The relation of smoking to body mass index and central obesity among Omani male adults

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ABSTRACT

Objectives: Despite the prevalence that smoking has declined in many countries, there is a large increase in the number of young adults starting to smoke and in per capita cigarette consumption. In some studies smoking was associated with a lower body mass index (BMI) and increased waist hip ratio (WHR). Our aim is to study the association of smoking with BMI and WHR among male adults aged 20 years and above in a community based survey as a part of the National Health Survey, 2000.

Methods: A cross sectional survey representing all parts of Oman was designed in the year 2000. A part of the survey was door to door interviews including demographic data and inquiry regarding current and former smoking for male adults aged 20 years and above. In addition, taking the weight, hip and waist measurements, blood pressure and fasting blood glucose for them.

Results: The crude prevalence of current smoking was 13.3% among adult males and 4.6% of them were former smokers. The mean BMI was non significantly lower among smokers than never or former smokers. There was no significant difference also regarding WHR. Adjusting BMI by 10 different multiple linear regression models for other co-variates; age, educational level, marital status, having hypertension and total fasting glucose intolerance revealed significant association in 3 of them of BMI with smoking status. Non-significant association was revealed for WHR.

Conclusion: Current smokers were of low BMI compared to non smokers and ex smokers, and currently light smokers were also of low BMI compared to ex smokers. There was no association of central obesity to smoking status. The association between smoking status and relative weight is modified by social factors as education.

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The social advances in Oman since 1970 have been accompanied by cultural changes, reduction of communicable diseases, increasing in life expectancy, change in nutritional habits and habitual physical activity and the increasing rate of non communicable diseases and its risk factors such as hypertension, diabetes, and smoking.[1] In the scientific literature, studies of the relationship between cigarette smoking and body weight yield conflicting results. Weight lowering effects in women and men has been associated with smoking in some studies while in others such relationship has not been found.[2-5] Smokers tend to weight less than non smokers do, and people who quit smoking tend to gain weight.[6-9] Cigarette smoking, is a known risk factor for heart disease and cancer, has been reported in some studies to be associated with increased risk of non insulin diabetes mellitus.[10,11] Other studies have reported that cigarette smoking is associated with increased abdominal adiposity as estimated by waist-to-hip ratio (WHR).[12,13] As increased WHR is associated

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with insulin resistance, glucose intolerance, and diabetes,[14] increased risk of diabetes observed among smokers in some studies may be mediated by smoking associated differences in the distribution of body fat. Our aim is to study the relationship between patterns of smoking and body mass index (BMI) among Omani male adults aged 20 years and above. We also aim to examine the association of current smoking status and central obesity estimated by WHR among Omani male adults in a community based survey as a part of the National Health Survey, 2000.

Methods. ***Sample design and subjects.*** The sample for the survey was selected to be representative of the Nation as a whole. The survey adopted a multi-stage, stratified probability sampling design. In the first stage all the 10 regions of the Sultanate of Oman were chosen, and the sample was distributed according to proportional allocation of the population size in each region. In each region, one or more willayates were randomly chosen according to the size of the population in each region. The total number of willayates selected was 16 out of 59 (27%). Then, each willayate was stratified into 2 strata; the first stratum was the willayate's centers representing the urban area and the second stratum was the villages or remote areas, which represent the rural areas. The ratio of urban to rural subjects was 2:1. The second stage was the random selection of enumeration areas (EAs) in each stratum. These EAs were the census enumeration areas, which were used during 1993 population census, and each EA contains around 80 households. The third stage was the selection of households in each EA. Maps of the selected EAs were updated and a complete listing of all Omani households in each EA was made to obtain the sampling frame, and then the households were systematically randomly selected. All subjects aged 20 years and above in the selected household were invited to participate in the survey. The total number of households selected was 1968 with total of 7011 subjects of both genders fulfilling the criteria of selection. The response rate varied from 83% fasting blood sugar (FBS) to 91% (blood pressure measurement) according to the type of measurement or completed lab investigation. As of authors were studying males only, a sub-sample of 3506 male subjects was subjected to the statistical analysis.

The questionnaire and measurements. The Household Health Status questionnaire covers the demographic data; age, sex, marital status, educational status, and working status and includes also self-reporting of diabetes mellitus, hypertension, and smoking habits. Measurements of blood pressure, weight, height, waist and hip circumference were registered in the questionnaire. The World Health Organization (WHO) procedures were used for taking the measurements.[15] The questionnaire also included items for the results of lab investigations taken for FBS, and serum cholesterol.

