Objective: To estimate the magnitude of obesity and its relation to the 10-year probability of developing coronary artery disease (CAD) in patients attending primary health care centers (PHCCs) in Abha, southern Saudi Arabia.

Subjects and Methods: Saudi patients aged between 30-70 years who had attended

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three PHCCs in Abha city over a 6-month period (January to June 1998) and agreed to participate in the study were enrolled. All such patients had their weights and heights measured, body mass index (BMI) was calculated and they were screened for risk factors of CAD and requested to provide a fasting venous sample for lipoprotein analysis. The probability of developing coronary artery disease (CAD) over the next ten years was calculated for each patient by means of the computer model based on Framingham heart study.

Results: A total of 858 subjects were studied: 46% males and 54% females. The percentage of obesity was 49% and overweight 35%; Females were dominantly obese while overweight was more prevalent in males. Of the study subjects 11.5% were hypertensive with significantly higher BMI than normotensives ($P<0.001$); diabetes mellitus was represented in 29.6% with no significant difference in their BMI from nondiabetics. Smokers were 4.2% and they had a significantly lower BMI than non-smokers. Individuals with high-risk threshold of TC/HDL-c ratio ($\geq 5.6\%$ for women and $\geq 6.4\%$ for men) represented 70.48% and had significantly higher BMI than those with low risk threshold. There was no direct relationship between BMI and PCADI ($r^2=0.007, p<0.12$).

Conclusion: (1) Obesity is an epidemic health problem with an expected upward trend in Saudi Arabia similar to that of USA and Western Europe. (2) The risk factors for CAD were highly prevalent among the PHCC patients and had a strong significant association with obesity; thus weight control should be an integral part of the prevention of CAD at PHCCs level. (3) Although obesity was found to have a significant individual association with CAD risk factors, obesity per se had no significant direct relationship with the probability of CAD at 10 years. This confirms the conclusion reached by NCEP II that obesity caused CAD through the associated risk factors.

Key Words: Obesity, risk factors of CAD, probability of CAD.

INTRODUCTION

Individuals may become obese, partly because they have a genetic predisposition to gain weight readily when they are exposed to unhealthy diet and lifestyles. The principal causes of the accelerating obesity problem worldwide are sedentary lifestyles and high fat diets as a reflected in the profound changes in society and in the behavioral patterns of communities over the last 2-3 decades. Obesity is now well-recognized as a disease in its own right; it is a major determinant of many noncommunicable diseases such as diabetes mellitus, coronary artery disease and stroke. It increases the risk of several types of cancers, gallbladder disease, musculoskeletal disorders and respiratory problems. Recent studies have shown that overweight and obesity affect over half the adult population in many countries. The prevalence of obesity in adults is 10-25% in most countries of Western Europe and 20-25% in most countries in the Americas. This figure increases to 40% for women in East European and Mediterranean countries and black women in the USA. In Saudi Arabia, the prevalence of overweight was 27.3% in males and 25.2% in females, while the prevalence of obesity was 13.05% and 20.26% in males and females respectively. Other risk factors of coronary artery diseases
have become more prevalent in Saudi society: diabetes mellitus 10-20%, hypertension 11%, hypercholesterolemia 16-23% and smoking 20-30%. The main objective of this study was to estimate the magnitude of obesity in patients attending the PHCCs and determine its relation to the 10-year probability of developing coronary artery disease (CAD) as calculated by the computer model based on the Framingham heart study.

SUBJECTS AND METHODS

Subjects
Out of the 6 Primary Health Care Centers (PHCC) in Abha, the capital of the southwest region of Saudi Arabia, 3 centers were randomly selected according to their geographical location in the city with a total catchment area of 50,000 inhabitants. Saudi patients aged between 30-70 years who had attended these PHCC over a 6-month period (January - June 1998) and agreed to participate were enrolled in the study. All such patients had their weight and height measured and were screened for risk factors of CAD and requested to provide a fasting venous sample for lipoprotein analysis.

Methods
1. Anthropometry: Weight and height were measured for every patient in the study; weight was measured with light clothes and recorded to the nearest 0.1 kg, height was measured without shoes and recorded to the nearest 0.1 cm, body mass index (BMI) was calculated according to the equation: weight (kg)/height (m²). Body mass index was considered normal if BMI <25, overweight if BMI >=25 and <30, and obese if BMI >=30.

2. Screening for risk factors of CAD: Physicians working at the PHCC under the direct supervision of the research team interviewed each patient in the sample. Information collected comprised name, age, sex and presence of risk factors for CAD including; current smoking, family history of premature CAD (definite myocardial infarction or sudden death before 55 years of age in a father or a first degree male relative; or a similar death before 65 years in a mother or other first degree female relative). Risks also included previously or currently diagnosed diabetes mellitus, and blood pressure was measured according to the Saudi national quality assurance protocols as indicated in in-patients’ family health records. A fasting venous sample was drawn, the serum was separated then transferred to Biochemistry Department, Abha Medical College where it was stored at -20°C until the time of lipoprotein analysis. Total cholesterol (TC) and triglyceride (TG) were measured spectrophotometrically using the automated chemistry analyzer Hitachi 911. High density lipoprotein cholesterol (HDL-c) was measured after precipitation of very low density lipoprotein (VLDL) and low density lipoprotein (LDL-c) according to the kit from Bio-Merieux (France) and then the supernatant was assayed enzymatically.

