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ORIGINAL ARTICLE

EFFECT OF SMOKING ON BODY MASS INDEX: A COMMUNITY-BASED STUDY

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ABSTRACT

Smoking has a negative effect on Body Mass Index (BMI). This association may be confounded by demographic factors. Secondary analysis of data of 3446 non-smokers and 948 current smokers from a previously published community study on respiratory morbidity in Delhi was carried out to examine the association between smoking and BMI, and the confounding effects of gender and economic status. The BMI values were higher among non- smokers while smokers had a higher proportion of underweights. After adjusting for gender and economic status, the odds ratio for being underweight was 1.34 (95% CI 1.13-1.6) among smokers whereas non-smokers had an adjusted odds ratio for overweight/obesity of 2.16 (95% CI 1.24-3.78). The study shows that smoking is independently associated with reduced BMI after adjusting for gender and economic status in an Indian population.

Key words: Body mass index, Smoking, Community-based study, Gender, Economic status

INTRODUCTION

Epidemiological studies have generally shown an inverse relationship between smoking and body weight or nutritional status measured as Body Mass Index (BMI). This association is evident in both sexes and at all ages, and has been shown to be present after adjustment for caloric intake, physical activity, illness or socioeconomic status.[1-4] Negative effects of smoking on food intake, such as anorexia and reduced olfactory and gustatory receptor sensitivity, may contribute to this inverse association.

In population studies, the effect of smoking on nutritional status has been found to be confounded by several demographic variables. In the WHO Monica project, carried out in 42 populations in the mid-1980s, smoking was observed to be variably associated with lower relative body weight in individuals as well as in populations as a whole. The magnitude of this association was found to be affected by the proportion of smokers and ex-smokers.[5] However, the association has weakened or even reversed over time in western countries.[5, 6] At a population level the metabolic effects of smoking seem to be increasingly overridden by several other unfavorable health behaviors of smokers such as unhealthy diet, low physical activity and alcohol intake.[2,7]

Among other well known demographic variables that affect the nutritional status are gender and economic status.[8] Given the high prevalence of smoking habit in India with gross gender differences (male predominance),[9] and the fact a nutritional transition is occurring with both undernutrition and overweight or obesity becoming increasingly common,[10,] the magnitude and direction of the association between smoking and nutritional status needs to be studied in India as both are major public health issues. So far, only one study has been

carried out in India that looked into this association, but only in underweight subjects in Mumbai.[11] Recently, we have carried out a community-based study on the association between respiratory morbidity and air pollution in Delhi.[12] A secondary analysis of data on smoking and BMI from that study was carried out to examine the association between the two, and the confounding effects of gender and economic status in Delhi

METHODS

Data on height and weight, gender, smoking and economic status obtained during a community-based study [12] was analyzed. The study had been approved by the Ministry of Environment and Forests, Government of India and financially supported by the World Health Organization.

Sample selection and Methodology. The details of sampling have been described earlier.[18] Briefly, nine urban and four rural areas of Delhi were surveyed. A stratified random sample was taken from each area allowing inclusion of population across a wide economic spectrum. In each selected house, all the available members above 18 years of age were included and administered a standardized symptoms questionnaire, and examined by physicians. Standing height to the nearest cm without shoes, and weight rounded off to the nearest kilogram were recorded using standard techniques. For the present analysis, data of healthy adults (current smokers and non-smokers) were included. Ex-smokers and those found to have symptoms of respiratory or any other disease were excluded. This was done to avoid the confounding effect of diseases on nutritional status.

Smoking status was classified as follows: *Current smokers:* smoked regularly within 1 month prior to the examination; *Non-smokers:* never smoked; subjects occasionally having a smoke; *Ex-smokers:* stopped more than 1 month prior to the examination. Depending upon the monthly family income, the population was classified into three convenient categories of economic status (equivalent to US$): *Low:* income below US$ 100; *Middle:* income between $100 to 350; *High:* income above $350.

BMI was calculated by dividing the weight of an individual in kg by the square of his/her height measured in meters. The subjects were classified into one of the four categories as follows: (1) underweight - BMI < 18.5 kg/m^2; (2) normal – BMI 18.5 to 24.9 kg/m^2; (3) overweight – BMI 25 to 29.9 kg/m^2; (4) obese – BMI >= 30 kg/m^2. As the 5th, 85th and 95th percentiles have also been used to define underweight, obesity and overweight subjects, these were also calculated.