Specimens collection and analysis. Twenty-five teams consisting each of a nurse to take the measurements, a lab technician to draw the samples, a health educator to interview the subjects, a health inspector to transport the lab samples, and a field supervisor (statistician) to supervise and review the questionnaires during field operation. They were all trained on the methodology of the survey for 2 weeks. The eligible members in the selected households were asked to fast one to 2 hours before midnight the night before they were due a visit by the survey team. The following morning at 7am the eligible household members were interviewed, measurements were taken, and venous fasting blood samples were collected. Fasting blood samples for glucose was collected in sodium fluoride potassium oxalate tubes, labeled and transferred immediately with lab forms to the laboratory in the willayate hospital in iceboxes. Samples were then immediately centrifuged, the plasma was separated and fasting plasma glucose was determined by a glucose oxidase method[16] on the same day using Hitachi 911 automated clinical chemistry analyzers (Boehringer Mannheim). The same manufacturer supplied used reagents. The samples for estimation of cholesterol were collected in tubes containing lithium heparin anticoagulants transferred to the lab. Estimation of serum cholesterol was carried out by enzymatic colorimetric method[17] using Hitachi 911 automated clinical chemistry analyzer (Boehringer Mannheim).

Diagnostic criteria. The WHO criteria (1999) for diagnosis of hypertension, hypercholesterolemia, anthropometric measurement and glucose intolerance[18] was adopted. 1. Hypertension. Prevalence was estimated based upon on adding up the subjects with self-reporting of systolic or diastolic hypertension (whether their blood pressure was normal or not at the screening time) to the subjects with mean of 2 readings of 140 mm Hg systolic blood pressure or 90 mm Hg diastolic phase 5 blood pressure or greater for example either isolated systolic or diastolic hypertension. Hypertensive subjects were further sub classified in the logistic regression models into mild hypertension group (diastolic blood pressure was between 90-104 mm Hg), and moderate/severe hypertension group (diastolic blood pressure =>105 mm Hg). 2. Hypercholesterolemia High Total Cholesterol: ≥5.2 mmol/1 or ≥200 mg/dl 3. Anthropometric Measurements.

Body mass index. Weight in Kg/ Square of Height in meters subjects were considered underweight if their BMI was <18.5, normal if their BMI was 18.5-24.9, Overweight if their BMI was 25-29.9, Obese if their BMI was 30-39.9, morbid obese if their BMI was ≥40.

Waist hip ratio. The cut off point of abnormal waist hip ratio (central obesity), which should be according to males as the aim of the study, equals 0.95. Males having WHR equal or above 0.95 were considered having central obesity. The centiles for the WHR were also used in some tables. 4. Impaired fasting glycemia and diabetes mellitus. 1. Impaired Fasting Glycemia (IFG)

Table 1 - Association of smoking status with some demographic or epidemiological characteristics.

Characteristics	**Never**	**Former**	**Smoking status**	**Current**		**Total**
			1-10 cigs.	**11-20 cigs.**	**>20 cigs.**	
Age (years)						
Mean	37.94	47.13	38.82	36.55	38.94	**38.37**
SD	16.89	15.41	16.01	12.6	14.22	**16.65**
F=12.27, P=0.000						
Education						
Illiterate. -prep	(68.4)	(89.3)	(85.4)	(91.5)	(96.2)	**(72.1)**
Secondary +	(31.6)	(10.7)	(14.6)	(8.5)	(3.8)	**(27.9)**
X^2=131.62, P=0.000						
Marital status						
Married	(64.6)	(85.6)	(74.2)	(70.5)	(66.7)	**(66.6)**
Not married	(35.4)	(14.4)	(25.8)	(29.5)	(33.3)	**(33.4)**
X^2=42.99, P=0.000						
Work status						
Working	(66.9)	(65)	(71.4)	(70.3)	(63)	**(67.3)**
Not working	(33.1)	(35)	(28.6)	(29.7)	(37)	**(32.7)**
X^2=3.59, P=0.464						
Total impaired fasting glucose						
Normal	(82.3)	(70.4)	(81.4)	(80.6)	(77.8)	**(81.5)**
Total impaired fasting glucose	(17.7)	(29.6)	(18.6)	(19.4)	(22.2)	**(18.5)**
X^2=11.68, P= 0.020						
Hypertension						
Normal	(66.5)	(47.1)	(60.2)	(61.2)	(55.3)	**(64.7)**
Hypertension	(33.5)	(52.9)	(39.8)	(38.8)	(44.7)	**(35.3)**
X^2=28.06, P=0.000						
Cholesterol level						
Normal	(60.1)	(53.8)	(65)	(57.2)	(50)	**(59.9)**
Hypocholesterolemia	(39.3)	(46.2)	(35)	(42.8)	(50)	**(40.1)**
X^2=6.78, P=0.148						
Smoking status (%)	(82.1)	(4.6)	(7.1)	(4.7)	(1.5)	**100**

P - probability, cigs - cigarettes

when Fasting blood glucose ≥6.1-6.9 mmol/l. 2. Diabetes mellitus: diabetes prevalence was estimated based on adding up the subjects with self-reporting of DM and subjects with fasting blood glucose ≥7.0 mmol/l 3. Total impaired fasting glucose (TIFG) by adding A and B.

