First Nationwide Survey of Prevalence of Overweight, Underweight, and Abdominal Obesity in Iranian Adults

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Abstract

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Objective: The goal was to estimate the prevalence of overweight, obesity, underweight, and abdominal obesity among the adult population of Iran.

Research Methods and Procedures: 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, and waist circumference (WC) of 89,404 men and women 15 to 65 years of age (mean, 39.2 years) were measured. The criteria for underweight, normal-weight, overweight, and Class I, II, and III obesity were BMI $<$18.5, 18.5 to 24.9, 25 to 29.9, 30 to 34.9, 35 to 39.9, and $\geq$40 (kg/m^2), respectively. Abdominal obesity was defined as WC $\geq$102 cm in men and $\geq$88 cm in women.

Results: The age-adjusted means for BMI and WC were 24.6 kg/m^2 in men and 26.5 kg/m^2 in women and 86.6 cm in men and 89.6 cm in women, respectively. The age-adjusted prevalence of overweight or obesity (BMI $\geq$25) was 42.8% in men and 57.0% in women; 11.1% of men and 25.2% of women were obese (BMI $\geq$30), while 6.3% of men and 5.2% of women were underweight. Age, low physical activity, low educational attainment, marriage, and residence in urban areas were strongly associated with obesity. Abdominal obesity was more common among women than men (54.5% vs. 12.9%) and greater with older age.

Discussion: Excess body weight appears to be common in Iran. More women than men present with overweight and abdominal obesity. Prevention and treatment strategies are urgently needed to address the health burden of obesity.

Key words: abdominal obesity, adiposity, adults, BMI, epidemiology

Introduction

Obesity is 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). Individuals who are overweight are at higher risk for a variety of disabling and life-threatening chronic conditions, including high blood pressure, menstrual abnormalities, psychosocial dysfunction, cardiovascular disease, diabetes mellitus, arthritis, Pickwickian syndrome, gout, gallbladder disease, digestive disease, cancer, respiratory dysfunction, diverticular disease, various skin conditions, and overall mortality (4,12–20). Of these conditions, diabetes may be the most closely linked to obesity, and its prevalence appears to increase as the prevalence of obesity increases. Abdominal obesity is considered an independent predictor of cardiovascular risk factors, morbidity, and mortality (21).

The prevalence and pattern of obesity vary substantially from nation to nation (3,22,23), and its current prevalence (BMI $\geq$30 kg/m^2) ranges from as low as $<$5% in China, Japan, and certain African nations to as high as $>$75% in urban Samoa (23). But even in relatively low-prevalence countries, such as China, rates are almost 20% in some

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cities (23). Although, the nationwide data on the prevalence of overweight are available for some developing countries (5,6,9,24–26), they have not been reported for Iran. Accurate information regarding the prevalence of overweight and thinness is important for appropriate public health responses.

The rapid social and economic transition of Iran has been accompanied by cultural changes, reduction of communicable diseases, increased life expectancy, changes in nutritional habits and physical activity, and increases in non-communicable diseases, such as hypertension, diabetes, and their risk factors. In Iran, only limited information exists on the local prevalence of overweight in adulthood (27–29), and there are no studies on the prevalence of underweight.

The objectives of this population-based survey were to estimate the prevalence of overweight, underweight, and abdominal obesity among adults 15 to 65 years of age in Iran, and to conduct a preliminary investigation of the determinants of overweight. These data will also serve as the baseline for future examination of secular trends.

Research Methods and Procedures

Data Source

From December 2004 to February 2005, we conducted a population-based cross-sectional survey among 89,404 Iranian men and women studied for non-communicable disease risk factors. The survey was designed to provide information about a wide range of behaviors that affect Iranians' health at a provincial level so that provincial health authorities can adjust national policies and programs and respond to their local needs. By accumulating the provincial data, an estimate of the national figures can be obtained. The study protocol is based on the World Health Organization (WHO)[1] STEPwise approach to Surveillance of risk factors for non-communicable disease (30). STEPwise approach to Surveillance uses different levels of risk factor assessment, including collecting information using questionnaires (Step 1), taking physical measurements (Step 2), and taking blood samples for biochemical assessment (Step 3).

