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Original article

Socioeconomic determinants and metabolic syndrome: results from the Isfahan Healthy Heart Program

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Summary. *Introduction:* The prevalence of metabolic syndrome (MetS) is increasing in Iran. We assessed the relationship between socioeconomic status (SES) and Mets components in the Iranian population. *Materials and Methods:* The sample for this study comprised a random cross-section of men and women from two province districts who participated in the Isfahan Healthy Heart Program (IHHP) in 2007. Each participant completed a questionnaire, underwent anthropometric testing and blood pressure measurements, and provided a blood sample. Mets was defined based on ATPIII criteria. Several SES dimensions, such as education, occupation, and number of children, as well as home, car, and personal computer ownership, were assessed to determine the participant's SES. *Results:* A higher-than-average income, car ownership, owning or renting a private home, and having a computer are increasing towards increment in SES. All MetS components were more prevalent in participants defined as having a lower SES, while low HDL levels were more common in participants having an SES II (P>0.001). A multivariate analysis showed that having the lowest SES (I) increased the risk of MetS by 1.72 [1.44-2.07], whereas subjects having an SES III had a 1.23 [1.04-1.47] lower risk for MetS. *Conclusions:* The relationship between SES and Mets is due largely to behavioural factors, such as practicing unhealthy eating habits. Given the high prevalence of Mets in Iran, we propose that regular health check-ups may be useful in the early detection of the syndrome and, consequently, in the prevention of its effects. In addition, the early detection of MetS may result in the early diagnosis and prevention of cardiovascular diseases. (www.actabiomedica.it)

Key words: metabolic syndrome, socioeconomic status, MetS

Introduction

Recent studies have provided undeniable evidence that demonstrates an inverse relationship between health and socioeconomic status (SES) over time and in different countries (1). This relationship has been found to involve major indicators of SES, such as education, type of employment, and income (2). Moreover, SES has been shown to have both direct and indirect consequences on an individual's health (3). Some studies have reported that a poor SES is associated with poor health outcomes; however, not all study findings are consistent with this conclusion (4). Some research has shown that SES significantly affects the lifestyle

and risk factors (5) associated with cardiovascular disease (CVD). An increased prevalence of MetS characteristics among individuals in lower socioeconomic strata (6-8) has also been demonstrated. The prevalence of MetS is high in Iran (1); overall, in 2007, the age-adjusted prevalence of MetS was 22.5% for Iranians residing in urban areas (2). One comprehensive review revealed a powerful association between SES and major components of MetS, such as obesity among men, women, and children in developed countries (7), and a similar relationship was found between SES and obesity in developing countries (8). Some studies have found an inverse relationship between SES and MetS components in high-income countries as the result of the high prevalence and confounding effects of multiple behavioural and psychosocial risk factors in people with a low SES; in addition, one's place of residence can affect his or her risk for CVD (9).

During 1971 to 2010, the Iranian population has experienced relatively rapid SES changes, resulting in many lifestyle modifications that have increased the prevalence of obesity and its associated diseases, such as diabetes and dyslipidemia (10). For instance, there has been a change in Iranian eating habits to include more fast food and fried foods (11). However, some definitions of class look only at numerical measures, such as wealth or income, while others take into account qualitative factors, such as education, culture, and social status (12, 13). There is no consensus as to which of these variables is essential and which are merely common correlates. Nevertheless, SES is one of the most influential predictors of MetS, although there has been some debate as to which SES plays the most important role in the incidence of MetS in the Iranian population (14). For the first time, we defined SES in the Iranian population while considering culture and several SES dimensions. Within this context, this study analyzed the relationship between SES and MetS in the Iranian society.

