Association of body mass index and abdominal adiposity with educational level in Iranian adults

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ABSTRACT. Aims: To determine the relationship of body mass index (BMI) and abdominal adiposity with current educational level among the adult population of Iran. Methods: A nationwide cross-sectional survey was conducted from December 2004 to February 2005. The selection was conducted by stratified probability cluster sampling through household family members in Iran. Weight, height, waist circumference (WC) and educational level of 89,404 men and women aged 15-65 (mean 39.2) were recorded. Four classes of BMI (<18.5, 18.5-24.9, 25-29.9, and ≥30) and three educational levels (primary or below, secondary, and matriculation or above) were used. Abdominal adiposity was defined as WC ≥102 cm in men and ≥88 cm in women. Results: Thirty-two percent of men and 32.5% of women were overweight (BMI=25-29.9), and 10.9% of men and 24.6% of women were obese (BMI≥30). The prevalence of obesity and abdominal adiposity decreased with increase in educational level in both men and women. In women, overweight was decreased slightly with increase in educational level, while in men it increased. The prevalence of obesity according to educational level was as follows for women: primary or below – 28.1%; secondary – 18.7%; matriculation or above – 13.0%. In men, these figures were 12.2%, 9.9%, and 10.0%, respectively. Conclusions. Higher education level is associated with a lower prevalence of obesity and abdominal adiposity in both men and women in Iran.

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Key words: Adults, body mass index, education, Iran, obesity, overweight, prevalence, underweight.

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INTRODUCTION

Obesity continues to be an important public health problem worldwide, and its prevalence is increasing in both developed and developing nations with changes in dietary habits and activity level (1-11). The excess body weight raises the risk of overall mortality and morbidity from hypertension, dyslipidemia, type 2 diabetes, coronary heart disease, stroke, gallbladder disease, osteoarthritis, sleep apnea and respiratory problems, and endometrial, breast, prostate, and colon cancer (4, 12-20). Obesity results not only in medical consequences, but it has a strong inverse relationship with social position as reported from many affluent societies (21-25).

Though education is often used as a measure of social position, its role as a risk factor for obesity remains unresolved. In developed societies, obesity is more common in groups with less schooling, especially in women (25, 26), though not all studies agree (24, 27). In most developing countries, a direct relationship among obesity, income, level of education and social class has been demonstrated (21, 27-30). To our knowledge, no studies describe the possible association between educational level and the risk of obesity and abdominal adiposity in Iran.

The objectives of this population-based survey were to determine the relationship of body mass index (BMI) and abdominal adiposity with educational level among adults aged 15 to 65 years. We used a representative population survey in Iran, with special reference to differences between women and men. The cross-sectional design of our study does not allow the assessment of causal associations.

SUBJECTS AND METHODS

Data source

From December 2004 to February 2005, we conducted a nationwide population-based cross-sectional study of 89,404 men and women, subjects in the Iranian noncommunicable disease (NCD) risk factor surveillance system which was designed to provide information about a wide range of behaviors that affect Iranians' health at a provincial level. According to the National Health System of Iran, provincial health authorities at medical universities/schools are supposed to adjust and implement national policies and programs in their territories and respond to their local needs at the same time. Consequently, rating the accumulated provincial data by a reference population will estimate the national figures. The study protocol is based on the World Health Organization (WHO) STEPwise approach to Surveillance (STEPS) of risk factors for NCD (31). STEPS uses different levels of risk factor assessment, including collecting information by questionnaire (Step 1), taking physical measurements (Step 2), and taking blood samples for biochemical assessment (Step 3).

Subjects

A stratified, multistage probability cluster sample, with probability in proportional size procedure, was used to obtain a nationally representative sample of the population. The frame for the selection of the sampling units was based on the Iranian national zip code databank. The postal address of starting points for the survey in each cluster was determined centrally; a counterclockwise movement from this point was considered to ensure a random approach to the households. A total of 45,082 men and 44,322 women aged 15-65, free from any physical handicaps, were weighed, and their height and waist circumference (WC) were measured. In total of 89,404 participants in the study, 1920 (2.1%) participants who lacked data on education, 1821 (2.0%) on marital status, and 2 414 (2.7%) on physical activity were excluded from subgroup analyses. The subjects had a mean [standard error (SE)] age of 39.2 (0.07) years. All of the women were post-menarche. Women who reported they were pregnant at the time of the survey, homeless people, and subjects living in institutions or in the armed forces were excluded from the analysis.

