

Socioeconomic Disparities and Smoking Habits in Metabolic Syndrome: Evidence from Isfahan Healthy Heart Program

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Abstract

Background: Metabolic syndrome (MetS) is a clustering of risk factors for cardiovascular disease (CVD), which includes obesity, hypertension, diabetes, dyslipidemia, and unhealthy lifestyle. A combination of these risk factors has been shown to predict type 2 diabetes and CVD. To examine the association between socioeconomic determinants and smoking behavior in a population-based sample of Iranians with MetS.

Patients and Methods: This cross-sectional survey comprised 12,600 randomly selected men and women aged ≥ 19 years living in 3 counties in the central part of Iran. These subjects had participated in the baseline survey of a community-based program for CVD prevention, entitled "Isfahan Healthy Heart Program," conducted in 2000-2001. Subjects with MetS were selected on the basis of the National Centers for Environmental Prediction-Adult Treatment Panel III (NCEP-ATPIII) criteria. Data for demographic factors, medical history, medication use, and lifestyle behaviors were obtained using questionnaires, and physical examination and fasting blood sampling were performed to measure blood pressure, obesity indices, and serum lipid levels. Smokers were defined as persons smoking at least 1 cigarette per day at the time of the study. Five social determinants were used: education, income, marital status, place of residency, and car ownership. Logistic regression analysis was performed to assess the association between socioeconomic determinants and smoking habits and other health-related behaviors.

Results: The mean age of subjects with MetS was significantly higher than that of subjects without MetS. In both MetS and non-MetS groups, the mean ages of smokers were higher than those of non-smokers. However, smokers in both groups showed lower waist circumference (WC) and waist-hip ratio (WHR). Our data showed that marital status, age category, and residency were not significantly different in smokers and non-smokers with MetS. Smoking was more common (12.4 %) in the group with intermediate educational level (6-12 years of education), the same as the high percentage of smokers (12.3 %) in the middle economic group by the income category (Quartile 1-3). MetS is significantly related to age, sex, and education. On the basis of the results of logistic regression analysis, middle-aged and elderly smokers were at approximately 4-5 times higher risk of developing MetS than nonsmokers. Low levels of education

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decreased the risk of MetS by 0.48; similarly, in non-smokers, 6–12 years of education decreased the risk of MetS by 0.72 (ranging between 0.63-0.82).

Conclusions: This study showed that the 3 dimensions of socioeconomic status, i.e., education, occupation, and income, were associated with MetS in smokers. It is assumed that. Awareness of the effect of smoking on health is increased with a higher level of education. more educated people also have better practice, control and treatment related to their wealth. Therefore, we recommend prevention efforts against smoking in the lower social strata of the Iranian population.

Keywords: Socioeconomic status; Smoking; Metabolic syndrome; Iran

Introduction

Metabolic syndrome (MetS) is a clustering of cardiovascular disease (CVD) risk factors (1). The main CVD risk factors are obesity, hypertension, diabetes, dyslipidemia, and unhealthy lifestyle (2, 3). A combination of these risk factors has been shown to predict type 2 diabetes and CVD (4). MetS has been suggested to be associated with demographic and potentially modifiable lifestyle factors (5). This syndrome is relatively common in societies undergoing epidemiological transition and alterations in lifestyle behaviors, which are typically caused by economic and technological changes (6). MetS is an important health problem in Iran, with a prevalence of approximately 25.4 % in the general population (7). In the past decades, the Iranian population has experienced rapid

socioeconomic improvements, which have resulted in lifestyle changes. These changes have led to an increase in the prevalence of obesity and its associated conditions such as diabetes and dyslipidemia, which are considered to be part of the nutritional transition process (8). In recent years, the prevalence of smoking has increased in Iran, similar to the trend observed in many developing countries. Smoking has a positive association with the incidence of MetS in both sexes (9). Some studies have reported that low socioeconomic status (SES) may increase the risk of CVD by influencing known behavioral risk factors such as smoking and unhealthy dietary habits (6, 10). However, the effects of smoking and SES factors on MetS are still a matter of debate. Some studies have reported that smoking has a protective effect against MetS. Other studies have reported that the relationship