The probability of developing coronary artery disease (PCAD) over the next 10 years was calculated with the computer model, which was based on Framingham heart study. The following risk factors of CAD were used: age in years, sex, systolic blood pressure in mmHg, cholesterol/HDL ratio, presence or absence of DM, and current status of smoking.

Data analysis
SPSS statistics computer program was utilized in all statistical analysis. Student t-test was used to compare the differences in mean values between subgroups, multiple regression analysis was used to determine the direct relationship of obesity to PCAD at 10 years.
RESULTS
A total of 858 subjects were studies, 46% were males and 54% were females. The mean age of males (47.61 years) was significantly higher than that of females (45.82 years). Females had higher BMI (32.15) than males (28.60) p<0.001, however cross tabulation of gender with BMI classes, revealed that females were dominantly obese while overweight was more prevalent in males (X^2 = 90.90, p<0.001). Total Cholesterol (TC), HDL-c, TG, TC/HDL-c ratio and PCAD 10 were done for 666 individuals. There was no significant difference between males and females in the mean TC. However, males had significantly lower HDL-c values and higher Triglyceride, TC/HDL-c ratio and PCAD10 compared to females (Table 1).

Table 1 showed that 11.5% of the study subjects were hypertensive with significantly higher BMI than normotensives (p<0.001); DM was 29.6% with no significant difference in their BMI from non-diabetics; 4.2% were smokers with significantly lower BMI than non-smokers. Individuals with high risk threshold of TC/HDL-c ratio (≥ 5.6% for women and ≥ 6.4% for men) represented 70.48% and had significantly higher BMI than those with low risk threshold.

Figure 1 shows the linear regression analysis of PCAD at 10 years on BMI. It demonstrates no significant direct relationship between BMI and PCAD10 (r^2 = 0.007, p<0.12).

Table 1: Demographic features, lipid parameters and probability of CAD at 10 years in relation to sex in all study subjects

| Parameters                  | Total No 858 | Male No 466 (46%) | Female No 392 (54%) | p-value |
|-----------------------------|--------------|-------------------|---------------------|---------|
|                             | Mean          | SD                | Mean                | SD      |         |
| Age                         | 46.64         | 10.31             | 47.61               | 10.67   | 45.82   | 9.33    | 0.002  |
| Body Mass Index (BMI)       | 29.82         | 1.22              | 28.0                | 1.20    | 32.15   | 1.20    | <0.001 |
| Total cholesterol*          | 219.58        | 1.19              | 221.41              | 1.17    | 217.62  | 1.22    | 0.21   |
| HDL-c*                     | 31.46         | 1.36              | 30.02               | 1.39    | 33.09   | 1.32    | <0.001 |
| Triglyceride               | 179.51        | 1.61              | 192.75              | 1.64    | 166.34  | 1.55    | <0.001 |
| TC-HDL-c ratio*            | 6.98          | 1.42              | 7.38                | 1.44    | 6.58    | 1.37    | <0.001 |
| PCAD10†                    | 8.68          | 2.33              | 11.65               | 2.03    | 6.27    | 2.42    | <0.001 |

* Lipoproteins analysis was done in 666 individuals
† Probability of CAD at 10 years was calculated for 666 individuals

Table 2: Association of risk factors of CAD with body mass index (BMI)

| Risk Factors                | Number | %   | Mean | SD   | p-value |
|-----------------------------|--------|-----|------|------|---------|
| Hypertension:               |        |     |      |      |         |
| Yes                         | 99     | 11.5| 32.68| 6.12 | <0.001  |
| No                          | 759    | 88.5| 30.12| 6.26 |         |
| Diabetes Mellitus:          |        |     |      |      |         |
| Yes                         | 254    | 29.6| 30.14| 6.89 | 0.41    |
| No                          | 604    | 70.4| 30.52| 5.87 |         |
| Smoking:                    |        |     |      |      |         |
| Yes                         | 36     | 4.2 | 26.35| 4.24 | <0.001  |
| No                          | 822    | 95.8| 30.59| 6.2  |         |
| TC/HDL-c Risk Threshold*    |        |     |      |      |         |
| Yes                         | 468    | 70.27| 31.27| 6.39 | 0.001   |
| No                          | 198    | 29.73| 29.43| 5.52 |         |

* High risk threshold (TC/HDL-c ratio ≥ 5.6% for women and ≥ 6.4% for men)
DISCUSSION

