oldest group dropped to a rate lower than the 31-50 year-old age groups. Waist circumference was found to be a better measure of abdominal obesity among the younger and obese subjects while WHR was a better predictor of this parameter among the older subjects, and those with lower BMI values. In the youngest age group, while WC showed abdominal obesity among 53 subjects, WHR indicated its presence in only 33 subjects. Alternately, while WC showed abdominal obesity in 9 subjects among the oldest group, WHR indicated its presence in 18 subjects. Similarly, WC did not reveal abdominal obesity among the subjects with "normal" BMI. However, WHR showed abdominal obesity among 12 of these subjects. Conversely, among the obese, with BMI ≥ 30, WC was a better indicator of abdominal obesity, showing a steady rise in the prevalence of abdominal obesity with rise in BMI. However, WHR showed a dip in the prevalence rate of abdominal obesity among class 3, showing up in only 18 of the 30 subjects.

The subjects were categorized into 4 groups based upon the classification of blood pressure by JNC-7.[4] Only one third of the subjects were found to have normal blood pressure, while over a half had prehypertension **(Table 3)**. Of the rest, 12.2% had stage one and 2.6% had stage 2 hypertension. Age-specific analysis showed a steady increase in the prevalence of frank hypertension with rising age **(Table 3)**, with the lowest incidence (7.4%) among the youngest group and a quadrupling of the prevalence rate among the oldest (31.1%). However, prehypertension showed the highest prevalence in the younger age groups, with approximately half the 20-50 years old having their blood pressure in this range. The proportion of individuals with normal blood pressure declined with rising age. While over two-fifths of the youngest age group had a normal reading, a third of the 31-40 year olds and only a quarter of 41-60 year olds had blood pressure in the normal range. An analysis of the prevalence of hypertension among the 6 BMI categories showed that frank hypertension was present in nearly half the subjects with class 3 obesity and a fifth of those with class 2 obesity. Among the overweight and those with class 1 obesity, the prevalence ranged from 10-15%. However, among those with normal BMI, the prevalence was only 5.6%. Prehypertension was present in more than a half of the overweight and obese class 1 and 2. Over 40% of those with normal BMI had prehypertension. The mean values of both DBP and SBP showed a steady rise with increasing age, abdominal, and general obesity **(Tables 1, 2 and 4)**.

Individuals with self-reported history of diabetes with current anti-diabetic medication and those with a FPG ≥7 mmol/L were considered diabetic. Those with a FPG <6.1 mmol/L were considered to be normoglycemic while those with an FPG ≥6.1 mmol/L but <7 mmol/L, were considered to have impaired fasting plasma glucose (IFPG), as per the guidelines of American Diabetes Association.[6] While 78% of the subjects were found to be normoglycemic, 13.8% had IFPG, and 8.3% frankly diabetic **(Table 3)**. It was seen that the prevalence of diabetes and IFPG rose with rising age and obesity. Their prevalence showed a doubling with the presence of abdominal obesity. The means of FPG showed a rise with increasing age, BMI, and the presence of abdominal obesity. The differences among the various age groups, BMI categories and abdominal obesity were found to be statistically significant. (**Tables 1, 2 and 4)** High-risk values for serum lipid components were based upon the Third Report of the National Cholesterol Education Program (NCEP) Adult Treatment Panel III.[7] Dyslipidemia was present in one third of the study population. Hypercholesterolemia (TC ≥5.18 mmol/L), Hypertriglyceridemia (TG ≥1.69 mmol/L), raised serum LDL cholesterol (≥4.14 mmol/L) and low serum HDL cholesterol (≤0.9 mmol/L) were found in 35.8%, 32.2%, 8%, and 15.4% of the subjects **(Table 3).** Age-specific analysis of the

Table 1 - Body mass index (BMI) category specific means of anthropometric and laboratory characteristics. (Means ± SD; Range within brackets)