Data collection

Trained staff of medical universities/schools were sent on preplanned scheduled visits, at the convenience of the inhabitants of the cluster, and served as interviewers in pairs; a trained supervisor monitored the process in each district. Before the study began, interviewers thoroughly explained to subjects the purpose and procedure of the study and sought their consent. Interviews and anthropometric measurements were performed at the subjects' home with standard techniques and equipment (32), and 25-64-year-old subjects were then invited to a referral laboratory for blood testing, 25,511 men and 27,574 women provided blood samples.

Height and weight were measured on subjects in light clothes and without shoes using standard apparatus. Weight was measured to the nearest 0.1 kg on a calibrated beam scale.

Height and WC were measured to the nearest 0.5 cm with a measuring tape. To measure height, the measuring tape was fixed to the wall. Height was measured while the subject stood with heels, buttocks, shoulders, and occiput touching the vertical tape. The head was held erect with the external auditory meatus and the lower border of the orbit in one horizontal plane. Waist was measured midway between the lower rib margin and the iliac-crest at the end of a gentle expiration. In addition to measurements, all participants completed a set of interviewer-administered questionnaires on sociodemography, smoking habits, diet, physical activity, diabetes mellitus, and hypertension. The Medical Ethics Committee of the Iranian Ministry of Health and Medical Education approved the study protocol, and all subjects gave their written consent. The study complied with the current version of the Declaration of Helsinki.

Definitions

BMI is recognized as the measure of overall obesity. The criteria for underweight, desirable weight, overweight and obesity used in the present study were based on BMI [weight/height^2 (kg/m^2)] and were consistent with the definitions set forth by the WHO and the National Heart, Lung, and Blood Institute (NHLBI) as follows: underweight <18.5, desirable weight 18.5-24.9, overweight 25-29.9, and obese ≥30 (4, 12). WC was used as a measure of abdominal adiposity, defined as WC≥102 cm in men and ≥88 cm in women to distinguish subjects at increased cardiovascular risk (33, 34). Residential area was divided into two broad categories of rural and urban. Smoking was estimated from self-report and categorized in current, former, and never smokers. The leisure time physical activity variable was based on a detailed interview about activity at work and leisure time. Interviewers had a

codebook that listed an activity level beside common occupations and also probed participants about the nature of their activity outside of working hours. When a participant repeatedly spent at least 30 min/week of his/her leisure time performing physical activity, this was considered as "regular physical exercise". Educational level was classified into three groups: "primary or below" (≤5 years); "secondary" (6-12 years); and "matriculation or above" (≥13 years).

Analysis

Data were entered on a computer in each medical university/school, with EPI info software. Datasets were transferred into SPSS-compatible format to calculate mean and SE, t-test, chi-square test, and stepwise binary logistic regression. All analyses were stratified by gender. The results are given in the text as mean (SE). Robust SEs were calculated to minimize the effect of cluster sampling on the test statistics. A general linear model (for continuous variables) and logistic regression (for dichotomous variables) were used to assess the age-adjusted relationship (by test for linear trends) between BMI categories and education. Multivariate logistic regression was performed with the SPSS for Windows computer package (SPSS Inc., Chicago, IL, USA) to assess associations of underweight, overweight, and obesity with education level with desirable weight subjects as reference and with adjustment for age, marital status, leisure time physical activity, smoking habits, and area of residence for men and women separately. All tests for statistical significance were two tailed and performed at $\alpha < 0.05$.

RESULTS

Characteristics

Differences in distribution of several age-adjusted characteristics among 45,061 (51.9%) individuals with primary or below education, 33,506 (38.6%) with secondary education and 8214 (9.5%) with matriculation or above are shown in Table 1. Individuals with primary or below education were older, had lower age-

Table 1- Age and age-adjusted characteristics of 89,404 men and women by educational level, Iran.*