Subjects

A stratified, multistage probability cluster sample, with a probability in proportion to 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 addresses of the starting points for the survey in each cluster were determined centrally, using Iranian national zip code databank. A counterclockwise movement from this point was used to ensure a representative sample of households. A total of 45,082 men and 44,322 women 15 to 65 years of age, free from any physical handicaps, were weighed, and their height and waist circumference (WC) were measured. Of the 89,404 participants in the study, 1920 (2.1%) participants had missing data on education, 1821 (2.0%) on marital status, and 2414 (2.7%) on physical activity. These individuals were excluded from subgroup analyses. The subjects had a mean age of 39.2 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

Subjects were contacted to schedule an interview in their homes at their convenience. Pairs of trained staff members of local medical universities/schools served as interviewers, and a trained supervisor monitored the process in each district. Before the data collection began, the 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' homes with standard techniques and equipment (31), and subjects 25 to 64 years of age were then invited to a referral laboratory for blood testing, and 25,511 men and 27,574 women provided blood samples.

Height and weight were measured with 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, a measuring tape was fixed to the wall and 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.

Overnight fasting blood samples were taken, and plasma was separated and analyzed on the same day. Total cholesterol and fasting blood glucose were assessed by standardized procedures. Blood pressure was measured with a standard mercury sphygmomanometer and a cuff of suitable size on the right arm after an adequate rest period of at least 15 minutes. Korotkoff Phases I and V were used for systolic and diastolic blood pressure, respectively. Two measurements were taken for each subject with a 30-second interval between measurements. 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 Ministry of Health and Medical Education approved the study protocol, and all

[1] Nonstandard abbreviations: WHO, World Health Organization; WC, waist circumference; SE, standard error.

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, normal-weight, overweight, and Classes I, II, and III 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 as follows: underweight $<$18.5, normal-weight 18.5 to 24.9, overweight 25 to 29.9, Class I obesity 30 to 34.9, Class II obesity 35 to 39.9, and Class III obesity $\geq$40 kg/m^2 (4,12). WC was used as a measure of abdominal obesity, defined as WC $\geq$102 cm in men and $\geq$88 cm in women to distinguish subjects at increased cardiovascular risk (21,32). A daily smoker was defined as one who smoked at least 1 cigarette per day (at least 7 cigarettes per week). Those who smoked fewer than 1 cigarette per day or 7 cigarettes per week were designated as occasional smokers. Current smokers included daily and occasional smokers. Those who had smoked at least 1 cigarette per day for at least 6 months but had quit were designated as ex-smokers, and those who had never smoked at all were designated as 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 minutes/wk of their leisure time performing physical activity, this was considered as "regular physical exercise."

Analysis

Data were entered on a computer in each medical university/school, with EPI info software (Centers for Disease Control and Prevention, Atlanta, GA). Datasets were transfer into SPSS-compatible (SPSS, Inc., Chicago, IL) format to calculate means and standard errors (SEs), *t* test, and χ^2 tests. All analyses were stratified by gender. The mean (SE) and 95% confidence interval were calculated for weight, BMI, and WC. Robust SEs were calculated to minimize the effect of cluster sampling on the test statistics. Multivariate logistic regression was performed with the SPSS for Windows (SPSS, Inc.) computer package to assess associations between underweight, overweight, and obesity and age, marital status, educational level, leisure time physical activity, smoking habits, and area of residence. Prevalence rates of overweight, underweight, and abdominal obesity were age-adjusted, using the direct method of adjustment, within the WHO European standard population (33). All tests for statistical significance were two tailed and performed at $\alpha < 0.05$.

Results

Characteristics

Distributions of selected characteristics among 45,082 men and 44,322 women are shown in Table 1. Women had lower educational level, physical activity, age-adjusted weight, height, and systolic and diastolic blood pressure and were more likely never to have smoked than men. Men had lower age-adjusted BMI, WC, cholesterol, and fasting blood glucose than women. The age-adjusted mean (SE) BMI was 24.6 (0.02) kg/m^2 in men, and 26.5 (0.02) kg/m^2 in women. The age-adjusted mean (SE) WC was 86.6 (0.06) cm in men and 89.6 (0.06) cm in women.