Characteristics	BMI categories Underweight (n=10)	Normal (n=181)	Overweight (n=405)	Class 1 Obese (n=343)	Class 2 Obese (n=110)	Class 3 Obese (n=30)	*P*-value
Age	33.1 ± 5.6 (24-36)	34.5 ± 7.9 (20-52)	36.3 ± 7.2 (20-60)	36.9 ± 6.9 (20-60)	36.4 ± 6.7 (24-56)	35.6 ± 6.9 (20-50)	0.0088
BMI (Kg/M^2)	17.7 ± 0.74 (16.1-18.1)	22.8 ± 1.7 (18.8-24.9)	27.4 ± 1.4 (25-29.9)	31.9 ± 1.5 (30-34.9)	36.8 ± 1.4 (35.7-39.6)	43.4 ± 3.5 (40.1-55.4)	< 0.001
Waist circumference (cm)	66.6 ± 3.5 (61-71)	81.1 ± 6.9 (65-100)	93 ± 5.7 (70-109)	103.8 ± 5.8 (89-120)	113.7 ± 5.4 (102-126)	126.2 ± 11.4 (110-163)	< 0.001
Waist hip ratio	0.81 ± 0.6 (0.72-0.89)	0.9 ± 0.07 (0.73-1.08)	0.96 ± 0.06 (0.78-1.13)	1 ± 0.5 (0.84-1.23)	1.02 ± 0.6 (0.89-1.13)	1.03 ± 0.7 (0.85-1.15)	< 0.001
Systolic BP (mm Hg)	107 ± 12.5 (100-140)	112.4 ± 12.1 (90-160)	117.5 ± 13.1 (90-170)	120.7 ± 13.5 (98-180)	123.3 ± 13.5 (100-170)	126.7 ± 13.7 (100-150)	< 0.001
Diastolic BP (mm Hg)	70 ± 4.7 (60-80)	72.7 ± 6.1 (60-90)	75.1 ± 7.9 (60-110)	76.8 ± 8.5 (60-120)	78.2 ± 8.2 (60-110)	82.9 ± 9.2 (70-100)	< 0.001
Fasting plasma glucose (mmol/L)	4.7 ± 0.5 (4.1-5.9)	5.2 ± 1.9 (3.7-16.8)	5.5 ± 1.9 (3.08-18.9)	5.7 ± 2.2 (3.1-20.7)	5.5 ± 1.5 (3.9-12.9)	6.4 ± 3.1 (4.3-18.03)	0.023
Total cholesterol (mmol / L)	4.5 ± 1.07 (3.5-6.3)	4.7 ± 0.82 (2.9-7.3)	4.9 ± 0.9 (2.2-7.9)	5.02 ± 0.8 (3.1-7.4)	4.9 ± 0.9 (3.1-8)	4.9 ± 0.9 (1.9-6.5)	< 0.001
LDL-cholesterol (mmol/L)	2.7 ± 1.1 (1.6-4.7)	2.7 ± 0.69 (1-4.6)	2.9 ± 0.84 (0.3-5.6)	3.02 ± 0.79 (0.5-5.8)	3.02 ± 0.9 (0.7-5.5)	2.8 ± 0.84 (0.2-4.1)	0.002
Serum triglycerides (mmol/L)	0.92 ± 0.4 (0.35-1.8)	1.3 ± 0.9 (0.43-6.4)	1.6 ± 1.1 (0.33-9.9)	1.7 ± 0.9 (0.45-6.7)	1.6 ± 0.8 (0.11-5.25)	2.1 ± 1.4 (0.85-6.69)	< 0.001
Serum HDL-cholesterol (mmol/L)	1.33 ± 0.24 (0.90-1.7)	1.32 ± 0.37 (0.5-2.72)	1.26 ± 0.4 (0.6-3.46)	1.22 ± 0.3 (0.69-3.5)	1.18 ± 0.26 (0.7-2.09)	1.16 ± 0.46 (0.7-3.2)	0.0069

BMI - body mass index, BP - blood pressure, LDL - low-density lipoprotein, HDL - high-density lipoprotein

Table 2 - Age-specific means of anthropometric and laboratory values. (Means ± SD; Range within brackets)