Characteristic	Age-adjusted mean (standard error)		
	Primary or below (n=45,061)	Secondary (n=33,506)	Matriculation or above (n=8214)
Age (yrs)	46.4 (0.06)	30.9 (0.07)	33.8 (0.13)
Weight (kg)	65.6 (0.07)	69.8 (0.08)	71.1 (0.15)
Height (cm)	160.6 (0.05)	165.5 (0.06)	167.2 (0.10)
Waist circumference (cm)	88.1 (0.07)	88.2 (0.08)	88.1 (0.15)
BMI (kg/m²)	25.5 (0.03)	25.6 (0.03)	25.4 (0.06)
	%	%	%
Gender			
Men	42.7	57.5	61.4
Women	57.3	42.5	38.6
Marital status			
Married	92.5	63.0	64.3
Single	7.5	37.0	35.7
Divorced/widowed			
Smoking			
Never-smoker	79.3	84.0	88.9
Current-smoker	20.7	16.0	11.1
Leisure time physical activity			
Yes	16.3	39.3	44.7
No	83.7	60.7	55.3
Residential area			
Urban	52.7	75.2	89.6
Rural	47.3	24.8	10.4

*Age-adjusted means were calculated using general linear models.

Table 2 - Prevalence rates and odds ratio [95% confidence interval (CI)] of underweight, overweight and obesity by educational level for 45,082 men and 44,322 women, Iran.

Characteristic	Cases (n)	Prevalence (%)	Age-adjusted odds ratio (95% CI)	Multivariate-adjusted odds ratio (95% CI)†
			Men	
Underweight	2725	6.5	-	-
Matriculation or above	208	4.1	1.00	1.00
Secondary	1530	8.0	1.82 (1.54-2.14)***	1.71 (1.43-2.04)***
Primary or below	987	5.1	1.49 (1.28-1.74)***	1.43 (1.22-1.68)***
Overweight	13,903	32.0	-	-
Matriculation or above	1929	38.3	1.00	1.00
Secondary	5657	29.4	0.54 (0.50-0.58)***	0.69 (0.64-0.75)***
Primary or below	6317	32.9	0.78 (0.72-0.83)***	0.86 (0.80-0.92)***
Obese	4749	10.9	-	-
Matriculation or above	504	10.0	1.00	1.00
Secondary	1900	9.9	0.74 (0.66-0.83)***	0.99 (0.88-1.12)
Primary or below	2345	12.2	1.03 (0.92-1.16)	1.18 (1.05-1.33)**
Abdominal adiposity	5597	12.9	-	-
Matriculation or above	588	11.7	1.00	1.00
Secondary	2012	10.5	0.83 (1.09-1.33)***	1.01 (0.90-1.12)
Primary or below	2997	15.6	1.05 (1.18-1.36)	1.13 (1.01-1.25)*
			Women	
Underweight	2252	5.2	-	-
Matriculation or above	218	6.9	1.00	-
Secondary	1092	7.7	1.20 (1.02-1.42)*	-
Primary or below	942	3.7	1.19 (1.02, 1.39)*	-
Overweight	13,984	32.5	-	-
Matriculation or above	951	30.2	1.00	1.00
Secondary	4291	30.2	1.01 (0.92-1.11)	1.17 (1.06-1.30)**
Primary or below	8742	34.0	1.22 (1.11-1.33)***	1.20 (1.10-1.32)***
Obese	10,576	24.6	-	-
Matriculation or above	409	13.0	1.00	1.00
Secondary	2658	18.7	1.66 (1.47-1.87)***	2.09 (1.84-2.38)***
Primary or below	7509	28.1	1.77 (1.57-2.00)***	1.80 (1.59-2.05)***
Abdominal adiposity	23,106	54.6	-	-
Matriculation or above	1034	33.5	1.00	1.00
Secondary	5725	41.3	1.61 (1.48-1.76)***	1.82 (1.66-2.00)***
Primary or below	16,347	64.4	1.51 (1.39-1.65)***	1.46 (1.34-1.60)***

Category definitions are based on World Health Organization (WHO) and National Heart, Lung, and Blood Institute (NHLBI) cut-offs [4, 12]. Underweight: body mass index (BMI)<18.5 kg/m², overweight: BMI=25-29.9 kg/m², and obese: BMI≥30 kg/m². Abdominal obesity was defined as waist circumference ≥102 cm in men and ≥88 cm in women [26, 27]. †Odds ratio (with 95% CI) calculated by binary logistic regression. Adjusted for age, marital status, leisure time physical activity, smoking habits, and area of residence. *p<0.05, **p<0.01, ***p<0.001.