Prevalence

Table 2 presents the gender-specific crude and age-adjusted prevalences of underweight, overweight, and Classes I, II, and III obesity; 50.8% of the men and 37.8% of women were normal-weight. Nearly half of adults 15 to 65 years of age were overweight or obese (49.9%). Overall, 42.9% men and 56.9% women were overweight or obese (BMI $\geq$25), and 10.9% men and 24.5% women were obese (BMI $\geq$30); 6.3% of men and 5.2% of women were underweight. When age was adjusted to the WHO European standard population, the age-adjusted prevalence rates of underweight and obesity were 6.4% and 11.1% in men, and 5.3% and 25.2% in women, respectively. The age-adjusted prevalence rates of high WC ($\geq$102 cm in men and $\geq$88 cm in women) were 12.5% among men and 53.5% among women. As expected, WC increased with age and BMI; 1.1% of men and 21.5% of women who were normal-weight (BMI, 18.5 to 24.9) had high WC, and 55.2% of men and 94.1% women with Class III obesity had high WC. The prevalence of overweight, obesity, and abdominal obesity was greater in women than in men, among married persons compared with singles, among older compared with younger people, and among residents of urban compared with rural areas (Table 3). The prevalence of underweight was greater in men than in women, among singles compared with married, among younger compared with older people, and among residents of rural compared with urban areas (Table 3). There was an increasing prevalence of overweight or obesity (BMI $\geq$25) with increasing age, from 22.3% in the 15- to 24-year age group to 84.7% in the 55- to 64-year age group (($p < 0.001$). Marital status was significantly associated with overweight and Classes I, II, and III obesity in both genders. Married men were 4.0 times and married women were 3.7 times more likely to be obese (BMI $\geq$30) than never married subjects. In both men and women, overweight and Classes I, II, and III obesity and abdominal obesity were more common with low educational attainment. The prevalence rates of overweight or obesity (BMI $\geq$25) among men and women in rural areas were 34.0% and 49.0%, whereas these rates in urban areas were 47.7% and 61.3%, respectively. The prevalence rates

Table 1. Age-adjusted means and proportions of selected characteristics among 45,082 men and 44,322 women

Characteristic	Age-adjusted [mean (SE)]	
	Men	Women
Age (yrs)	39.1 (0.07)	39.0 (0.07)
Weight (kg)	70.8 (0.06)	64.7 (0.07)
Height (cm)	169.7 (0.04)	156.5 (0.04)
Waist circumference (cm)	86.6 (0.06)	89.6 (0.06)
BMI (kg/m^2)	24.6 (0.02)	26.5 (0.02)
Systolic BP (mmHg)	123.3 (0.08)	121.3 (0.08)
Diastolic BP (mmHg)	78.4 (0.06)	76.5 (0.06)
Cholesterol (mg/dL)	196.6 (0.26)	206.4 (0.25)
Fasting blood glucose (mg/dL)	96.2 (0.21)	98.4 (0.20)
Education (%)		
Primary or below	44.1	59.7
Secondary	44.3	33.0
Matriculation or above	11.6	7.3
Marital status (%)		
Married	76.0	73.5
Single	23.3	19.9
Divorced/widowed	0.7	6.6
Smoking (%)		
Never-smoker	64.4	91.5
Current-smoker	28.1	5.8
Ex-smoker	7.5	2.7
Leisure time physical activity (%)		
Yes	35.4	20.3
No	64.6	79.7
Residential area (%)		
Urban	73.5	71.3
Rural	26.5	28.7

SE, standard error; BP, blood pressure. Age-adjusted means were calculated using general linear models.

of obesity (BMI $\geq$30) among men and women living in rural areas were 8.1% and 19.8%, which were lower than the rates in urban areas, 12.4% and 27.1%, respectively. The prevalence rates of underweight (BMI $<$18.5) among men and women living in rural areas were 8.0% and 6.4%, which were higher than the rates in urban areas, 5.4% and 4.6%, respectively.

In both genders, BMI was strongly correlated with weight (r = 0.83 men, 0.89 women), WC (r = 0.71 men, 0.74 women), age (r = 0.25 men, 0.31 women), systolic blood pressure (r = 0.28 men, 0.30 women), diastolic blood pressure (r = 0.25 men, 0.28 women), cholesterol (r = 0.21 men, 0.20 women), and fasting blood glucose (r = 0.14 men, 0.12 women).

Risk Factors

Table 4 shows the mean (SE) of age, systolic and diastolic blood pressure, cholesterol, fasting blood glucose, height, weight, and WC by BMI class. As expected, all of the variables increased with increasing BMI class in both men and women, except height, which decreased with increasing BMI class.