Characteristics	Age groups 20-30 (n=257)	31-40 (n=549)	41-50 (n=244)	51-60 (n=29)	*P*-value
Age	27.0 ± 2.6 (20-30)	35.7 ± 2.8 (31-40)	44.6 ± 2.9 (41-50)	53.3 ± 2.5 (51-60)	< 0.001
BMI (Kg/M^2)	27.9 ± 4.9 (17.1-43.2)	29.9 ± 5.2 (16.1-55.4)	29.6 ± 4.6 (18.8-44.9)	28.9 ± 3.2 (23.5-35.3)	< 0.001
Waist circumference (cm)	91.7 ± 13.0 (64-126)	98.7 ± 12.5 (61-163)	99.9 ± 11.3 (68-128)	99.8 ± 8.1 (87-120)	< 0.001
Waist hip ratio	0.92 ± 0.07 (0.75-1.12)	0.98 ± 0.62 (0.72-1.2)	1.0 ± 0.06 (0.8-1.23)	1.02 ± 0.05 (0.9-1.12)	< 0.001
Systolic BP (mm Hg)	115.5 ± 11.9 (100-150)	118.1 ± 13.2 (90-180)	121.3 ± 14.5 (96-170)	125.9 ± 19.7 (100-170)	< 0.001
Diastolic BP (mm Hg)	73.7 ± 6.9 (60-100)	75.9 ± 8.6 (60-120)	77.2 ± 7.8 (60-100)	77.6 ± 9.5 (60-100)	< 0.001
Fasting plasma glucose (mmol/L)	4.9 ± 1.3 (3.08-18.9)	5.4 ± 1.8 (3.1-20.7)	6.2 ± 2.6 (3.9-18.1)	7 ± 2.4 (4.8-11.8)	< 0.001
Total cholesterol (mmol / L)	4.7 ± 0.86 (2.8-7.1)	4.95 ± 0.91 (2.9-7.92)	4.98 ± 0.85 (2.48-8.03)	4.96 ± 0.7 (3.4-6.5)	<0.001
LDL-cholesterol (mmol/L)	2.8 ± 0.78 (1.2-5.1)	2.9 ± 0.85 (0.2-5.8)	2.9 ± 0.78 (1.03-4.9)	2.85 ± 0.72 (1-3.7)	0.075
Serum triglycerides (mmol/L)	1.34 ± 0.78 (0.35-5.12)	1.6 ± 1.04 (0.11-9.87)	1.75 ± 0.9 (0.49-6.36)	1.95 ± 1.65 (0.87-9.95)	< 0.001
Serum HDL-cholesterol (mmol/L)	1.25 ± 0.31 (0.7-2.6)	1.26 ± 0.38 (0.6-3.5)	1.22 ± 0.41 (0.5-3.5)	1.2 ± 0.26 (0.8-1.6)	0.49

BMI - body mass index, BP - blood pressure, LDL - low-density lipoprotein, HDL - high-density lipoprotein

Table 3 - Prevalence of cardiovascular risk factors in the study population.