Material and methods

We conducted the present analysis as a part of the Isfahan Healthy Heart Program (IHHP), a cross-sectional study initiated in 2001 to prevent and to control CVD risk factors in the Iranian population. Introduced in Isfahan, Najafabad, and Arak in 2001, the IHHP consisted of three phases: (1) a baseline survey for situational analysis; (2) the implementation of interventional activities in the study areas (2001-2005); and (3) a post-intervention survey (2007), which was designed to evaluate program outcomes. After the baseline survey, a five-year intervention program was started in both urban and rural areas of Isfahan and Najaf-Abad. In 2007, IHHP team conducted outcome evaluations on individuals ≥19 years via a multistage random sampling. In this study, we used the third-phase data from 9,572 participants, all of whom provided us with written informed consents. The methods used were in accordance with the standards of the Ethical Committee of Isfahan Cardiovascular Research Institute. Full details of the program have been reported elsewhere (15-16). Trained interviewers collected information using a structured questionnaire. Data on social, demographic, personal and family medical history, and behavioral characteristics (physical activity, smoking, alcohol intake, and diet) were obtained from either physical and laboratory examinations (anthropometric testing, blood sample laboratory analysis, and blood pressure measurements) or questionnaires.

SES can be measured in various ways, either subjectively or objectively. Education level, income, occupational and marital status, as major SES determinants, were measured via detailed questionnaires. We categorized SES into the following four classes: low, lower-middle, middle, and high. The SES was measured in more detail based on car and home ownership, number of travels per year and travel destinations, possession of a personal computer, number of children in each family, and having several jobs. Education was assessed based on the highest educational degree achieved and categorized according to Iran's training system (i.e., illiterate, elementary, middle school, high school or diploma, and university training). The number of completed years of formal education was recorded and categorized into four levels: less than five; five to nine; 10 to 12; and more than 12 years.

Participants currently engaged in paid positions were classified as manual or nonmanual workers; the remaining participants were classified as retired, unemployed, students, or homemakers.

Individuals who have a single home, a car, a personal computer, and a higher number of travels, as well as those who have travelled abroad, were considered to have a higher SES.

Information on participants' incomes was also collected. Income was categorized into five levels; a monthly income of 1,000,000 rials or less was considered a low income, and more than 10,000,000 rials was considered a high income. Each American dollar was equal to approximately 10,000 Iranian rials, at the time of the study. Marital status was separated into four categories: single, divorced, widowed, and married.

Using mercury sphygmomanometers and appropriately sized cuffs, blood pressure was measured three times after a 10-minute rest in a seated position. The mean of the three measurements was then calculated (17). With the participant standing, waist circumference was measured to the nearest centimetre with flexible, nondistendable tape, while avoiding exertion of pressure on the tissues. The waist circumference (WC) was measured midway between the lower limit of the rib cage and the iliac crest. Participants in this study were evaluated according to the Mets criteria of the National Cholesterol Education Program (NCEP) Adult Treatment Panel (ATP) III (18). To be classified as having MetS, participants must have exhibited three or more of the following characteristics: abdominal obesity, measured by WC (WC ≥102 cm in men and ≥88 cm in women); high blood pressure (systolic BP ≥130 mmHg or diastolic BP ≥85 mmHg); triglycerides (TG) ≥150 mg/dL; high-density lipoprotein-cholesterol (HDL-C) <40 mg/dL in men and <50 mg/dL in women; and fasting blood sugar (FBS) ≥110 mg/dL (15). Triglyceride (TG), HDL-C and FBS levels were measured by enzymatic methods (Pars Azmon commercial kits, Iran) according to previously published methods (15). In terms of quality control, the central laboratory in which these analyses were performed meets the criteria of the National Reference Laboratory of the Ministry of Health in Iran, which is a WHO-collaborating centere in Tehran. Additionally, external standardization was completed with the Central Laboratory of the University Hospital of Leuven in Belgium. In terms of lipids, this laboratory has been qualified by the Northwest Lipid Metabolism and Diabetes Research Laboratories (USA).