and area of residence modestly altered these relationships compared with the model adjusted for age alone (Table 2). The adjusted relationship showed a decreased likelihood of attaining matriculation or above for obese men and women and overweight women and an increased likelihood of attaining higher education for overweight men. Low level of education was positively associated with underweight in men but not women. Accordingly, compared with men with matriculation or above education, the multivariate-adjusted ORs for primary or below education were 1.43 (95% CI 1.22-1.68) for underweight men, 0.86 (95% CI 0.80-0.92) for overweight men, 1.18 (95% CI 1.05-1.33) for obese men, and 1.13 (95% CI 1.01-1.25) for high WC men. Compared with women with matriculation or above education, the multivariate-adjusted ORs for primary or below education were 1.20 (95% CI 1.10-1.32) for overweight women, 1.80 (95% CI 1.59-2.05) for obese women, and 1.46 (95% CI 1.34-1.60) for high WC women (Table 2). Older age, non-smokers, married,

adjusted weight and height, were more likely to be married, a smoker, a woman, a resident in a rural area, and to have lower physical activity than those with secondary education and those with matriculation or above. The age-adjusted mean BMI and WC did not differ among the groups.

Prevalence

In the studied population, 50.8% [95% confidence interval (CI) 50.3-51.3] of the men and 37.8% (95% CI 37.3-38.2) of the women were in desirable weight. Nearly half of 15-65-year-old adults were overweight or obese [49.9% (95% CI 49.6-50.2)]. Overall, 32.0% (95% CI 31.6-32.4) men and 32.5% (95% CI 32.0, 32.9) women were overweight (BMI 25-29.9), and 10.9% (95% CI 10.6-11.2) men and 24.6% (95% CI 24.1-24.9) women were obese (BMI≥30), while 6.3% (95% CI 6.0-6.5) men and 5.2% (95% CI 5.0-5.4) women were underweight (Fig. 1). The prevalence rates (95% CI) of high WC (>102 cm in men and >88 cm in women) were 12.9% (12.6-13.2) among men and 54.6% (54.1-55.0) among women (Table 2).

Risk of obesity/abdominal adiposity with education

Globally, distribution by educational level demonstrated that the great majority of men had secondary or below [44.2% (19,192) primary or below and 44.3% (19,233) secondary education]. The percentage of men with more than 12 years of schooling was 11.6% (5037). The majority of women had primary or below education [59.7% (25,733) primary or below and 32.9% (14,188) secondary education]. The percentage of women with more than 12 years of schooling was 7.3% (3153).