STATISTICS

Data was analyzed using SPSS 11.0 and GraphPad Prism 4.01. Descriptive exploration of data on BMI was carried out to determine the 5th, 15th, 50th, 85th and 95th percentiles among smokers and nonsmokers. The homogeneity of distribution was checked to decide the tests to be applied. Comparison of mean BMI ± sd among categories of smoking, gender and economic status was done using student's unpaired t test or analysis of variance (ANOVA) as applicable. Chi square test was applied to study the difference in proportions of underweight, normal, overweight and obese subjects among smokers and nonsmokers, and obtain unadjusted odds ratios. A General Linear Model (GLM) analysis of variance was carried out to study the main effects of the three independent variables (smoking status, sex, and economic status) as well to explore any interactions between these. Multiple logistic regression analysis was carried out to calculate the adjusted odds ratio. Factors associated with occurrence of underweight status, and for overweight and obesity were obtained with normal BMI category serving as the reference.

RESULTS

There were 948 smokers and 3446 nonsmokers. The demographic and anthropometric characteristics of the study population are shown in Table 1. Data are presented as mean ± sd.

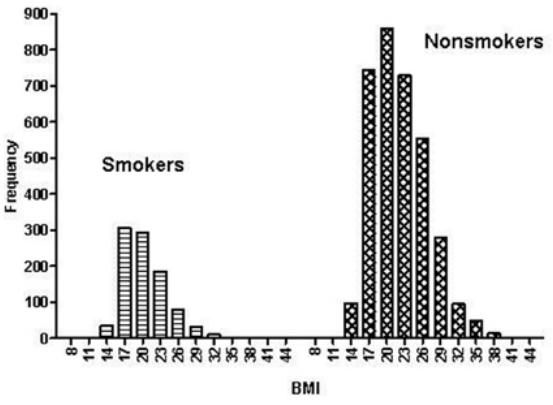

Fig 1: BMI in smokers and nonsmokers

Table 1: Demographic and anthropometric characteristics of the study population

	Smokers (n=948)	Nonsmokers (n=3446)
Age, years	36.87 ±12.58	35.03 ± 14.08
Height, m	1.65 ± 0.08	1.58 ± 0.09***
Weight, Kg	56.06 ± 11.33	55.57 ± 12.78ns
BMI, Kg/m²	20.42 ± 3.64	22.14 ± 4.61***
Gender ratio (M:F)		
Male	830 (87.6%)	1368 (39.7%)
Female	118 (12.4%)	2078 (60.3%)
Economic statusns		
Low	310 (32.7%)	846 (24.6%)
Middle	467 (49.3%)	1543 (44.8%)
High	171 (18%)	1057 (30.7%)

Ns: not significant, p>0.05, ***: p<0.001

The histogram showing frequency distribution of BMI in smokers and nonsmokers is given in Fig.1. The BMI ranged from 13.34 to 36.17 in smokers and from 9.13 to 40.04 in nonsmokers. There was a leftward shift in the frequency distribution of BMI in smokers with the 5th, 15th, 50th, 85th and 95th percentiles being 15.69, 16.96, 19.72, 24.16 and 27.41 for smokers and 16.02, 17.47, 21.53, 26.99, and 30.47 for the nonsmokers, respectively.

Table 2: Distribution of subjects across categories of BMI

BMI Category	Smoking status	
	Smokers	Nonsmokers
Underweight (less than 18.5)	342 (36.1%)	847 (24.8%)
Normal (18.5 to 24.99)	496 (52.3%)	1701 (49.7%)
Overweight (25 to 29.99)	95 (10.0%)	663 (19.4%)
Obese (30 or more)	15 (1.6%)	210 (6.1%)

Chi square 103.33, p<0.001

The proportions of subjects in the four categories of BMI (underweight, normal, overweight and obesity) among smokers and nonsmokers are shown in Table 2. There were more underweight subjects among smokers, and more overweight and obese subjects among nonsmokers (p<0.001). On comparison among categories by smoking status, gender and economic status, it was observed that nonsmokers, females, and those with a high economic status had a significantly higher BMI as compared to smokers, males, and those with a low economic status (Table 3).