The prevalence of overweight, obesity, and underweight was also analyzed with multivariate logistic regression. A total of 231 men and 223 women were excluded from these analyses because of missing risk factor information. Multivariate logistic regression analyses of underweight, overweight, and obesity in relation to age, physical activity, smoking, education, marital status, and residence are shown

Table 2. Prevalence rates (%) of underweight, overweight, Classes I, II, and III obesity, and abdominal obesity in Iran

		Prevalence rate (95% confidence interval)	
Weight category*	**Cases**	**Crude**	**Age-adjusted†**
Underweight			
Men	2739	6.3 (6.1, 6.5)	6.4 (6.2, 6.6)
Women	2266	5.2 (5.0, 5.5)	5.3 (5.2, 5.5)
Overall	5005	5.8 (5.6, 5.9)	5.9 (5.7, 6.1)
Overweight			
Men	13,926	32.0 (31.5, 32.4)	31.7 (31.4, 32.1)
Women	14,009	32.4 (32.0, 32.9)	32.3 (31.9, 32.7)
Overall	27,935	32.2 (31.9, 32.5)	32.0 (31.7, 32.4)
Class I obesity			
Men	3913	9.0 (8.7, 9.3)	8.9 (8.7, 9.1)
Women	7711	17.9 (17.5, 18.2)	17.7 (17.4, 17.9)
Overall	11,624	13.4 (13.2, 13.6)	13.2 (13.0, 13.5)
Class II obesity			
Men	631	1.4 (1.3, 1.6)	1.4 (1.3, 1.5)
Women	2182	5.1 (4.9, 5.3)	5.0 (4.8, 5.2)
Overall	2813	3.2 (3.1, 3.4)	3.2 (3.1, 3.3)
Class III obesity			
Men	212	0.5 (0.4, 0.6)	0.5 (0.4, 0.5)
Women	699	1.6 (1.5, 1.7)	1.2 (1.1, 1.3)
Overall	911	1.0 (0.9, 1.1)	1.0 (0.9, 1.1)
Obesity (BMI ≥30)			
Men	4756	10.9 (10.5, 11.0)	11.1 (10.9, 11.4)
Women	10,592	24.5 (24.0, 24.8)	25.2 (24.9, 25.6)
Overall	15,348	17.6 (17.3, 17.8)	18.1 (17.9, 18.4)
Abdominal obesity			
Men	5599	12.9 (12.6, 13.2)	12.5 (12.2, 12.7)
Women	13,147	54.5 (54.1, 55.0)	53.5 (53.1, 53.8)
Overall	18,746	33.5 (33.1 33.8)	32.7 (32.4, 33.1)

WHO, World Health Organization; NHLBI, National Heart, Lung, and Blood Institute.
* Category definitions are based on WHO and NHLBI cutoffs (4,12). Underweight = BMI <18.5 kg/m^2; overweight = BMI 25 to 29.9 kg/m^2; Class I obesity = BMI 30 to 34.9 kg/m^2; Class II obesity = BMI 35–39.9 kg/m^2; Class III obesity = BMI ≥40 kg/m^2. Abdominal obesity was defined as waist circumference ≥102 cm in men and ≥88 cm in women (26,27).
† Adjustments for age have been performed to the WHO European standard population.

in Table 5. Older age, non-smoking, married, low level of education, and living in urban areas were positively associated with overweight and obesity in both men and women. 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. Low level of education was positively associated with underweight in men but not women.

Discussion

In this nationwide cross-sectional study of 89,404 adults 15 to 65 years of age, we found that overweight and obesity

Table 3. Age-adjusted mean* (SE) BMI and prevalence (%) of underweight, normal-weight, overweight, obesity, and abdominal obesity in 45,082 men and 44,322 women according to selected characteristics in Iran