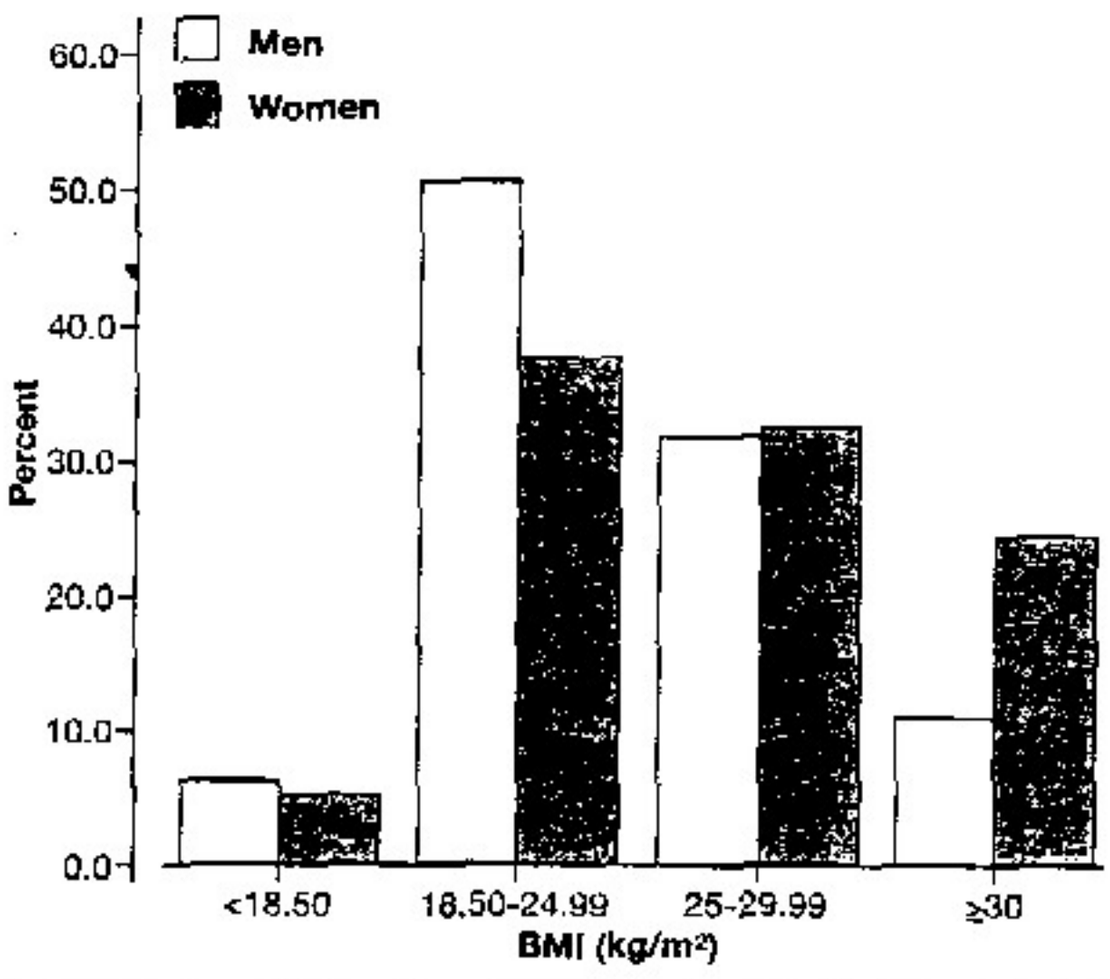

Fig. 1 - Distribution of subjects according to categories of body mass index (BMI) by gender in 89,404 Iranian men and women.

An analysis of the cross-table between educational level and BMI showed that the percentage of obesity (BMI≥30) or abdominal adiposity decreased directly with the increase in educational level in both men and women (Fig. 2). The influence of education on the risk of male obesity is less clear. Among women, 28.1% in the group of primary or below education, 18.7% in the group of secondary education, and 13.0% in the matriculation or above group were obese. Among men, these figures were 12.2%, 9.9%, and 10.0%, respectively. Among women, 64.4% in the group of primary or below education, 41.3% in the group of secondary education, and 33.5% in the matriculation or above group had high WC. In men, these figures were 15.6%, 10.5%, and 11.7%, respectively. The percentage of overweight (BMI=25-29.9) women decreased slightly with the increase in educational level, while it increased in men. Among women, 34.0% in the group of primary or below education and 30.2% in the groups with secondary education and matriculation or above group were overweight. In men, these figures were 32.9%, 29.4%, and 38.3%, respectively.

Compared with women with matriculation or above education, the age-adjusted risk of obesity was 77% higher in those with primary or below [age-adjusted odds ratio (OR) 1.77; 95% CI 1.57-2.00] and 66% higher in those with secondary education (OR 1.66; 95% CI 1.47-1.87). In men, the age-adjusted risk of obesity was similar in those with primary or below and matriculation or above (OR 1.03; 95% CI 0.92-1.16) and 26% lower in those with secondary education (OR 0.74; 95% CI 0.66-0.83). In men, the age-adjusted risk of overweight was 22% lower in those with primary or below than those with matriculation or above (OR 0.78; 95% CI 0.72-0.83) and 46% lower in those with secondary education (OR 0.54; 95% CI 0.50-0.58). In women, the age-adjusted risk of overweight was 22% higher in those with primary or below than those with matriculation or above (OR 1.22; 95% CI 1.11-1.33). The association between overweight and education was similar among women with secondary and matriculation and above education (age-adjusted OR 1.01; 95% CI 0.92-1.11). Low level of education was positively associated with underweight in both men and women (Table 2).