	Smoking	**Blood pressure**			**Impared glucose metabolism**			**High-risk lipid profile components**		
	Smokers (n=205)	**Pre-Htn (n=566)**	**Stage 1 Hypertension (n=126)**	**Stage 2 Hypertension (n=28)**	**Diabetes mellitus (n=89)**	**Impaired FPG (n=149)**	**Total cholesterol (n=386)**	**LDL-cholesterol (n=86)**	**Serum triglycerides (n=347)**	**HDL-cholesterol (n=166)**
Total (n=1079)	19 (17.7-20.3)	52.5 (49.4-55.5)	11.7 (9.9-13.8)	2.6 (1.8-3.8)	8.3 (6.7-10.1)	13.8 (11.8-16.0)	35.8 (32.9-38.7)	8.0 (6.5-9.8)	32.2 (29.4-35.1)	15.4 (13.3-17.7)
Age groups										
20-30 (n=257)	25.7 (20.5-61.1)	49.4 (43.1-55.7)	6.2 (3.6-9.9)	1.2 (0.2-3.4)	1.6 (0.4-3.9)	8.2 (5.1-12.2)	23.7 (18.7-29.4)	7.0 (4.2-10.8)	21.0 (16.2-26.5)	12.5 (8.7-17.1)
31-40 (n=549)	18.4 (15.3-22.0)	53.9 (49.6-58.1)	10.8 (8.3-13.7)	2.7 (1.6-4.6)	7.3 (5.3-9.9)	12.2 (9.6-15.3)	39.9 (35.8-44.1)	8.9 (9.6-15.3)	33.0 (29.1-37.1)	14.0 (11.3-17.3)
41-50 (n=244)	14.3 (20.1-31.4)	53.3 (46.8-59.7)	18.4 (13.8-23.9)	2.9 (1.2-5.8)	14.8 (10.6-19.8)	21.3 (16.3-27.0)	38.5 (32.4-44.9)	7.8 (4.8-11.9)	41.4 (35.1-47.9)	20.9 (16.0-26.5)
51-60 (n=29)	10.3 (2.2-27.4)	44.8 (26.4-64.3)	20.7 (8.0-39.7)	10.4 (2.2-27.4)	31 (15.3-50.8)	27.6 (12.7-47.2)	41.4 (23.5-61.1)	0 (0-11.9)	37.9 (20.7-57.7)	20.7 (8.0-39.7)
P-value	0.039	0.26	0.001	0.042	< 0.001	< 0.001	0.0127	0.3648	0.0045	0.0984
BMI categories										
Underweight (n=10)	50 (18.7-81.3)	10 (0.3-44.5)	10 (0.3-44.5)	0 (0-30.8)	0 (0-30.8)	10 (0.3-44.5)	20 (2.5-55.6)	20 (2.5-55.6)	10 (0.3-44.5)	10 (0.3-44.5)
Normal (n=181)	26 (19.7-33.0)	40.9 (33.6-48.4)	5.0 (2.3-9.2)	0.6 (0.0-3.0)	6.1 (3.1-10.6)	4.9 (2.3-9.2)	24.3 (18.3-31.2)	2.2 (0.6-5.6)	19.9 (14.3-26.5)	10.5 (6.4-15.9)
Overweight (n=405)	19 (15.4-23.2)	53.6 (48.6-58.5)	9.6 (7.0-13.0)	1.7 (0.8-3.7)	8.1 (5.8-11.4)	13.1 (10.0-16.9)	34.8 (30.2-39.7)	8.6 (16.2-11.9)	30.4 (26.0-35.1)	14.8 (11.6-18.7)
Obese Class 1 (n=343)	14.6 (11.1-18.9)	56.9 (51.4-62.2)	13.4 (10.1-17.6)	3.8 (2.1-6.6)	9.3 (6.6-13.0)	16.4 (12.7-20.8)	41.7 (36.5-47.1)	8.5 (5.8-12.0)	39.1 (33.9-44.5)	17.2 (13.4-21.7)
Obese Class 2 (n=110)	17.3 (10.7-25.7)	61.8 (52.1-70.9)	18.2 (11.5-26.7)	3.6 (1.0-9.0)	7.3 (3.2-13.8)	22.7 (15.3-31.7)	38.2 (29.1-47.9)	13.6 (7.8-21.5)	31.8 (23.3-41.4)	14.5 (8.5-22.5)
Obese Class 3 (n=30)	23.3 (9.9-42.3)	36.7 (19.9-56.1)	36.7 (19.9-56.1)	10.0 (2.1-26.5)	16.7 (5.6-34.7)	16.7 (5.6-34.7)	46.7 (28.3-65.7)	3.3 (0.1-17.2)	60.0 (40.6-77.3)	36.7 (19.9-56.1)
P-value	0.062	0.0924	< 0.001	0.026	0.47	0.005	0.102	0.016	0.0046	0.077
ABD OB										
Yes (n=472)	15.7 (12.6-19.3)	55.7 (51.1-60.2)	16.9 (13.7-20.7)	4.9 (3.2-7.3)	11.3 (8.6-14.5)	18.6 (15.3-22.5)	42.2 (37.7-46.8)	9.5 (7.1-12.6)	42.8 (38.3-47.4)	18.9 (15.5-22.7)
No (n=607)	21.6 (18.4 –25.1)	49.9 (45.9-54.0)	7.6 (5.7-10.1)	0.8 (0.3-2.0)	5.9 (4.2-8.2)	9.9 (7.5-12.4)	30.8 (27.2-34.7)	6.8 (4.9-9.1)	23.9 (20.6-27.5)	12.7 (10.2-15.7)
P-value	0.042	0.29	< 0.001	< 0.001	0.004	< 0.001	< 0.001	0.123	< 0.001	0.0173

Prevalence in percentage, 95% confidence intervals within brackets, BMI - body mass index, ABD Ob - abdominal obesity (waist circumference > 102cm or Waist-Hip Ratio >1), Hypertension classified according to JNC7 criteria, Pre-Htn - pre-hypertension, FPG: Fasting Plasma Glucose (Diabetes: FPG ≥ 7.00-mmol/L; IFG - impaired fasting glucose: 6.1-6.99 mmol/L), High-risk serum lipids: total cholesterol ≥ 5.18 mmol/L; LDL cholesterol ≥ 4.61 mmol/L; Triglycerides ≥ 1.69 mmol/L; HDL - cholesterol ≤ 0.9 mmol/L, LDL - low-density lipoprotein, HDL - high-density lipoprotein.

prevalence of high-risk individual components of the lipid profile among the study population showed an increase with rise in age. However, the differences across age groups were statistically significant only for total cholesterol and triglycerides. There was an increase in the prevalence of high-risk TC, TG and HDL cholesterol with rise in BMI. However, there was statistical significance for the inter-category difference in TG alone. The difference in other lipid parameters was not statistically significant. Those with abdominal obesity showed significantly higher prevalence of high-risk TC, TG and HDL cholesterol. Though the prevalence of high-risk LDL-cholesterol was higher among those with abdominal obesity than those without, the difference was not statistically significant. The means of individual components of the lipid profile showed an increase with rise in age and BMI as well as with the presence of abdominal obesity **(Tables 1, 2 and 4)**. Age-specific analysis of the lipid components showed that there was a statistically significant rise in the means of TC, and serum TG with increase in age. Though LDL-cholesterol showed an increase and HDL-cholesterol showed a decrease with rising age, the difference between the various age groups was not statistically significant. An analysis of the lipid profile among the 6 BMI categories showed a significant fall in HDL-cholesterol with rising BMI. However, though there was a statistically significant difference in the means of total cholesterol, LDL-cholesterol and serum triglycerides among the