Data processing and analysis. Data entry was carried out using EPI INFO version 6.[19] The process of preparation of data file was completed by July 2000. Analysis of the data was carried out using statistical package for social sciences 5.0.[20] Starting by BI-variate analysis, group means were compared using analysis of variance, where F statistics was considered significant if P at the level of 0.05 or below. The likelihood Chi-squared test examined the distribution of data at the same level of significance. In Multivariate analysis, multiple linear regression models were conducted to test the significant associated independent factors, which predict the studied dependent variable (BMI or WHR). The associations between BMI or WHR as the dependent variable and the different smoking patterns in the 10 models was adjusted to other confounders namely age, education, marital status, being hypertensive or having total impaired fasting glucose (TIFG). In the tables for each model, the standard β− coefficient of the examined smoking pattern and its P of significance is mentioned. A p-value of <0.05 was considered statistically significant.

Results. **Table 1** shows that the mean age of the sample was 38.37 and only 28% of the sample got secondary education or higher. Approximately 67% of them were married and working for cash. Thirty-five percent had hypertension and almost 19% had a total impaired fasting glucose. The crude prevalence of current smoking was 13.3% among Omani adult males aged 20 years and above and 4.6% of them were former smokers, the rest were never smokers, 82.1%. Current smokers were classified into 3 groups according to the number of cigarettes smoked per day; 1-10 cigarette /day, 11-20 cig. /day, and >20 cig. /day. The mean age of former smokers was significantly higher then never

Table 2 - Crude and adjusted body mass index (BMI) and waist hip ratio (WHR) means according to smoking status.

Smoking status	Crude Mean	BMI	Mean 95% CI	Adjusted BMI Mean		Mean 95% CI
Never	25.241	25.041	25.442	25.249	25.049	25.450
Former	25.334	24.529	26.140	25.053	24.242	25.863
Current (1-10 cig.)	24.911	24.240	25.582	24.843	24.171	25.515
Current (>10 cig.)	24.693	23.884	25.501	24.364	23.556	25.171
Current (>20 cig.)	25.111	23.683	26.540	24.806	23.355	26.256
Smoking status	**Crude**	**WHR**	**Mean**	**Adjusted WHR**		**Mean**
Never	0.920	0.915	0.926	0.922	0.916	0.928
Former	0.930	0.907	0.952	0.913	0.890	0.937
Current (1-10 cig).	0.916	0.896	0.935	0.915	0.895	0.935
Current (>10 cig.)	0.916	0.892	0.939	0.915	0.891	0.939
Current (>20 cig.)	0.918	0.878	0.959	0.908	0.866	0.950

Table 3 - Relation of the smoking status to the body mass index. Results of 10 linear regression.

Variable	St. β-coeff	P
Smoker versus non-smoker and ex-smoker	-0.042	-0.023
Smoker versus non-smoker	-0.044	-0.022
Ex-smoker versus non-smoker and smoker	-0.010	-0.584
Ex-smoker versus smoker	-0.025	-0.556
Ex-smoker versus non-smoker	-0.015	-0.438
Heavy smoker versus light smoker	-0.030	-0.555
Heavy smoker versus non-smoker	-0.011	-0.591
Light smoker versus non-smoker	-0.047	-0.16
Heavy smoker versus ex-smoker	-0.002	-0.976
Light smoker versus ex-smoker	-0.043	-0.350

β - beta, coeff - coefficient

Table 4 - Relation of the smoking status to the waist hip ratio. Results of 10 linear regression.