Variable	Mean (SE)	Weight category†				Abdominal obesity‡
		Underweight	Normal-weight	Overweight	Obesity	
Men						
Age (yrs)						
15 to 24	23.9 (0.15)	15.3	65.8	14.8	3.8	3.2
25 to 34	25.3 (0.09)	4.8	55.2	31.0	9.0	7.4
35 to 44	25.3 (0.05)	4.1	45.7	37.3	12.9	13.4
45 to 54	24.9 (0.09)	3.4	42.6	39.4	14.7	19.1
55 to 64	23.6 (0.15)	3.9	45.1	37.2	13.8	21.1
Education						
Primary or below	24.2 (0.04)	5.1	49.7	32.9	12.2	15.6
Secondary	24.9 (0.04)	8.0	52.8	29.4	9.9	10.5
Matriculation or above	25.4 (0.06)	4.1	47.6	38.3	10.0	11.7
Marital status						
Married	25.0 (0.03)	4.1	46.6	36.4	18.4	15.6
Single	23.3 (0.06)	13.3	64.6	17.5	4.6	4.0
Others	24.0 (0.25)	8.1	53.1	26.4	12.4	15.4
Smoking						
Non-smokers	24.7 (0.03)	6.3	49.7	32.7	11.3	12.9
Current-smokers	24.1 (0.04)	6.9	55.1	29.1	8.9	11.4
Ex-smokers	25.5 (0.08)	4.0	44.5	36.5	15.0	18.1
Physical activity						
No	24.7 (0.04)	5.8	49.7	32.7	11.8	14.2
Yes	24.6 (0.03)	7.2	52.8	30.7	9.3	10.4
Residential area						
Urban	25.1 (0.03)	5.4	47.0	35.3	12.4	14.8
Rural	23.8 (0.04)	8.0	58.0	25.9	8.1	9.2
Women						
Age (yrs)						
15 to 24	24.9 (0.18)	14.0	60.4	19.3	6.3	18.1
25 to 34	26.9 (0.10)	4.8	42.8	33.6	18.9	44.5
35 to 44	27.8 (0.06)	2.3	29.1	37.0	31.6	64.2
45 to 54	27.2 (0.10)	2.3	26.3	36.4	35.0	71.5
55 to 64	25.6 (0.18)	2.8	30.0	36.0	31.1	73.3
Education						
Primary or below	26.5 (0.04)	3.7	33.2	34.0	28.1	64.4
Secondary	26.6 (0.05)	7.7	43.3	30.2	18.7	41.3
Matriculation or above	25.8 (0.10)	6.9	50.0	30.2	13.0	33.5
Marital status						
Married	27.1 (0.03)	3.1	32.6	35.8	28.5	62.5
Single	24.3 (0.07)	13.9	58.9	19.4	7.8	21.2
Others	26.2 (0.10)	3.6	32.5	33.9	30.0	66.7

are common in Iran, as 42.9% of men and 56.9% of women had excess body weight (BMI $\geq$25). In contrast, underweight has a low prevalence (6.3% men and 5.2% women present BMI values $<$18.5). The obesity prevalence (BMI

Table 3. Continued

Variable	Mean (SE)	Weight category†				Abdominal obesity‡
		Underweight	Normal-weight	Overweight	Obesity	
Smoking						
Non-smokers	26.5 (0.03)	5.1	37.9	32.6	24.4	54.0
Current-smokers	26.2 (0.11)	7.8	38.8	29.7	23.7	57.4
Ex-smokers	27.6 (0.17)	3.3	32.2	33.6	30.9	66.5
Physical activity						
No	26.7 (0.06)	5.1	37.2	32.5	25.1	56.3
Yes	26.4 (0.03)	5.6	39.7	32.3	22.3	47.9
Residential area						
Urban	26.9 (0.03)	4.6	34.1	34.2	27.1	57.5
Rural	25.6 (0.04)	6.4	44.5	29.2	19.8	49.0

SE, standard error; WHO, World Health Organization; NHLBI, National Heart, Lung, and Blood Institute.
* Age-adjusted means were calculated using general linear models.
† Category definitions are based on WHO and NHLBI cutoffs (4,12). Underweight = BMI <18.5 kg/m^2; normal-weight = BMI 18.5 to 24.9 kg/m^2; overweight = BMI 25 to 29.9 kg/m^2; obese = BMI ≥ 30 kg/m^2.
‡ Abdominal obesity was defined as waist circumference ≥ 102 cm in men and ≥ 88 cm in women (26,27).

≥ 30) was 10.9% in men and 24.5% in women. These data are consistent with local reports of the high prevalence of overweight and obesity in Iran (27–29) and other countries in the Middle East (34–41). As in other studies in developing countries, obesity tends to increase with age and is more common in women and people with low educational attainment.