Table 4 - Means of anthropometric and laboratory values among abdominal obese and non-obese. (Means ± SD; Range within brackets)

Characteristics	Abdominal Obesity Yes (n=472)	Abdominal Obesity No (n=607)	*P*-value	Total
Age	38.4 ±7.1 (20-60)	34.4 ± 6.8 (20-55)	< 0.001	36.1 ± 7.2 (20-60)
BMI (Kg/M^2)	32.9 ± 4.5 (19.8-55.4)	26.6 ± 3.5 (16.1-37.0)	< 0.001	29.4 ± 5.1 (16.1-55.4)
Waist circumference (cm)	107.7 ± 9.0 (87-163)	89.3 ± 8.7 (61-102)	< 0.001	97.4 ± 12.7 (61-163)
Waist hip ratio	1.03 ± 0.05 (0.85-1.23)	0.93 ± 0.06 (0.72-1.00)	< 0.001	0.97 ± 0.7 (0.7-1.2)
Systolic BP (mm Hg)	122.1 ± 14.0 (90-180)	115.6 ± 12.6 (90-170)	< 0.001	118.4 ± 13.6 (90-180)
Diastolic BP (mm Hg)	78.2 ± 8.8 (60-120)	73.8 ± 7.1 (60-108)	< 0.001	75.7 ± 8.2 (60-120)
Fasting plasma glucose (mmol/L)	5.9 ± 2.4 (3.1-20.7)	5.3 ± 1.7 (3.08-18.9)	< 0.001	5.53 ± 2.05 (3.1-20.7)
Total cholesterol (mmol / L)	5.0 ± 0.89 (1.9-8.0)	4.8 ± 0.87 (2.7-7.9)	< 0.001	4.9 ± 0.9 (1.9-8.0)
LDL-cholesterol (mmol/L)	2.96 ± 0.85 (0.2-5.83)	2.87 ± 0.78 (0.31-5.64)	0.066	2.91 ± 0.8 (0.2-5.8)
Serum triglycerides (mmol/L)	1.78 ± 1.03 (0.11-9.95)	1.43 ± 0.96 (0.33-9.87)	< 0.001	1.58 ± 1.0 (0.11-9.95)
Serum HDL-cholesterol (mmol/L)	1.22 ± 0.39 (0.6-3.5)	1.27 ± 0.35 (0.5-2.9)	0.026	1.25 ± 0.37 (0.5-3.5)

Abdominal obesity - waist circumference greater than 102 cm or waist-hip ratio greater than one.
BMI - body mass index, BP - blood pressure, LDL - low-density lipoprotein, HDL - high-density lipoprotein

BMI categories, the rise in values across the categories was not uniform. The means of non-HDL lipids were higher, and HDL-cholesterol was lower among the abdominal obese. While the difference was highly significant for TC and serum TG, it was less significant for HDL-cholesterol and not significant for LDL-cholesterol.

Approximately one fifth of the study population were current smokers while over one fourth were ex-smokers **(Table 3)**. Age-specific analysis showed a statistically significant decrease in the prevalence of smoking with rising age. However, the distribution of prevalence rates was not uniform across the BMI categories. Subjects with normal and underweight BMIs had the highest prevalence, while obese class 1 had the lowest rate. Subjects with abdominal obesity exhibited a statistically significant lower prevalence of smoking than those with low-risk abdominal girth.