Table 3: Comparison of BMI among categories of smoking status, sex and economic status

	Categories	BMI mean ±sd
Smoking status	Smokers	20.42 ± 3.64
	Nonsmokers**	22.14 ± 4.61
Gender	Males	21.15 ± 3.95
	Females**	22.38 ± 4.87
Economic status+	Low	19.75 ± 3.44
	Middle***	21.49 ± 4.32
	High***	24.12 ± 4.53

**: p<0.01; + : p<0.001 ANOVA (for economic status) followed by Bonferroni test, *** p<0.001 for each paired comparison: middle vs low, high vs low, high vs middle

GLM analysis of variance revealed that the main effects were significant: Gender (F = 9.15, p<0.01); Economic status: (F = 50.08, p<0.001); Smoking status: (F = 11.13, p<0.01). The interactions (gender × economic status, gender × smoking status, economic status × smoking status and gender × economic status × smoking status) were not significant (p>0.05).

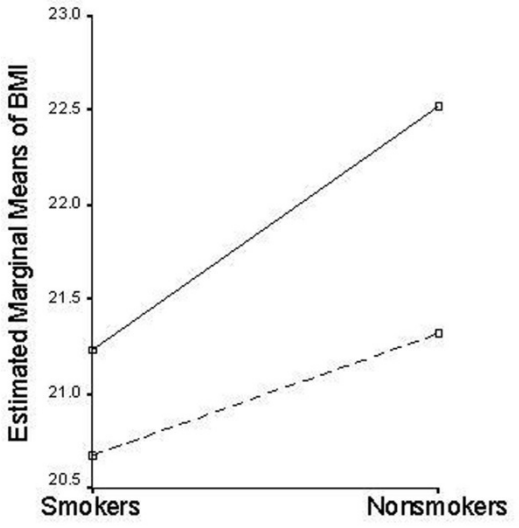

Fig 2. General Linear Model Analysis of variance results showing estimated marginal means for BMI among smokers and nonsmokers across categories of gender, and lack of interactions between smoking and gender;(——Females, - - - - -Males)

The lack of interactions is illustrated by the near-parallel and non-intersecting lines in Figs. 2 and 3 showing the estimated marginal means for BMI among smokers and nonsmokers across categories of gender and economic status.

The descriptive data of BMI in smokers and nonsmokers across the three levels of economic status for males and female subjects are shown in Table 4.

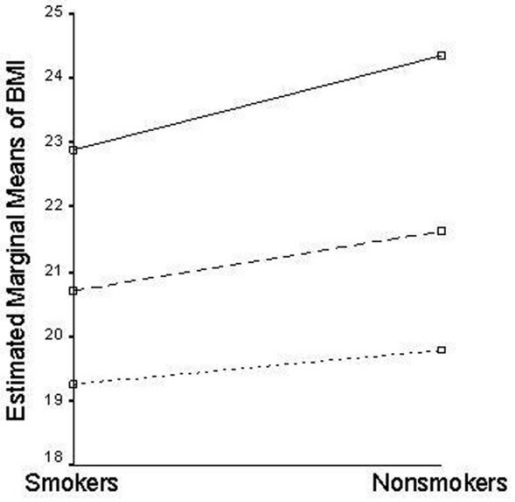

Fig 3. General Linear Model Analysis of variance results showing estimated marginal means for BMI among smokers and nonsmokers across categories of economic status, and lack of interactions between smoking and economic status; (——High, - - - - - Middle, ·····Low)

Table 4: BMI in smokers and nonsmokers across the three levels of economic status among males and female subjects

Gender	Economic level	Smoking status	BMI
Males	Low	Smokers	19.09 ± 2.83
		Nonsmokers	19.12 ± 2.63
	Middle	Smokers	20.34 ± 3.28
		Nonsmokers	20.99 ± 3.81
	High	Smokers	22.59 ± 4.22
		Nonsmokers	23.85 ± 3.98
Females	Low	Smokers	19.42 ± 2.59
		Nonsmokers	20.46 ± 3.97
	Middle	Smokers	21.07 ± 4.23
		Nonsmokers	22.27 ± 4.79
	High	Smokers	23.19 ± 5.51
		Nonsmokers	24.83 ± 4.93

Models of multiple logistic regression were developed to identify the determinants of underweight and overweight/obese nutritional status. The odds and the 95% confidence intervals are presented in Table 5. Males, subjects with low economic status and smokers had significantly greater odds for being underweight as compared to females, subjects with high economic status and nonsmokers. Similarly, females, subjects with high economic status and nonsmokers had greater odds for having obesity or overweight as compared to males, subjects with low economic status and smokers.