Saudi society has gone through remarkable changes in lifestyle. Currently, most Saudis lead more sedentary lives and have adopted the increasingly popular high fat western diet. Those changes have led to the high prevalence of overweight (27-38% in males, 25-34% in females) and obesity (13.5-23% in males, 20-34% in females) in the Saudi population.2,3 The current study was done in city residents with a relatively high percentage of obesity (49%), and overweight (35%); thus predicting an escalating epidemic of overweight and obesity in the Saudi society similar to that in most countries in Western Europe and Americas.1

Many studies showed that obesity is closely related to several known cardiovascular risk factors, such as hypertension, hyperlipidemia, and impaired glucose metabolism.9-12 This relation is clearly obvious in the current study; the prevalence of hypertension was 11% with significantly higher BMI than normotensive (<0.001); 82% of diabetic patients were either overweight or obese. However, there was no significant difference in their BMI when compared to non-diabetics. When the high risk threshold of TC/HDL-c ratio (≥ 5.6% for women and ≥ 6.4% for men) was used to identify those at high risk for developing CAD according to Kinosian et al,13 the results showed that 70.48% of the individuals had high risk threshold and significantly higher BMI than those with low risk threshold.

Despite the positive association between body weight and the risk of CAD, the question of whether this risk was independent of other CAD risk factors is debatable. Although the American National Cholesterol Education Program II (NCEP II)10 did not include obesity as an independent risk factor of CAD, a recent study in Eastern Finland concluded that obesity was an independent

**Figure 1:** Linear regression curve of Probability of CAD at 10 years upon BMI (kg/m²) for all people in the study
risk factor for CAD mortality among men and also contributed to the risk of CAD among women. In the current study, the probability of developing CAD at 10 years was used as an end point to test whether obesity exerted its effect through the known associated risk factors or was an independent risk. The result clearly showed no significant association between BMI and probability of CAD at 10 years ($r^2=0.007$, $p=0.12$).

CONCLUSION
1. Obesity is an epidemic health problem with expected upward trend in Saudi Arabia similar to that in USA and Western Europe.
2. The risk factors for CAD were highly prevalent among the PHCC patients and had a strong and significant association with obesity, therefore weight control should be an integral part of the prevention of CAD at PHCCs level.
3. Although obesity was found to have a significant individual association with CAD risk factors, obesity per se had no significant direct relationship with the probability of CAD at 10 years. This further confirms the conclusion reached by NCEP II that obesity exerted its effect of the development of CAD through the associated risk factors.

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REFERENCES
1. World Health Organization (Geneva). Obesity: Preventing and Managing the Global Epidemic. Geneva: World Health Organization; 1998.
2. El Hazmi MAF, Warsi AS. Prevalence of obesity in the Saudi population. Annals of Saudi Medicine 1997;17:302-6.
3. Al-Nuaim AR. High prevalence of metabolic risk factors for cardiovascular diseases among Saudi population, aged 30-64 years. Int J Cardiol 1997;62:227-35.
4. Abolfotouh MA, Abu-Zeid HAH, Abdelaziz M, Alakija W, Mahfouz AA, Bassuni WA. Prevalence of hypertension in southwestern Saudi Arabia. Eastern Mediterranean Health Journal 1996;2(2):211-8.
5. Al-Nuaim AR, Al-Rubeaan KA, Al-Mazrou Y, et al. Prevalence of hypercholesterolemia in Saudi Arabia, epidemiological study. Int J Cardiol 1996;54:41-9.
6. Taha A, Bener A, Noah MS, et al. Smoking habits of King Saud University students in Riyadh. Ann Saudi Med 1991;11:141-3.
7. The Scientific Committee of Quality Assurance in Primary Health Care. Quality Assurance in Primary Health Care Manual. WHO-EM/PHC/81-A/G/93, 199-223.
8. Friedewald WT, Levy RI, Redrickson DS. Estimation of concentration of low density lipoprotein cholesterol in plasma, without use of the preparative ultracentrifuge. Clin Chem 1972;18:499-502.
9. Anderson KM, Wilson WF, Odell PM, Kannel WB. An updated coronary risk profile: A statement for health professionals. Circulation 1991;83:356-62.
10. The Expert Panel. Second report of the Expert Panel on detection, evaluation, and treatment of high blood cholesterol in adults. NIH Publication No. 93-3095. Washington DC: US Government Printing Office;1993.
11. Manson JE, Colditz GA, Stampfer MJ, et al. A prospective study of the obesity and risk of coronary heart disease in women. N Engl J Med 1990;322:882-9.
12. Pi-Sunyer Fx. Medical hazards of obesity. Ann Intern Med 1993;119:655-60.
13. Kinosian B, Glick H, Garland G. Cholesterol and coronary heart disease: predicting risks by levels and ratios. Ann Int Med 1994;121:641-7.
14. Joushilahi P, Tuomilehto J, Vartiainen E, Pekkanen J, Puska P. Body weight, cardiovascular risk factors, and coronary mortality. Circulation 1996;93:1372-9.