Discussion. Studies to assess the prevalence of obesity in Saudis have shown varied results with prevalence rates ranging from 16-46% for clinical obesity and 29-35% for overweight. No study has so far been performed exclusively on personnel in active service in the armed forces of Saudi Arabia. Al-Turki[8] found a high prevalence of obesity in his retrospective study based in 10 primary health care centers in Riyadh. He found that only 19% of the subjects had ideal body weight with 35% overweight and 46% clinically obese. Al-Shammari et al[9] found a prevalence of 32.8% clinical obesity among the family practice attendees at King Fahad National Guard Hospital in their study published in 1993. Al-Nuaim et al[10] found a prevalence of 29% overweight and 16% obesity among the males in a nationwide household survey conducted throughout the Kingdom. Warsy and El-Hazmi[11] in their study of a wide cross-section of the Saudi population living in different areas of the Kingdom, showed a combined prevalence of overweight and obesity of 40.3% among Saudi males. However, this study had a broader age range including all individuals older than 14 years. They found that the prevalence showed a statistically significant increase with rising age. Osman and Al-Nozha[12] in their national nutritional survey of Saudi adults aged 18 years and over, conducted between 1989 and 1994, found an overall prevalence of clinical obesity of 20.8% with a wide regional variation. The highest regional prevalence was found in Hail province (33.9%) followed by the Eastern Province (27.7%), and Qassim (26.5%). The locale of the present study is a part of the Eastern Province, but is in geographical proximity with Qassim and Hail provinces. The high prevalence in these provinces is likely to be reflected in the population studied at this institution. Al-Mahroos and Al-Roomi[13] in their review of published studies on obesity in the Arabian Peninsula have shown the prevalence of obesity among Saudi adults to be the highest in this region. Few studies have assessed the prevalence of abdominal obesity among the Saudis. A study performed by Abolfotouh et al[14] found central obesity among 32.4% subjects using WC as the marker and 43.5% using WHR as the measure. They found that abdominal obesity was significantly associated with diabetes and hypertension. The prevalence of hypertension among Saudis has been assessed by various investigators, arriving at widely differing rates, ranging from a low of 5.39% to as high as 33.3%. Differing inclusion criteria and definitions of hypertension account for some of these variations. The prevalence rate of 14.3% in the present study was arrived at using the criteria for the definition and classification of hypertension as laid down by JNC-7 report.[4] Osman and Al-Nozha[12] found an overall prevalence of 25.9% for diastolic and 20.4% for systolic hypertension. Al-Shammari et al[9] found a prevalence of 11.1% in their study at Riyadh. Warsy and El-Hazmi[11] found a prevalence of 5.39% among Saudi males aged 14 years and above. The criterion used for the diagnosis of hypertension in their study was a combination of SBP of $\geq$140 mm Hg, and a DBP of 90 mm Hg or more. These, together with the inclusion of the adolescent age group of 14 years and above, are the likely reasons for the low rate of prevalence reported in that study. Kalantan et al[15] found a prevalence of 33% hypertension among males in their study of patients attending primary health care centers in Al-Qassim region. The prevalence showed a progressive rise with increase in age and body fat. Mira et al[16] found a prevalence of 33.3% hypertension among diabetic Saudi males attending an outpatient clinic at a University hospital in Jeddah. Abalkhail et al[17] found 19.9% of their subjects among the University and school employees at Jeddah to be hypertensive.

An overall prevalence of 8.3% of diabetes mellitus is lower than the rate reported in other studies in the Kingdom. Other studies have put the rate in a range varying from 9-13%. Warsy and El-Hazmi[11] found a prevalence of 9.7% diabetes mellitus among the males in their study. Osman and al-Nozha[12] reported an overall prevalence of 13.2% in the Kingdom with significant inter-regional variation ranging from a low of 4.5% to a high of 23.3%. Al-Shammari et al[9] found a prevalence of 24.2% among a tertiary care hospital family practice clinic patients. Comparing the prevalence of diabetes mellitus among rural and urban Saudis aged 15 years and above, Al-Nuaim[18] found a prevalence of 12% among urban and 7% among rural Saudis. Al-Nozha et al[19] found the prevalence of diabetes and impaired fasting glucose among adult male Saudis in a national epidemiological health survey conducted to study coronary artery disease and risk factors between 1995 and 2000 to be 26.2% and 14.4%. Several studies have assessed the prevalence of dyslipidemia in Saudi Arabia. Mira et al[16] assessed all 4 components of the lipid profile among diabetic Saudi adults at a University hospital at Jeddah. The prevalence rates for all 4 components were higher than the present study at 47.6% for hypercholesterolemia, 40.5% for hypertriglyceridemia, 42.8% for raised serum LDL-cholesterol and 71.4% for low serum HDL-cholesterol. However, the cut-off values for HDL-cholesterol were set higher and for non-HDL lipids, set lower, in that study. Further, the subjects were all diabetics, followed up at a tertiary care hospital. Three other studies assessed only 2 parameters in the lipid profile in the general population. Osman and Al-Nozha[12] showed a prevalence of 49.6% for hypertriglyceridemia and 35.4% for hypercholesterolemia with wide regional variation. Prevalence of hypercholesterolemia varied from a high of 58.2% to a low of 27.7%, while that of hypertriglyceridemia had a range of 28.7-65.4%. Al-Shammari et al[9] found high-risk TC in 48.8% of their subjects and hypertriglyceridemia in only 5%. Both indices increased progressively with rise in age. Al-Nuaim et al[10] in an earlier study involving a wide cross-section of Saudis aged 15 years and above found a prevalence of 16% high-risk TC among male subjects, with progressive increase in prevalence and mean values with rising age, BMI and history of smoking. In a separate study, Al-Nuaim et al[20] found that the population of Eastern Province was at significantly higher risk for developing hypercholesterolemia. Ogbeide et al[21] in their population based study of serum lipid levels in Al-Kharj among subjects aged 13 years and above found high-risk serum cholesterol in 43.3% and raised serum TG levels in 40.2%. Abalkhail et al[17] assessed only TC and found it high among 10.1% of their subjects. In a recent study on coronary artery disease conducted by Al-Nozha et al,[22] means of non-HDL components of lipid profile were higher and mean HDL-Cholesterol was lower than the present study in a large cohort of subjects without coronary artery disease.