Table 1. Baseline values for the selected participants stratified according to the incidence of metabolic syndrome (MetS) and the smoking status

Parameter	Without MetS			With MetS			P (for current smokers between MetS groups)	P (for non-smokers between MetS groups)
	Current smoker	Non-smoker	P	Current smoker	Non-smoker	P		
Age, y	37.57 ± 12.77	36.01 ± 14.27	< 0.001	47.59 ± 13.42	47.56 ± 14.59	0.977	< 0.001	< 0.001
Waist circumference	85.56 ± 10.72	87.46 ± 12.25	< 0.001	101.79 ± 10.84	101.97 ± 11.11	0.813	< 0.001	< 0.001
Hip circumference	96.49 ± 8.98	98.89 ± 10.45	< 0.001	105.90 ± 9.73	106.87 ± 9.63	0.134	< 0.001	< 0.001
FBS ^a	79.57 ± 19.82	79.65 ± 22.65	0.892	99.36 ± 42.08	97.19 ± 50.32	0.518	< 0.001	< 0.001
2hhp ^b	89.84 ± 39.60	94.32 ± 36.57	< 0.001	123.04 ± 73.85	128.04 ± 76.18	0.343	< 0.001	< 0.001
T.CHOL ^c	192.27 ± 46.04	190.16 ± 47.31	0.103	220.41 ± 53.16	223.57 ± 50.89	0.358	< 0.001	< 0.001
TG ^d	167.83 ± 102.71	143.88 ± 96.28	< 0.001	274.13 ± 141.56	239.34 ± 115.69	< 0.001	< 0.001	< 0.001
HDL	44.95 ± 10.45	48.43 ± 10.69	< 0.001	39.51 ± 9.17	43.93 ± 9.66	< 0.001	< 0.001	< 0.001
LDL ^e	114.68 ± 38.61	113.64 ± 39.64	0.353	129.52 ± 44.86	133.64 ± 43.88	0.198	< 0.001	< 0.001
SBP ^f	110.93 ± 15.14	111.87 ± 16.28	0.024	128.07 ± 21.21	130.08 ± 22.88	0.188	< 0.001	< 0.001
DBP ^g	72.97 ± 9.71	73.63 ± 10.04	0.015	82.40 ± 11.49	82.66 ± 12.78	0.759	< 0.001	< 0.001
Global Dietary Index	1.13 ± 0.26	1.08 ± 0.26	< 0.001	1.03 ± 0.297	0.98 ± 0.29	0.009	< 0.001	< 0.001

^a FBS: Fasting blood sugar
^b 2hhp: 2 hours postprandial
^c T.CHOL: Total cholesterol
^d TG: Triglyceride
^e LDL: Low density lipoprotein
^f SBP: Systolic blood pressure
^g DBP: Diastolic blood pressure

between environmental factors, such as SES and lifestyle, may influence the prevalence of MetS. The purpose of this study was to determine the relationship between smoking as a modifiable lifestyle behavior and SES in Iranian individuals with MetS, and to compare the findings with those obtained in individuals without MetS.

Patients and Methods

Isfahan Healthy Heart Program (IHHP) is a cross-sectional study that began in the year 2001 to prevent and control CVD risk factors in the Iranian population. This program was conducted in Central Iran. A stratified multi-stage probability sampling method was used for the baseline survey conducted in 2001 and for the post-intervention survey conducted in 2007. The final sample included 12,600 subjects who were older than 19 years

and had undergone the required health examinations at their nearest health centers. The details of the study have been described previously (12). All the subjects provided written informed consent after receiving a full explanation about the study and the procedures involved in it. This study was approved by the Ethics Committee of Isfahan Cardiovascular Research Center, a WHO collaborating center. Data for the participants' socioeconomic parameters; family history of diabetes, hypertension, or cardiovascular disease (CVD); and lifestyle, including smoking habits; dietary patterns, and physical activity levels of the subjects, were recorded. In addition, data about the current use of prescribed medications was recorded. All participants were interviewed at their respective homes and subsequently attended a clinic for physical examination. After overnight fasting, the participants were invited to give blood samples for evaluating