Prevalence rates in various studies from around the world show considerable variation. Estimates of prevalence of overweight and obesity will depend on methodological factors, the definition of obesity used, and the composition of the community examined by age, ethnicity, and social class, making comparisons among studies of limited value. One study from Thailand among Thai adults 20 to 59 years of age, found 28.3% and 6.8% were overweight and obese, respectively (24). Another study from Singapore of ages 18 to 69 found 8.5% of women and 5.9% of men were obese (25). A study from China, which has a low prevalence of coronary heart disease in the general population, found the prevalence of overweight in men and women 20 to 45 years of age was 13.6% and 19.2% and for obesity 0.5% and 1.5%, respectively (5). The prevalence of obesity among Turkish women and men was 32.4% and 14.1%, whereas the prevalence of overweight among men and women was 65.9% and 50.4%, respectively (34,35). In Saudi Arabia, the prevalence of obesity is estimated to be 17% to 44% in women and 12% to 26% in men (36–38), and in Egypt, the prevalence of obesity ranges from 40.6% among women living in urban areas to 6% among men living in rural areas (39). The current prevalence of obesity (BMI ≥ 30) is $\sim$20% to 25% in the United States and 10% to 24% in most countries in Western Europe (3,4,22). The prevalence of overweight and obesity in Iran is higher than the values reported in China (5), Thailand (24), and Singapore (25), but lower than the prevalence in Turkey, Saudi Arabia, Kuwait, Persian Gulf countries, and the United States. Our prevalence rate in the age group 20 to 65 years was comparable to those of developed nations such as Finland, Australia, and the United Kingdom, in the same age group, whose obesity prevalence ranges from 12% to 22% (4).

Consistent with prior studies (27–29,34,35,40,41), prevalence of overweight and Classes I, II, and III obesity and abdominal obesity was found to be higher among women than men, and the difference was more evident in abdominal obesity where the rate for women was more than four times that for men. These results may be explained by differences in physical activity or caloric intake. Iranian women may have less physical activity 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, and these may contribute to the differences in prevalence of overweight between men and women.

Table 4. Comparison of selected age-adjusted cardiovascular risk factors among underweight, normal-weight, overweight, and Classes I, II, and III obesity by gender in Iran

	Age-adjusted [mean (SE)]					
Variable	Underweight	Normal-weight	Overweight	Class I obesity	Class II obesity	Class III obesity
Men						
Age (yrs)	30.9 (0.30)	37.2 (0.10)	42.9 (0.11)	44.4 (0.20)	43.0 (0.50)	41.0 (0.95)
Systolic BP (mm Hg)	117.8 (0.29)	121.2 (0.10)	125.5 (0.13)	129.7 (0.24)	131.7 (0.60)	132.0 (1.03)
Diastolic BP (mm Hg)	74.7 (0.21)	77.0 (0.07)	80.2 (0.09)	82.4 (0.17)	83.3 (0.43)	82.3 (0.73)
Cholesterol (mg/dL)	180.4 (1.28)	189.9 (0.38)	203.8 (0.43)	208.8 (0.79)	211.5 (2.03)	204.6 (3.48)
Fasting blood glucose (mg/dL)	92.5 (0.98)	93.6 (0.29)	98.5 (0.33)	101.1 (0.60)	106.5 (1.55)	100.9 (2.66)
Height (cm)	169.6 (0.15)	170.0 (0.05)	169.9 (0.07)	168.9 (0.12)	166.7 (0.31)	142.8 (0.53)
Weight (kg)	49.9 (0.16)	63.9 (0.05)	78.4 (0.07)	90.4 (0.13)	102.1 (0.32)	101.6 (0.55)
BMI (kg/m^2)	17.4 (0.04)	22.1 (0.01)	27.1 (0.02)	31.7 (0.03)	36.7 (0.07)	50.5 (0.12)
Waist circumference (cm)	72.2 (0.18)	80.9 (0.06)	92.8 (0.08)	102.5 (0.15)	111.0 (0.37)	104.1 (0.63)
Women						
Age (yrs)	29.3 (0.30)	35.0 (0.12)	41.5 (0.11)	44.3 (0.13)	45.5 (0.24)	45.0 (0.42)
Systolic BP (mm Hg)	116.2 (0.37)	118.4 (0.14)	121.8 (0.15)	124.9 (0.20)	128.3 (0.37)	128.7 (0.66)
Diastolic BP (mm Hg)	72.8 (0.25)	74.4 (0.09)	76.9 (0.10)	79.1 (0.14)	81.1 (0.25)	81.4 (0.45)
Cholesterol (mg/dL)	187.2 (1.44)	197.9 (0.45)	208.8 (0.42)	213.3 (0.54)	213.9 (1.02)	219.2 (1.83)
Fasting blood glucose (mg/dL)	92.2 (1.21)	94.5 (0.38)	99.0 (0.35)	100.9 (0.46)	103.4 (0.86)	110.0 (1.54)
Height (cm)	158.2 (0.15)	157.0 (0.06)	156.6 (0.06)	155.9 (0.08)	154.9 (0.15)	149.5 (0.26)
Weight (kg)	43.2 (0.15)	54.7 (0.06)	67.2 (0.06)	77.8 (0.08)	88.2 (0.15)	99.8 (0.27)
BMI (kg/m^2)	17.3 (0.04)	22.2 (0.01)	27.4 (0.02)	32.0 (0.02)	36.8 (0.04)	45.0 (0.07)
Waist circumference (cm)	71.9 (0.21)	80.9 (0.08)	92.0 (0.08)	101.0 (0.11)	109.0 (0.21)	115.5 (0.37)