The prevalence of smoking among the subjects of this study showed a negative correlation with increase in age, BMI and abdominal girth. An overall prevalence of 19% current smokers falls in the lower range of the rates reported by other studies in Saudi Arabia, which vary from a low of 17%[23] to a high of 34%.[24] While these studies have assessed age-specific prevalence of the habit among Saudis, no study has estimated the prevalence across BMI categories or with reference to abdominal obesity. In a cross-sectional study among Turkish subjects, Yalcin et al,[25] found a similar negative correlation between general and abdominal obesity with smoking.

Though the composition of the study sample was a broad mix of soldiers hailing from all parts of the Kingdom, they have certain pronounced differences from the general population. The armed forces personnel are an affluent group with a sedentary lifestyle and westernized dietary habits. In conformity with the service conditions of the military personnel, a majority of the study sample were aged 20-40 years. The subjects were drawn from those attending the primary care clinics for medical care either for themselves or for their family members. The cut-off point for high-risk WC in this study was fixed at 102 cm based upon the clinical guidelines of National Institutes of Health.[26] However, based upon the data obtained from the Rotterdam study,[27] the WHO has advised that the cut-off point should be lowered to 94 cm for men.[28] Adoption of this modified measure is likely to show a dramatic increase in the prevalence of abdominal obesity. Exclusion of women, children and adult males aged over 60 years is a further weakness of this study. Two other studies are in progress at this institution to assess the prevalence of obesity in women and school children residing in this city. A collation of the results of these 3 studies is likely to better reflect the rates in the general population of Saudi Arabia.

The high prevalence of obesity and overweight shown in this study calls for concerted public health efforts to educate the population on the harms of excess body fat. Periodical campaigns should be held to educate the general public and targeted groups such as the armed forces personnel, on ways to reduce excess body weight and inculcate in them the advantages of a healthy diet and regular physical activity. There is a need to set appropriate standards for recruitment to the armed forces and provision of incentives and disincentives for physical fitness among the soldiers in Saudi Arabia. Primary care physicians, who represent the front line of the healthcare establishment, should be encouraged to actively screen obese individuals and set aside a small part of their consultation time to counsel such patients on the benefits of weight reduction. Rather than treating obesity as a variation of normal, it should be regarded as a disease per se. Active treatment should be instituted for all patients with clinical obesity. This is likely to halt the progressive increase in the prevalence of obesity in Saudi Arabia. However, it may take a longer time and greater efforts at both community and individual levels, to roll back the prevalence rates to the low levels found in this region before the advent of the twin evils of sedentary lifestyle and high-fat, energy dense diets.