In a multivariate model, controlling for age, marital status, leisure time physical activity, smoking habits,

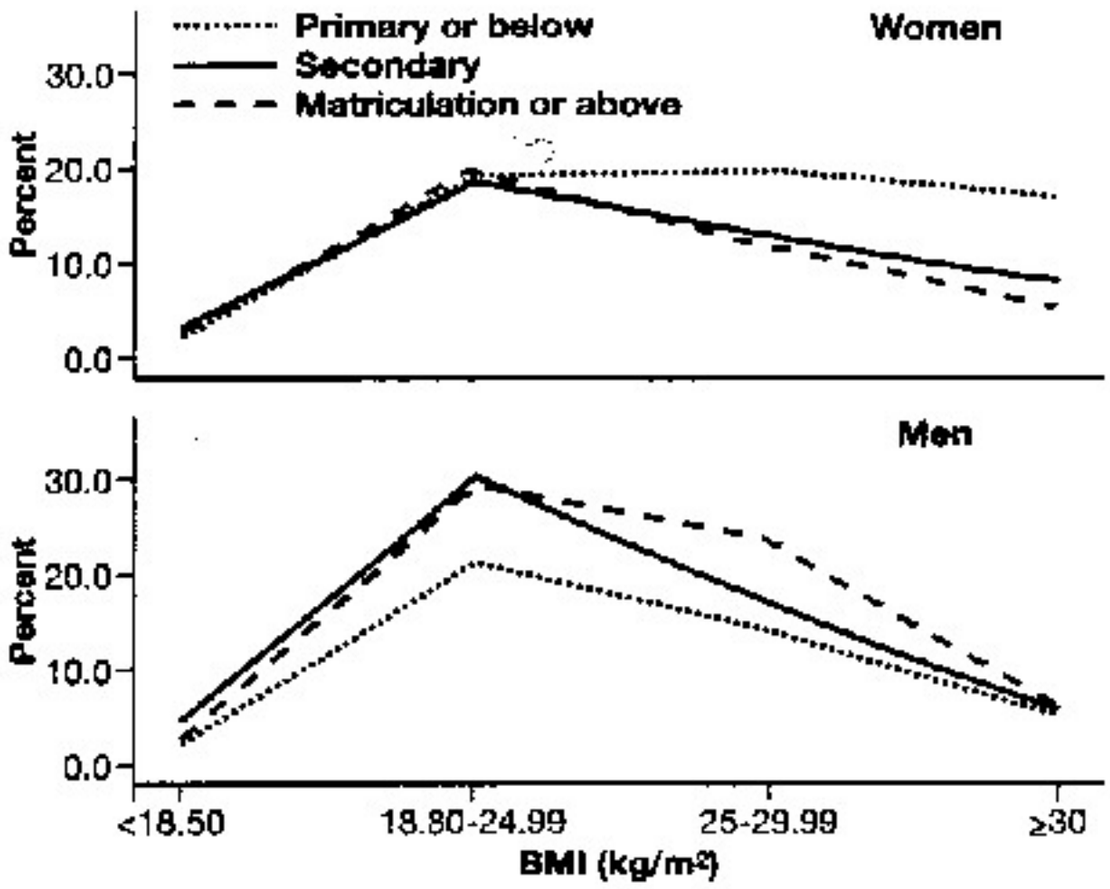

Fig. 2 - Association between categories of body mass index (BMI) and education by gender in 89,404 Iranian men and women.

and living in urban areas were positively associated with overweight and obesity in both men and women (data not shown). Low physical activity was positively associated with overweight and obesity in women but not men. Underweight adults were more likely than those of desirable weight to be younger, to smoke, to be physically active, and to live in rural areas.