Statistical Analysis

Data were entered into EPITM and analyzed with SAS (9.2). Qualitative variables were expressed as numerals (percentages) and compared with socioeconomic classes using the chi-square test. The determination of socioeconomic class was considered a latent construct and based on the following 11 variables, which were collected via detailed questionnaires: Education, Job, Income, Marital, Car Ownership, Home ownership, Number of Travels per Year, Travel Destinations, Possession of a Personal Computer, Number of Children in the Family, and Number of Jobs. The categorizations were determined via "latent class analysis (LCA)", a statistical method of classifying individuals into population subgroups by using their responses to the manifest items. In other words, LCA examines the pattern of relationships among a set of observed categorical or continuous variables and identifies and classifies similar individuals into latent classes. Subjects within each latent class are highly similar to each other and uniquely different from those in the other classes. As our data were drawn from a multistage cluster sampling, our LCA analysis considered subjects nested within clusters based on residency and urbanization. We chose four latent classes based on reaching the lowest Bayesian Information criteria (BIC) and the Akaike information criterion (AIC) value while also considering the principle of parsimony. Logistic regression models were used to examine the associations between SES and MetS components. Potential confounders and covariates, including gender, age, total daily physical activity, and dietary score, were adjusted in the analysis. Crude and adjusted odds ratios (ORs) and 95% confidence intervals (CIs) were calculated. A two-tailed P value <0.05 was considered to be statistically significant.

Results

A total number of 9,572 individuals enrolled in this study, and 1,955 subjects with MetS participated in this sub-study. Participants with MetS had a mean age of 49.11±15.28, and participants without MetS had a mean age of 38.79±15.57. Years were recruited

to the analysis and included 34.2% male and 65.8% female subjects with MetS.

The distribution of cardiovascular risk factors based on SES components and according to SES is presented in Table 1. The percentage of participants having a higher level of education increased in conjunction with the SES; in this regard, 14.2% of those in SES III and 29.1% of those in SES IV had university degrees. A higher income, car ownership, a private home, and a computer are factors that increased in proportion to SES. The percentage of well-educated participants (more than 12 years of education) in the

Table 1. Distribution of cardiovascular risk factors according by socioeconomic status (SES)

Components of SES		SES			
		SES I Low %	SES II Lower middle %	SES III Middle %	SES IV High %
Education (number of years)	Illiterate	52.2	33.6	0.6	0.0
	<5	45.5	52.7	19.1	3.4
	5-9	2.1	12.1	31.0	20.0
	10-12	0.2	1.6	35.2	47.6
	>12	0.0	.0	14.2	29.1
Job	Student/Unemployed/ Homemaker	65.3	64.2	49.9	46.2
	Retired	11.1	7.6	2.2	2.0
	Manual	20.4	23.9	31.2	25.9
	Non manual	3.2	4.3	16.8	25.9
Income	<100	35.7	22.9	11.7	4.6
	100-300	60.2	63.1	63.2	47.3
	300-500	3.7	12.7	19.8	32.8
	500-1000	0.4	1.3	4.7	12.5
	>1,000	0.0	0.0	0.6	2.8
Marital status	Widowed	12.6	9.2	0.4	0.1
	Divorced	0.3	0.3	0.7	0.5
	Single	0.0	0.4	23.3	34.4
	Married	87.1	90.1	75.6	65.0
Car ownership	Yes/No	21.5	33.3	40.0	57.9
Number of travels (per year)	0	100.0	0.0	100.0	0.0
	1	0.0	62.6	0.0	49.4
	≥2	0.0	37.4	0.0	50.6
Kind of travel	No Travel	100.0	0.0	100.0	.0
	National	0.0	90.8	0.0	94.3
	International	0.0	6.4	0.0	1.9
	Both	0.0	2.9	0.0	3.7
Have a personal computer	Yes	13.0	19.0	34.3	57.2
Number of children	Tertiles 3	67.1	54.1	4.4	4.6
	Tertiles 2	27.2	32.5	31.8	25.4
	Tertiles 1	5.7	13.4	63.7	70.1
Home ownership	Private	88.7	84.8	68.7	73.6
	Rental	10.0	12.4	24.1	20.5
	Other	1.2	2.4	6.7	4.4
Multiple jobs	Yes	1.0	2.2	4.3	4.5

high class was 29%, whereas the percentage was 14% for the former group. Participants in the highest SES had higher incomes and rates of car and personal-computer ownership that were greater than those of the participants in the lower socioeconomic classes. Other aspects of SES such as number of family members, travels per year, and jobs, differed among different socioeconomic classes.