Table 2. Socioeconomic status indicators stratified according to smoking behavior and the incidence of metabolic syndrome (MetS)

	Without MetS (n=9614)		P	With MetS (n=2900)		P
	Current smoker (n=1637)	Non-smoker (n=7977)		Current smoker (n=241)	Non-smoker (n=2659)	
Place of Residence			0.067			0.250
Urban	16.6	83.4		8.6	91.4	
Rural	18.1	81.9		7.2	92.8	
Occupation			< 0.001			< 0.001
Public	22.3	77.7		19.4	80.6	
Private	32.5	67.5		26	74	
House wife	1.2	98.8		2.4	97.6	
Not-working-student	15.3	84.7		22.7	77.3	
Retired	26	74		15.9	84.1	
Marital Status			< 0.001			0.202
Married	18.1	81.9		8.6	91.4	
Single	13	87		6.7	93.3	
Age category						0.147
19-39 y	16.1	83.9	< 0.001	7.7	92.3	
40-59 y	20	80		9.5	90.5	
≥ 60 y	16.1	83.9	< 0.001	7.2	92.8	
Sex						< 0.001
Female	1.2	98.8		2.3	97.7	
Male	29.4	70.6		26	74	
Education			0.447			< 0.001
0-5 y	17.7	82.3		6.7	93.3	
6-12 y	17.1	82.9		12.4	87.6	
> 12 y	16.1	83.9		9.9	90.1	
Income			0.016			0.010
< Quartile 1	16.2	83.8		6.7	93.2	
Quartile 1-3	19.7	80.3		12.3	87.7	
> Quartile 3	17	83		8.5	91.5	

plasma lipids and glucose levels. Fasting blood glucose (FBG) levels and 2-hour plasma glucose (2 hPG) levels after 2 hours of consumption of 75 g of glucose were measured. Serum levels of lipids, including total cholesterol (TC) and triglyceride (TG) levels, were also measured by analyzing the relevant fasting blood sample. All the blood-sampling procedures were performed in the central laboratory of the Isfahan Cardiovascular Research Institute. Three readings of blood pressure were obtained. The average values of the second and third systolic and diastolic blood pressure readings were used for the analyses (12). On the basis of the National Centers for Environmental Prediction-Adult Treatment Panel III (NCEP-ATP III) criteria, the participants were classified as having MetS when they had at least 3 or more of the following abnormalities: (1) abdominal obesity, which was determined by waist circumference (WC) ≥ 102 cm in men and WC ≥ 88 cm in women (2) and 2 or more of

the following 4 criteria: systolic blood pressure (BP) ≥ 130 mmHg and/or diastolic BP ≥ 85 mmHg; triglyceride (TG) levels ≥ 150 mg/dL; high density lipopolysaccharide (HDL)-C levels < 40 mg/dL in men and, < 50 mg/dL in women; fasting blood glucose (FBG) level ≥ 110 mg/dL (13). Global dietary index (GDI) was calculated to represent the general dietary behavior (14). Subjects were defined as smokers if they smoked at least 1 cigarette per day at the time of the study, or they were defined as non-smokers (15). Five dimensions associated with SES were assessed: occupation, education, residency, marital status, and income. Occupation was categorized as public, private, house-wife, unemployed, student, or retired. The participants' educational level was classified on the basis of the Iranian schooling system by determining the highest level of education achieved and the years spent at school: primary (0-5 y), intermediate and high school (6-12 y), university (≥ 12 y). City residence was used as a

Table 3. Adjusted odds ratio (OR) for smoking stratified according to the socio-economic variables among individuals with metabolic syndrome (MetS)