SE, standard error; BP, blood pressure; WHO, World Health Organization; NHLBI, National Heart, Lung, and Blood Institute. Category definitions are based on WHO and NHLBI cut-offs (4,12). Underweight = BMI $<$18.5 kg/m^2; normal-weight = BMI 18.5 to 24.9 kg/m^2; overweight = BMI 25 to 29.4 kg/m^2; Class I obesity = BMI 30 to 34.9 kg/m^2; Class II obesity = BMI 35 to 39.9 kg/m^2; Class III obesity = BMI $\geq$ 40 kg/m^2.

Another finding that requires further elaboration is the high prevalence of abdominal obesity in Iranian women. Whereas age-adjusted mean WC in 19 populations studied in the WHO MONICA project (42) was 83 to 98 cm in men and 78 to 91 cm in women, the age-adjusted mean WCs among men and women in our study were 86.6 and 89.6 cm, respectively. Therefore, Iranian women have considerably higher WC than women in other countries, and a large proportion of women in our study population had high WC even with normal weight. This may be due to genetic predisposition of Iranian women, low levels of physical activity, low smoking rates, high fertility rates, high illiteracy rates, or differences in epigenetic programming of Iranian women. In some developed countries, such as France, the percentage of obese subjects was similar in both genders. This is not the case for other developed countries, for example, Hungary, where it is substantially higher in men than in women, and in Greece and Portugal, where obesity is higher in women than in men (43,44).

Urban residents generally have a higher BMI and abdominal obesity than those living in rural areas. Urban residents are more likely to eat more Western-style food and less likely to be physically active. In most countries, urban residents consume a greater proportion of protein and fat and a smaller proportion of carbohydrates (26) and have generally higher availability of calories.

Overweight and obesity were found to be higher among ever married individuals than among never married persons after adjustment for other confounders, which suggests that people, particularly men, after marriage have less physical activity, change their dietary pattern, may be less focused on being attractive, or may be exposed to other environmental factors. Unfortunately, the data used here do not allow for an empirical test of these speculations. Further research

Table 5. Factors related to prevalence of underweight (BMI <18.5 kg/m^2), overweight (BMI 25 to 29.9 kg/m^2), and obesity (BMI ≥ 30 kg/m^2) (stepwise binary logistic regression model)