The MetS components were assessed based on the socioeconomic classes presented in Table 2. TG, FBS, SBP, and DBP were higher in the lower SES, while the prevalence of low HDL was greater in the SES II participants (P>0.001). Table 3 shows the association between SES and MetS, as well as the MetS components. In our study, the crude association showed a strong relationship between SES and MetS components. When confounders, such as age, gender, dietary score, and total daily physical activity, were introduced into the model, a significant association between social class and MetS components was found. Multiple analyses showed that being in the lowest versus the highest SES increased the risk of MetS by 1.72 [95% CI 1.44-2.07], whereas participants in the third versus the highest SES had a 1.23 (1.04-1.47) lower risk of MetS. Similar associations were found between all MetS components and socioeconomic classes.

Table 2. Class-specific level of components of socioeconomic status (SES) and the size of classes

		Components of Metabolic Syndrome					
		High Blood Pressure N (%)	High FBS N (%)	High Triglycerides N (%)	Low HDL N (%)	High WC N (%)	Metabolic Syndrome N (%)
SES	SES I (Low)	790 (43.1)	249 (13.5)	833 (45.3)	1053 (57.6)	851 (52.4)	656 (35.6)
	SES II (Lower Middle)	798 (35.9)	269 (12.1)	974 (43.8)	1285 (58.0)	913 (50.8)	684 (30.7)
	SES III (Middle)	339 (15.5)	83 (3.7)	693 (31.3)	1172 (52.9)	505 (26.1)	292 (13.2)
	SES IV (High)	447 (14.3)	116 (3.7)	913 (28.8)	1589 (50.2)	548 (19.9)	323 (10.2)
Total		2374 (25.3)	717 (7.6)	3413 (36.1)	5099 (54.1)	2817 (34.7)	1955 (20.7)
P-Value		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

Table 3. Crude and adjusted associations among socioeconomic status (SES) and metabolic syndrome (MetS) components

Components of MetS		SES class			
		SES I Low	SES II Lower-Middle	SES III Middle	SES IV High
High blood Pressure	crude	4.55 (3.97,5.22)	3.37 (2.95,3.84)	1.10 (.95,1.29)	Ref.
	Adjusted[1]	1.22 (1.02,1.45)	1.18 (1.001,1.39)	1.007 (0.86,1.18)	Ref.
High FBS	crude	4.12 (3.28,5.17)	3.61 (2.88,4.52)	1.02 (0.77,1.37)	Ref.
	Adjusted[1]	1.42 (1.08,1.88)	1.53 (1.17,1.99)	0.97 (0.73,1.30)	Ref.
High triglycerides	crude	2.05 (1.81,2.31)	1.93 (1.72,2.16)	1.12 (0.99,1.27)	Ref.
	Adjusted[1]	1.36 (1.17,1.58)	1.46 (1.27,1.67)	1.12 (.99,1.26)	Ref.
Low HDL	crude	1.35 (1.19,1.51)	1.37 (1.23,1.53)	1.12 (1.001,1.24)	Ref.
	Adjusted[1]	1.40 (1.21, 1.62)	1.37 (1.20, 1.55)	1.12 (0.998, 1.25)	Ref.
High WC	crude	4.43 (3.87,5.07)	4.17 (3.66,4.76)	1.42 (1.24,1.63)	Ref.
	Adjusted[1]	1.85 (1.54, 2.21)	1.96 (1.66, 2.31)	1.32 (1.13, 1.54)	Ref.

Data are expressed as odds ratio (95% confidence interval) and adjusted by dietary score, total daily physical activity, age and gender.
FBS: fasting blood sugar; HDL: high-density lipoprotein-cholesterol; WC: waist circumference

Discussion

Findings based on an existing sample of Iranians aged 19–65 years showed that SES is inversely associated with MetS and that having a higher SES decreases the risk of MetS. Our observation is supported by previous findings (18-21). A MetS study conducted in Trabzon, Turkey found that MetS was associated positively with marital status, parity, and cessation of cigarette-smoking, and associated negatively with education level and household income (22). The data on relationships between SES and MetS components, however, are inconsistent. Ford et al. found a significant association between SES variables and the prevalence of high systolic blood pressure (15), while a Canadian survey indicated no clear relationship between high blood pressure and education level (23). Moreover, another study suggested that the most improvements in blood pressure have been observed among those groups having medium and high income levels and who are moderately educated (24).