Variable	St. β-coeff	P
Smoker versus non-smoker and ex-smoker	-0.019	-0.314
Smoker versus non-smoker	-0.022	-0.269
Ex-smoker versus non-smoker and smoker	-0.013	-0.498
Ex-smoker versus smoker	-0.021	-0.632
Ex-smoker versus non-smoker	-0.016	-0.455
Heavy smoker versus light smoker	-0.026	-0.622
Heavy smoker versus non-smoker	-0.013	-0.552
Light smoker versus non-smoker	-0.018	-0.367
Heavy smoker versus ex-smoker	-0.020	-0.774
Light smoker versus ex-smoker	-0.034	-0.476

β - beta, coeff - coefficient

smokers and the current smokers groups. (F=12.27, P=0.00). Never smokers seemed to be of higher educational level than the former or current smokers. (Likelihood Ratio X^2=131.62, P=0.00). Smokers (former and current) were more likely to have total impaired fasting glucose or hypertension than never smokers were (X^2=11.68, P=0.02 and X^2=28.05, P=0.00 alternately). There was also no significant association of work status and cholesterol level with smoking status while there was significant association with marital status and smoking status (Likelihood Chi square= 42.99, P=.000) **Table 2** shows that crude BMI and WHR mean values did not significantly differ with smoking status groups. After adjustment for age, education, marital status, work status, hypertension, TIFG, hypercholesterolemia, and BMI (for WHR mean values) still there was no significant association. **Table 3** shows the results of running 10 multiple linear regression models in which

BMI was the dependant variable and different smoking status were adjusted for other independent variables which showed significant association in **Table 1**: age, education, marital status, hypertension, and TIFG. In only the first, second and the eighth models, smoking status was significantly associated with BMI. In the first model current smokers were having lower BMI than non and ex smokers. In the second model current smokers were having lower BMI than non smokers. In the eighth model, currently light smokers were having lower BMI than non smokers. Other models showed no significant association between the smoking status and BMI. When we re run the same 10 logistic models after splitting the file for the 2 categories of educational level; those illiterate to preparatory group and those had secondary level of education or above, we found that the same 3 models the first, second, and eighth showed significant results only with the lower education group and were non significant with the other group. (Data not shown) **Table 4** shows the results of running 10 multiple linear regression models in which WHR was the dependant variable and different smoking status were also adjusted for other independent variables which showed significant association in **Table 1**: age, education, marital status, hypertension, TIFG, and BMI as a predictor of WHR. None of the models revealed significant association of WHR with any smoking status. The results remained non significant even after splitting the file for the 2 educational level group and rerunning the 10 models.

Discussion. Our study did partially confirm the association between smoking and lower BMI, while it ruled out the association between smoking and abnormally high WHR. While never smokers had a higher BMI, there was no clear significant evidence that smoking cessation is related to higher BMI in comparison with never smokers. Our finding is different from what Rasky et al[21] found in their study. They concluded that smoking cessation was significantly correlated with higher relative weight in both sexes, and they explained that people who have never smoked put more effort into maintaining a lower weight than people who had previously smoked. It seems that never smokers could be more health conscious than smokers and ex-smokers.[22] The difference between our study and others could be explained by the lower rates of smoking in our sample. The same explanation was raised by Molarius et al.[23] They concluded that although in most populations the association between smoking and BMI is similar, the magnitude of this association may be affected by the proportions of smokers and ex-smokers in these populations. In addition, the factors underlying the association of cigarette smoking with relative body weight remain incompletely understood.[22] Some studies indicated a large gender difference in the use of smoking for weight control.[24,25] Females were more likely to smoke to control their weight than males.[26] This is not applied in the Omani culture where smoking prevalence is quite very low among females and in this paper we studied only male subjects. Other studies proved that cigarette smokers had more central obesity (abnormal WHR) than non smokers.[27,28] The explanation for the more central fat distribution in cigarette smokers is unknown. Physical inactivity or alcohol intake, which co-varies with cigarette smoking, could affect fat distribution.[29] Our study did not prove the association of smoking and central obesity and in Islamic culture alcohol drinking is prohibited. When we split the data file for the two educational level groups; low and high, we found that current smokers were of low BMI compared to non smokers and ex smokers, and currently light smokers were also of low BMI compared to ex-smokers only in the lower level of education group. This finding is consistent with what Molarius et al[23] found in their study. They concluded that the association between smoking and relative body weight may differ between subgroups within one population. Therefore, adjustment for these subgroups, for example for educational level, may be inappropriate in studies of the BMI smoking relationship. Also, they concluded that stopping smoking may have difference effects on weight in these subgroups.[30] The same conclusion was also drawn by Laaksonen et al[31] where they mentioned that the association between smoking status and relative weight varied according to educational level. Their finding suggests that the association between smoking status and relative weight is modified by social and behavioral factors.

In conclusion, current smokers were of low BMI compared to non smokers and ex smokers, and currently light smokers were also of low BMI compared to ex smokers. There was no association of central obesity to smoking status.

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