Table 5: Multiple logistic regression models for underweight and overweight/obesity

Factor	Odds for being underweight (95% CI)	Factor	Odds for overweight/ obesity (95% CI)
Smokers	1.34 (1.13 – 1.6)	Nonsmokers	2.16 (1.24 – 3.78)
Male	1.25 (1.08 – 1.47)	Females	2.44 (1.78 – 3.35)
Low economic status	5.5 (4.44 – 6.81)	High economic status	8.10 (4.77 – 13.78)
Middle economic status	3.03 (2.47 – 3.71)	Middle economic status	3.09 (1.80 – 5.31)

For the risk of being underweight, the reference categories were nonsmokers, females and high economic status; for the risk of being overweight/obese, the reference categories were smokers, males and low economic status.

DISCUSSION

The present community-based study shows that in the population in Delhi, smoking is negatively associated with BMI. The median BMI was higher in non–smokers as compared to smokers. The proportion of overweight and obese subjects was greater among non-smokers as compared to smokers while underweight subjects were in higher proportions among smokers as compared to nonsmokers. Although gender and economic status had significant associations with BMI, the effect of smoking was independent of these.

The results of our study are consistent with those of other studies[1-4] that have shown a negative association between smoking and nutritional status. The strength of the

association has however been found to vary among populations. In the WHO MONICA project it was observed that regular smokers had a significantly lower BMI in 20 populations for men and 30 populations among women out of the 42 populations studied.[5] Among men, the association between leanness and smoking was less apparent in populations with relatively low proportions of regular smokers and high proportions of ex-smokers. Similarly, in the US NHANES II data, [4] a lower BMI was observed in the current smokers as compared to nonsmokers. The only other study in an Indian population that examined the association between smoking and nutritional status was carried out in Mumbai. [11] All forms of tobacco use were associated with low BMI, being highest for bidi smokers. However, the study did not include overweight and obese subjects. The present study thus adds new information to the existing knowledge about this major public health issue in India.

In our study, after adjusting for gender and economic status, the odds for smokers being underweight were about 30% greater than among nonsmokers. In the study reported from Mumbai, the adjusted OR for low BMI was 1.8 for men and 1.6 for women.[11] The prevalence of overweight subjects was significantly lower among current smokers after adjusting for other socio-economic and dietary factors in a Chinese population.[13] In the Inter 99 study, daily smoking men had 3% lower BMI than never-smoking men and daily smoking women had 5% lower BMI than never-smoking women after adjusting for age and socio-economic status.[14] In contrast, in the FINRISK studies, male smokers were more likely to be obese as compared to never-smokers.[7] Similarly, in the Swiss health survey, the odds for obesity adjusted for age, nationality and physical activity were higher among ex-smokers and heavy smokers and lower among nonsmokers and light smokers.[6] Thus, the direction and the magnitude of association between smoking and nutritional status is not consistent, possibly confounded by other demographic and behavioral factors in the population [3,7,15] as well as the proportion of smokers and nonsmokers in the population as shown in the WHO Monica project.[5]

In a Finnish study where educational status was used as an indicator of socioeconomic status, current smokers weighed less at the lowest level and more at the highest level than never-smokers.[16] However we observed an inverse relation after adjusting for socioeconomic status. This is consistent with and explained by the observations in several studies that high socioeconomic status is negatively associated with obesity in developed countries but positively correlated with it in developing countries.[16] Similar to our results, in the WHO Monica project too, adjustment for socioeconomic status did not affect the relationship between smoking and leanness.[5]

Our study has a few limitations. It is a retrospective secondary analysis of data of an earlier study. Although only subjects who were apparently healthy were included, other factors that could contribute to abnormalities of nutritional status such as diet, genetics, exercise habits and other life style factors were not taken into account. These could yet confound the association between smoking and nutritional status. However, identification of determinants of the nutritional status was not the objective of the present study. Hence, only two well-known and major determinants, gender and economic status, were included as confounding factors.

To conclude, smoking is associated with reduced BMI in a population sample in Delhi. Its effect is independent of gender and economic status of the subject, both of which also influence the nutritional status.

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