In general, our results are consistent with other studies on the relationships between SES and MetS components, as well as those between MetS and health-related risk factors or behaviours (18-21). We found a lower prevalence of MetS among Iran's higher socioeconomic classes. The number of well-educated, nonmanual workers and higher income levels were significantly greater among higher socioeconomic classes. Occupations which require high educational attainment are well compensated and are held in high public esteem. Therefore, with respect to Iranian job categories, physicians, lawyers, engineers, scientists, and professors are largely considered to have a higher SES.

Zweig et al. believed that educational level affects the social class and, for most Americans, is directly linked to income and occupation (25). Although it has been acknowledged that higher education is required for many higher-class professions, it has biased the actual interaction between education and earning income among the Iranian population. Study at public universities in Iran (governmental degrees) is free; however, individuals who wish to earn other degrees can attend nongovernmental universities. Therefore, one can conclude that a higher level of income could affect the level of education.

Males and females who have a higher SES have generally adopted lifestyles that are healthier overall, while those who have a lower SES have adopted less healthy lifestyles (26). As mentioned earlier, Iran, as a developing country, has recently undergone rapid changes in both economy and lifestyle (11). It appears that, in light of these changes, people are not receiving adequate instruction related to a healthy lifestyle (11). Trend studies on blood pressure and cholesterol have shown that U.S. residents with low annual incomes and low educational levels are not being left behind. However, the lack of progress in reducing disparities in terms of these two risk factors, combined with worsening disparities in smoking and diabetes across the U.S. population, underscores the need for public health efforts to find ways to reach people with lower and intermediate levels of annual income and education (25). Other studies have revealed strong socioeconomic inequalities in terms of unhealthy nutrition and physical inactivity in other countries (27). A study by Behzadnia et al. demonstrated a higher prevalence of obesity in children with a good socioeconomic status. The authors found a significant relationship between the consumption of fast food and obesity (27). Conversely, poor Americans, like other populations, are more likely to use fast foods and processed foods that are of lower quality (28). One can therefore conclude that a low socioeconomic status contributes to a person's likelihood of being obese (28-30).

Significant relationships exist between some socioeconomic factors and controlled hypertension. This may be due to the increasing inequalities among those who lead a sedentary lifestyle, in term of SES, in Iran over time (among both males and females) (31,32). Sedentary lifestyle is known to be a risk factor for hypertension, which is proven to be significant relationships between some socioeconomic factors and controlled hypertension. Evidence indicates that about 30 minutes or more of moderate physical activity is needed daily (33-36). Although a supportive physical environment provides increased opportunities for physical activity (37), there are lack of appealing public places for physical activity (e.g., bicycle paths, walking paths, and exercise and recreation facilities), and not enough knowledge about exercise related issues (38).

The primary limitation of this study was the cross-sectional study design. Another limitation was a lack of reliable data regarding some social indicators that are acceptable in many countries, such as being a member of a specific subculture or social network, parental education, and agricultural income. The fact that we considered total household income, which may consist of either individual or multiple household members, was another limitation.

Conclusions

In some aspects of health-related lifestyles, Iran has been at the forefront of international policies (for example, tobacco control). In some key lifestyle-related factors, such as an unhealthy diet and living a sedentary lifestyle, socioeconomic inequalities have increased. It is not clear why we are witnessing a growth in the socioeconomic inequalities resulting from an increase in risk behaviours related to health. While, in Iran, there have been numerous efforts to persuade the population to adopt a healthier lifestyle, these efforts have targeted only those who are among the most economically disadvantaged; however, these efforts have not been as effective for those who are among the most economically disadvantaged. This may be due to the fact that few international comparative studies are available.

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