Parameter	With MetS versus without MetS			
	Non-smoker		Smoker	
	Odds ratio (95% CI)	P value	Odds ratio (95% CI)	P value
Age category				
19-39 y	R	—	R	—
40-59 y	3.24 (2.88-3.65)	< 0.001	3.93 (2.75-5.60)	< 0.001
≥ 60 y	6.04 (5.14-7.11)	< 0.001	5.07 (3.00-8.55)	< 0.001
Sex				
		< 0.001		0.639
Female	3.39 (2.60-4.43)		1.70 (0.19-15.67)	
Male	R	—	R	—
Place of Residence				
		< 0.001		0.081
Urban	1.55 (1.38-1.75)		1.39 (0.96-2.04)	
Rural	R	—	R	—
Occupation				
Public	R	—	R	—
Private	0.88 (0.69-1.11)	0.275	0.89 (0.57-1.37)	0.593
House wife	1.14 (0.85-1.52)	0.372	4.43 (0.46-42.96)	0.199
Not-working student	0.55 (0.39-0.77)	0.001	0.96 (0.496-1.85)	0.896
Retired	1.34 (0.96-1.87)	0.086	0.88 (0.43-1.81)	0.725
Marital Status				
Married	1.35 (1.16-1.58)	< 0.001	—	0.570
Single	R	—	R	—
Education				
0-5 y	R	—	R	—
6-12 y	0.72 (0.63-0.82)	< 0.001	1.22 (0.85-1.74)	0.285
> 12 y	0.62 (0.48-0.79)	< 0.001	0.48 (0.24-0.97)	0.040
Income				
< Quartile 1	R	—	R	—
Quartile 1-3	1.14 (1.01-1.29)	0.029	1.16 (0.78-1.72)	0.464
> Quartile 3	1.11 (0.92-1.33)	0.287	1.27 (0.75-2.15)	0.383

proxy measure of urbanization. Subjects were asked to name the place where they were living, which was then classified as urban or rural. Income was categorized in quartiles on the basis of the poverty line in Iran, which is 3,000,000 Rials a month (\$1 US ~10,000 Iranian Rials).

Statistical analysis

A trained team in statistics checked the recorded data for missing values and entry errors. Missing or unreliable data were rechecked by returning the questionnaires to the main cluster. Statistical analysis was performed with the Statistical Package for Social Sciences (SPSS) 15.0 (SPSS, Inc. Chicago, IL). Descriptive data are represented as mean \pm standard deviation (SD). Standard t test was used to compare the means of independent groups, and chi square test was used to analyze the appropriate and categorical variables among smokers and non-smoker and between subjects with and without MetS. Logistic regression analysis was performed to assess the determinants of smoking according to the SES variables among participants with MetS. SES and smoking status were included in 1 model to estimate their independent effects. P values smaller than 0.05 were considered to be statistically significant.

Results

This cross-sectional study was performed with 12,514 individuals, 23.2 % of whom met the criteria for MetS. Current smokers made up 8.3 % of the subjects with MetS and 17 % of those without MetS. *Table 1* shows the characteristics of study subjects stratified according to their MetS and smoking status. The mean age of subjects with MetS was significantly higher than that of subjects without MetS ($P < 0.001$). The mean ages of smokers in both the groups were higher than those of non-smokers ($P < 0.001$). However, smokers in both groups showed lower WC and waist-hip ratio (WHR; $P < 0.001$). There were non-significant differences in the biochemical factors among study groups, except in the case of TG and HDL levels. *Table 2* illustrates the percentage values of the SES variables in smokers and non-smokers with or without MetS. Our data showed that marital status, age category and residency were not significantly different for smokers and non-smokers with MetS. Occupation, sex, education, and income showed significant differences in the aforementioned categories. Smoking status was not significantly associated with education in the non-MetS group. As shown in *table 2*, MetS was significantly related to age ($P < 0.001$ in smokers and non-smokers), sex ($P < 0.001$ in smokers and non-smokers), marital status ($P = 0.202$ in smokers and $P < 0.001$ in non-smokers), education ($P = 0.010$ in smokers and $P < 0.001$ in non-smokers), occupation ($P < 0.001$ in smokers and non-smokers), and area of residence ($P < 0.001$ in smokers and non-smokers) among both smokers and non-smokers. Smoking status did not show any significant association with age