	Men			Women		
Variable	**Overweight**	**Obesity**	**Underweight**	**Overweight**	**Obesity**	**Underweight**
Age (yrs)						
15 to 24	1.0	1.0	1.0	1.0	1.0	1.0
25 to 34	2.09 (1.91,2.29)‡	1.99 (1.70,2.33)‡	0.41 (0.35,0.47)‡	1.94 (1.78,2.10)‡	3.00 (2.67,3.37)†	0.59 (0.52,0.67)‡
35 to 44	3.02 (2.73,3.35)‡	3.34 (2.83,3.95)‡	0.40 (0.34,0.48)‡	2.94 (2.68,3.22)‡	6.54 (5.80,7.37)‡	0.44 (0.37,0.53)‡
45 to 54	3.52 (3.17,3.92)‡	4.04 (3.41,4.78)‡	0.37 (0.31,0.44)‡	3.21 (2.92,3.53)‡	7.69 (6.80,8.69)‡	0.49 (0.41,0.59)‡
55 to 64	3.15 (2.82,3.51)†	3.47 (2.92,4.13)‡	0.41 (0.34,0.49)‡	2.83 (2.57,3.12)‡	5.90 (5.21,6.70)‡	0.51 (0.43,0.61)‡
Physical activity						
Yes	—	1.0	1.0	1.0	1.0	1.0
No	—	0.91 (0.85,0.98)*	0.90 (0.82,0.98)*	1.13 (1.06,1.20)‡	1.14 (1.06,1.22)‡	0.83 (0.74,0.92)‡
Smoking						
Non-smokers	1.0	1.0	1.0	1.0	1.0	1.0
Current smokers	0.62 (0.59,0.65)‡	0.51 (0.47,0.55)‡	1.51 (1.37,1.67)‡	0.69 (0.62,0.77)‡	0.65 (0.58,0.73)‡	2.28 (1.92,2.71)‡
Ex-smokers	1.01 (0.93,1.10)	1.14 (1.01,1.27)*	0.97 (0.80,1.18)	0.97 (0.83,1.12)	1.07 (0.91,1.25)	1.06 (0.75,1.49)
Education						
Matriculation or above	1.0	1.0	1.0	1.0	1.0	—
Secondary	0.73 (0.68,0.79)‡	1.04 (0.92,1.17)	1.45 (1.22,1.73)‡	1.21 (1.09,1.33)‡	2.09 (1.83,2.38)‡	—
Primary or below	0.89 (0.83,0.96)†	1.23 (1.09,1.37)‡	1.36 (1.17,1.60)‡	1.26 (1.15,1.39)‡	1.92 (1.69,2.19)‡	—
Marital status						
Married	1.0	1.0	1.0	1.0	1.0	1.0
Single	0.60 (0.55,0.65)‡	0.50 (0.44,0.58)‡	1.45 (1.27,1.66)‡	0.52 (0.48,0.56)‡	0.41 (0.37,0.45)‡	1.82 (1.62,2.04)‡
Residential area						
Urban	1.0	1.0	1.0	1.0	1.0	1.0
Rural	0.62 (0.59,0.65)‡	0.52 (0.48,0.56)‡	1.22 (1.12,1.33)‡	0.63 (0.60,0.67)‡	0.49 (0.46,0.52)‡	1.12 (1.02,1.23)*

Values are significant adjusted odds ratios (95% confidence interval).
* $p < 0.05$; † $p < 0.01$; ‡ $p < 0.00$.

would be useful to examine which factors play a role in the weight gain of married individuals in our society.

A high proportion of the men in this study smoked, and smoking was inversely related to weight. The negative association between smoking and overweight and obesity might be partly due to its effects on metabolic rate, energy intake and storage, and energy expenditure (45,46). In one study, however, weight gain was observed in current smokers as well as ex-smokers and non-smokers, suggesting that the factors promoting weight gain were overcoming the inverse effect of smoking (47). Although a greater risk of excess weight is found among non-smokers, many studies have shown that smoking has a larger impact on morbidity and mortality than any small increase in BMI (48,49).

Consistent with many prior studies (44,50,51), overweight and abdominal obesity were higher among low educated individuals, after adjustment for other confounders. Women who were overweight or obese exercised less than those of normal weight. This relationship could not be seen for overweight men in this survey. Conflicting results have been observed in different studies (44,52).

Our study has several strengths and limitations. The strengths include the large sample consisting of both urban and rural populations, sound representativeness of the national population, and information on potential determinants of obesity. One limitation of our study was the possibility that BMI cut-off points used in this study may understate health risk. The cut-off points are those recommended by the WHO and National Heart, Lung, and Blood Institute (4,12). Although 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 (53,54). As a cross-sectional study, the present analysis is limited in its ability to elucidate causal relationships between risk factors and overweight. 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 (55). However, estimates from these potentially misclassified groups likely had little overall impact on the analysis. Although we have not carried out any special studies of the validity or reliability of data for this analysis, a clerk was employed to check consistency and, where possible, to ensure completeness of data. Our experience with other parts of the dataset gives us some confidence that data quality is sufficient for this type of study and that our results provide useful additional evidence on the prevalence of and risk factors for underweight, overweight, and obesity. Despite the above limitations, the findings here add to our understanding of the epidemiology of overweight and obesity in Iran. Furthermore, this study provides new nationwide data from Iran, a developing country that has been under-represented in past studies.

In summary, excess body weight appears to be quite common in Iran. More women than men present with overweight and abdominal obesity. Preventive and treatment strategies are urgently needed to prevent overweight and obesity and promote weight maintenance and weight loss and address the health burden of obesity.

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