References

1. Fact sheet on Obesity and Overweight. Global strategy on diet, physical activity and health. Geneva, World Health Organization, 2004 [cited 2005 May 13]. Available from: http\\:www.who.int/hpr/NPH/docs/gs_obesity.pdf
2. The World Health Report. Reducing risks, promoting healthy life. Geneva: WHO; 2002.
3. Al-Nuaim AR. Population-based epidemiological study of the prevalence of overweight and obesity in Saudi Arabia, regional variation. ***Ann Saudi Med*** 1997; 17: 195-199.
4. Chobanian AV, Bakris GL, Black HR, Cushman WC, Green LA, Izzo JL Jr, et al. The seventh report of the Joint National Committee on Prevention, Detection, Evaluation and Treatment of High Blood Pressure: the JNC 7 Report. ***JAMA*** 2003; 289: 2560-2572.
5. Preventing and managing the global epidemic of obesity. Report of the World Health Organization Consultation of Obesity. Geneva: WHO; June 1997.
6. The Expert Committee on the Diagnosis and Classification of Diabetes. Follow-up Report of the expert committee on the diagnosis and classification of diabetes mellitus. Diabetes Care1997; 26: 1183-1197.
7. 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). Bethesda (USA): National Institutes of Health. 2002.
8. Al-Turki YA. The prevalence of overweight and obesity amongst hypertensive and diabetic adult patients in primary health care. ***Saudi Med J*** 2000; 21: 340-343.
9. Al-Shammari SA, Ali M, Al-Shammari A, Al-Maatouq M, Tennier A, Armstrong K. Blood lipid concentrations and other cardiovascular risk factors among Saudis. ***Fam Pract*** 1994; 11: 153-158.
10. Al-Nuaim A, Al-Rubeaan K, Al-Mazrou Y, Al-Attas O, Al-Daghari N. Prevalence of hypercholesterolemia in Saudi Arabia, an epidemiological study. ***Int J Cardiol*** 1996; 54: 41-49.
11. Warsy AS, Al-Hazmi MA. Diabetes mellitus, hypertension and obesity – common multifactorial disorders in Saudis. ***East Mediterr Health J*** 1999; 5: 236-1242.
12. Osman AK, Al-Nozha MM. Risk factors of coronary artery disease in different regions of Saudi Arabia. ***East Mediterr Health J*** 2000; 6: 465-474.
13. Al-Mahroos F, Al-Roomi K. Overweight and obesity in Arabian Peninsula: Overview. ***J R Soc Health*** 1999; 119: 251-253.
14. Abolfotouh MA, Daifallah AA, Khan MY, Khattab MS, Abdulmoneim I. Central obesity in elderly individuals in south-western Saudi Arabia: prevalence and associated morbidity. ***East Mediterr Health J*** 2001; 7: 716-724.
15. Kalantan KA, Mohamed AG, Al-Taweel AA, Abdul Ghani HM. Hypertension among attendants of primary health care centers in Al-Qassim region, Saudi Arabia. ***Saudi Med J*** 2001; 22: 960-963.
16. Mira SA, Akbar DH, Hashim IA, Salamah SH, Zawawi TH. The insulin resistance syndrome among type 2 diabetics. ***Saudi Med J*** 2002; 23: 1045-1048.

17. Abalkhail BA, Shawky S, Ghabrah TM, Milaat WA. Hypercholesterolemia and 5-year risk of development of coronary heart disease among university and school workers in Jeddah, Saudi Arabia. ***Prev Med*** 2000; 31: 390-395.
18. Al-Nuaim AR. Prevalence of glucose intolerance in urban and rural communities in Saudi Arabia. ***Diabet Med*** 1997; 14: 595-602.
19. Al-Nozha MM, Al-Maatouq MA, Al-Mazrou YY, Al-Harthi SS, Arafah MR, Khalil MZ, et al. Diabetes mellitus in Saudi Arabia. ***Saudi Med J*** 2004; 25: 1603-1610.
20. Al-Nuaim AR, Mirdad S, Al-Rubeaan K, Al-Mazrou Y, Al-Attas O, Al-Daghari N, et al. Population based epidemiological study on characteristics of risk factors of hypercholesterolemia in Saudi Arabia. ***Int J Cardiol*** 1997; 62: 47-54.
21. Ogbeide DO, Karim A, Al-Khalifa IM, Siddique S. Population based study of serum lipid levels in Al-Kharj Health Center, Saudi Arabia. ***Saudi Med J*** 2004; 25: 1855-1857.
22. Al-Nozha MM, Arafah MR, Al-Mazrou YY, Al-Maatouq MA, Khan NB, Khalil MZ, et al. Coronary artery disease in Saudi Arabia. ***Saudi Med J*** 2004; 25: 1165-1171.
23. Al-Shahri MZ, Al-Almaie SM. Promotion of non-smoking: The role of primary health care physicians. ***Ann Saudi Med*** 1997; 17: 515-517.
24. Siddiqui S, Ogbeide DO, Al-Khalifa I. Smoking in a Saudi community: prevalence, influencing factors and risk perception. ***Fam Med*** 2001; 33: 367-370.
25. Yalcin BM, Sahin EM, Yalcin E. Prevalence and epidemiological risk factors of obesity in Turkey. ***Middle East Journal of Family Medicine*** 2004; 2.
26. Clinical Guidelines on the Identification, Evaluation and Treatment of Overweight and Obesity in Adults. The Evidence Report: National Institutes of Health, September 1998; NIH Publication no. 98-4083.
27. Molarius A, Seidell JC, Visscher TL, Hofman A. Misclassification of high-risk older subjects using waist action levels established for young and middle-aged adults – results from the Rotterdam Study. ***J Am Geriatric Soc*** 2000; 48: 1638-1645.
28. Steering Committee of the Western Pacific Region of the World Health Organization, The International Association for the Study of Obesity and The International Obesity Task Force. The Asia-Pacific Perspective: redefining obesity and its treatment. Melbourne, Australia. Health Communica -tions Australia Pty Ltd 2000.