and marital status in subjects with MetS. Smoking status did not show a significant association with the place of residence in groups with and without MetS. Smoking was more common (12.4 %) in the group with intermediate educational level (6–12 years of education), with an approximate equal percentage of smokers in the middle group in the income category (12.3 %) (Quartile 1–3). The odds ratios for MetS stratified according to SES are shown in *Table 3*. MetS was significantly related to age, sex, and education ($P < 0.001$). On the basis of the findings of the logistic regression analysis, middle-aged and elderly smokers were at approximately 4–5 times higher risk for developing MetS than the non-smokers ($P < 0.001$). Low education decreased the risk of MetS by 0.48 ($P = 0.040$); similarly in non-smokers, 6–12 years of education decreased the risk of MetS by 0.72 (0.63 for 6 y of education and 0.82 for the 12 y of education). Our results did not reveal a significant relationship between the risk of MetS and occupation, marital status, and income among smokers ($P > 0.01$).

Discussion

Our findings support the hypothesis that social determinants, e.g., occupation, education, and income, are related to smoking habits in Iranian individuals with MetS. To the best of our knowledge, no previous study has assessed the role of socioeconomic differences in the risk of MetS among smokers. Most previous studies have shown that different dimensions of SES are correlated and have a complex impact on health issues. Further, the impact of some SES dimensions on the MetS components has been shown to differ across communities (16). In our study population, education had the strongest role in this regard, i.e. low education levels increased the risk of MetS among smokers. However, we have previously reported that high education level was a protective factor against smoking in men, but it increased the likelihood of smoking among women (17). In the current study, the income level had significant association with smoking habits. We found a significant relationship between quartile 1–3 or medium level of income and smoking habits in subjects with MetS, and medium level of income increased the risk of MetS among smokers by 1.14 fold. The ATTICA study showed an inverse association of education level with CVD-related clinical and biochemical parameters. This association was mainly explained by smoking habits, sedentary lifestyle, obesity, dietary habits, and non-management of risk factors (18). In our study population, the nutritional habits of non-smokers appeared to be better than those of smokers in the MetS group; hypertriglyceridemia and low HDL levels were significantly more frequent among smokers than non-smokers. We previously reported that the mean level of serum lipids and anthropometric measures in employed individuals were higher than those in unemployed individuals and those with private jobs (17). Smoking was more common among privately employed participants,

followed by the publicly employed participants and students. We found that the retired non-smokers showed a 1.34 times higher risk of MetS. Engstrom *et al.* found an association between new CVD risk factors and occupation (19). A study in Finland suggested that employees, especially those in managerial and administrative positions, have a more favorable risk factor profile than self-employed and industrial workers and farmers (20). Some studies reported that the increased risk of MetS in subjects with lower SES may be due to unfavorable behaviors such as smoking, sedentary lifestyle, and poor dietary habits as well as increased body mass index and non-compliance to treatment (20, 21). Further, the results of a Croatian study showed no significant relationship between different SES dimensions in MetS and non-MetS subjects, especially those pertaining to education and participation in physical activity, but educated persons participated more in sport activities (22). Our results showed that smoking was associated with elevated TG and low HDL levels. Our findings are similar to the findings of the study by Maksimovic *et al.* who reported that the TG levels in participants with low educational level were higher than those in subjects with high educational levels (23). Previous studies in developing countries have reported that with regard to social conditions, MetS is related to lower SES, which is defined by low household income and lower-grade employment (24).

Study limitations and strengths

The present study has several strengths and weaknesses. We examined a large and wide-ranging general population sample that included both subjects with and without MetS. The main limitation of our study is its cross-sectional design, which makes it difficult to address causal relations. Another limitation is the low accuracy of reported income.

Conclusions

We found that the 3 factors of SES (i.e., education, occupation, and income) were associated with MetS in smokers. Education was the most powerful determinant of MetS among smokers, whereas income was the weakest. It is assumed that more educated persons have a better awareness and behavior related to their wealth. Awareness regarding the effect of smoking on health was greater in highly educated persons than in less educated persons. We suggest that more prevention efforts against smoking are needed in the lower social strata of the Iranian population.

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Conflict of interest

None declared

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