DISCUSSION

In this first nationwide cross-sectional study of 89,404 adults aged 15-65, we found that obesity and abdominal adiposity prevalence tend to decrease with the level of education. Higher educational level also appears to be associated with a lower risk of being overweight, but this applies only to women. In developed countries, though not consistently, poverty and low level of education are associated with a greater prevalence of obesity (35-37), particularly in women, whereas in developing countries, greater abundance and higher education mean a higher risk of obesity (27-30). In developing countries, the association of socioeconomic status and education level with obesity follows a complex and diversified pattern (38). In elderly Zimbabweans, BMI increases with education level (39). In a study in Latin American and Caribbean countries, formal education appears negatively associated with obesity in five of the nine countries studied (38). In two countries formal education remained positively associated with obesity. Another analysis of these data in Brazil demonstrated that, for women living in the more modern part of Brazil, both formal education and access to information were negatively associated with obesity (40). A survey examining the independent effect of education on obesity, using data from successive cross-sectional national surveys of the U.S. adult population (41, 42), showed that BMI and skinfold thickness were independently associated with education (a strong negative association) in women, but not in men. It is interesting to note that the negative association between women's obesity and education became stronger in the U.S.A. over the period 1960-1980. In the U.S. male population over the same period, the slight positive association with education reverted to a slight negative association indicating that the pattern of education association with obesity presently found in Iran may be similar to the one prevailing decades ago in the U.S.A. and some other developed nations. It is likely that the influence of education on obesity changes with time, depending on the degree of economic development of a country. Initially, increasing education (and probably income) may be associated with a less healthy diet in relation to obesity. With time, the association becomes reversed. This appears to be the situation in Iran over a 50-year period. In parallel, other lifestyle factors may also be affected by socioeconomic changes, such as the level of physical activity. This is consistent with our findings showing that the prevalence of obesity and abdominal adiposity was greatest among poorly educated individuals. These findings confirmed our hypothesis that in transition societies education tends to be protective for obesity. They also indicate that, similar to findings in developed countries, women tend to shift their diet and activity patterns more rapidly than men do.

Iran, along with other countries in Asia and the Middle East, is further along in the nutrition transition. The shift in the structure of employment and overall time allocation pattern has pushed Iranians into a more sedentary lifestyle. The dietary shift over the past half century has been equally profound, and for much of the population there was a shift in the structure of diet to a diet considered a "Western style" higher-fat diet. However, Iran has now reached a level of economic and social development where some segments of the population have attained the affluence and education that afford them the time and other resources to consider alternative lifestyles.

According to this survey, excess body weight was more prevalent in women than in men in each education group. Iranian women may have less physical ac-

tivity than men because of limited outdoor activities due to specific climatic and/or social conditions. Smoking is shown to be associated with lower BMI. Current smoking rates among men and women were 28.1% and 5.8%, respectively. Therefore differences in smoking rates are consistent with other discrepancies between men and women.

The negative relationship between education and obesity or abdominal adiposity can be easily explained by the expected associations between levels of education and diet and nutrition knowledge, concern with weight controls and standards of physical attractiveness (21). Higher education may lead to healthier lifestyle (43). Our results may be explained by differences in physical activity, caloric intake, or smoking rates of men and women with higher education, or with lower fertility rates of Iranian higher-educated women. There may also be medical complications behind the lower educational achievements of obese men and women. Silventoinen et al. (44) suggested that common genetic factors affecting both BMI and education are likely explanations for the correlation between these two variables. A review of discrimination against obese subjects suggested that discrimination occurs in schools, health services, and employment setting (45). We are unable to exclude discrimination and genetic factors as contributors to the low educational achievement of obese men and women in our study.

Our study has several strengths and limitations. The strengths include the large sample consisting of both urban and rural populations, a sound representation of the national population, and detailed information on potential confounding factors. One limitation of our study is the possibility that BMI cut-offs used in this study understate health risk. The cut-offs are those recommended by the WHO and NHLBI (4, 12). While they have proven to be fairly robust for classifying obesity across populations, they are based primarily on the association between BMI and mortality in European and North American populations (46-48). As a cross-sectional study, the present analysis is limited in its ability to elucidate causal relationships between educational level and overweight or obesity. BMI can overestimate body fat in individuals who are very muscular and underestimate body fat in individuals who have lost muscle mass, such as many elderly (48). However, estimates from these potentially misclassified groups likely had little overall impact on the analysis. Although most studies on this topic have looked at the relation between socioeconomic status and BMI, we opted for educational level, as we did not have access to information on socioeconomic variables. The ages of our sample range from 15 to 65, and the education levels are defined based on the current education levels. Some people in the sample have not finished their education yet. Moreover, military service is compulsory for men in Iran and it also may affect the education achievement for men before 25. Despite these limitations, our findings add to our understanding of the relationship between educational level and obesity in Iran. Furthermore, this study provides new nationwide data from Iran, a developing country that has been underrepresented in past studies.

In summary, for Iran, a higher level of education is associated with a lower prevalence of obesity and abdominal adiposity in both men and women.

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