— Original Article —

Association of Body Mass Index and Abdominal Obesity with Marital Status in Adults

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Background: Obesity continues to be an important public health problem worldwide. The objective of this study was to determine the association of body mass index and abdominal obesity with current marital status among the adult population of Iran.

Methods: A nation-wide cross-sectional survey was conducted from December 2004 through February 2005.The subjects were selected by stratified probability cluster sampling through household family members in Iran. Weight, height, waist circumference, and marital status of 89,404 men and women aged 15 – 65 (mean: 39.2) years were recorded. Four classes of body mass index, *i.e.*, <18.5, 18.5 – 24.9, 25 – 29.9, and ≥30 kg/cm^2, and three marital status, *i.e.*, currently-, formerly-, and never-married were used. Abdominal obesity was defined as waist circumference ≥102 cm in men and ≥88 cm in women.

Results: The prevalence of overweight was twofold higher in married men (OR: 2.24; 95% CI: 2.08 – 2.41) and women (OR: 2.36; 95% CI: 2.20 – 2.53) than never-married men and women, even when age, educational level, leisure time physical activity, smoking habits, and place of residence were controlled. The multivariate OR of obesity was increased about threefold in married men (2.82; 95% CI: 2.51 – 3.18) and women (3.64; 95% CI: 3.31 – 3.99). The prevalence of abdominal obesity was twofold higher among married men (2.02; 95% CI: 1.79 – 2.29) and about threefold higher among married women (2.87; 95% CI: 2.69 – 3.06).

Conclusion: The marital status appears to influence the likelihood of developing overweight, obesity, and abdominal obesity in both men and women in Iran.

Archives of Iranian Medicine, Volume 11, Number 3, 2008: 274 – 281.

Keywords: Adults • Iran • marital status • obesity • overweight • prevalence

Introduction

Obesity continues to be an important public health problem worldwide. Its prevalence is increasing in both developed and developing nations with changes in dietary habits and activity level.[1–4] Those who are overweight are at higher risk for a variety of disabling and life-threatening chronic conditions and premature mortality.[5–7] Abdominal obesity is considered as an independent predictor of several risk factors and morbidity.[8] Obesity results not only in medical consequences but it has a strong inverse relationship with social position, as reported from many affluent societies.[9–11]

Marital status is also related to mortality and morbidity, especially for men, with married people at lower risk of death and more likely to be healthy than those unmarried.[12–13] However, it is not clear how marital status is associated with obesity and the role of marriage, as a risk factor for obesity and abdominal obesity, remains still unsolved. There have been conflicting reports about relationship between marital status and obesity.[13–28] Several of these studies showed a positive association,[15–18] whereas others reported no association[13,23,24]; or

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Accepted for publication: 19 December 2007

even an inverse relation[25,26] or a different association for men and women,[19,27,28] reflecting a complex and often paradoxical relationship.

The objectives of this population-based survey were to determine the relationship of body mass index (BMI) and abdominal obesity with marital status among adults aged 15 to 65 years in Iran. We used a representative population survey in Iran, with special reference to differences between women and men.

Subjects and Methods

Data source

From December 2004 through February 2005, we conducted a nation-wide population-based cross-sectional study on 89,404 men and women. They were subjects in the Iranian noncommunicable disease (NCD) risk factor surveillance system, which was designed to provide information on a wide range of behaviors which might 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 was based on the WHO stepwise approach to surveillance (STEPS) of risk factors for NCD.[29] 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 Postal 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 years who were free from any physical handicaps, were weighed, and their height and waist circumference (WC) were measured. Of the

total of 89,404 participants in this study, 1,920 (2.1%) subjects for lack of data on education, 1,821 (2.0%) on marital status, and 2,414 (2.7%) on level of physical activity were excluded from subgroup analyses. All of the women were post-menarche. Women who reported they were pregnant at the time of the survey, homeless people, and those 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 for the subjects the purpose and procedure of the study and sought their consents. Interviews and anthropometric measurements were performed at the subjects' home with standard techniques and equipment.[30] Those aged 25 – 65 years 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 the 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 a 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 socio-demography, smoking habits, diet, level of physical activity, diabetes mellitus, and hypertension. The Medical Ethics Committee of the Ministry of Health and Medical Education approved the study protocol, and all subjects gave their written consents. 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 World Health Organization (WHO) and the National Heart, Lung, and Blood Institute (NHLBI) as follows: underweight <18.5 kg/m^2, desirable weight 18.5 – 24.9, overweight 25 – 29.9, and obese ≥30.[2,31] WC was used as a measure of abdominal obesity, defined as WC≥102 cm in men and ≥88 cm in women to distinguish subjects at increased cardiovascular risk.[8,32] 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 the level of 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/wk of their leisure time performing physical activity, this was considered as "regular physical exercise." Educational level was classified into three groups: "primary or below" (≤5 yr); "secondary" (6 – 12 yr); and "matriculation or above" (≥13 yr). Marital status was classified into three categories, i.e., currently, formerly, and never married.

Analysis

Data were fed to a computer in each medical university/school, with EPI info software (CDC, Atlanta, USA). Datasets were transferred into SPSS-compatible format to calculate means and standard errors (SE), Student's t-test, χ^2 test, and stepwise binary logistic regression (SPSS for Windows; SPSS Inc., Chicago, IL, USA). All analyses were stratified by gender. The results are presented in the text as mean±SE. Robust SEs were calculated to minimize the effect of cluster sampling on the test statistics. Forward stepwise binary logistic regression was performed to assess associations of marital status with underweight, overweight, and obesity, with never-married subjects as reference after adjustment for age, educational level, 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 assuming a type I error probability of <0.05.

Results

Characteristics

Differences in distribution of several age-adjusted characteristics among 18,920 (21.6%) never-married, 65,451 (74.7%) married, and 3,226 (3.7%) formerly-married individuals are shown in Table 1. As expected, never-married individuals were younger, had lower age-adjusted weight, BMI, and WC. They had higher education level, were more likely to be nonsmoker, male, residence in an urban area, and had higher physical activity than those married (*P*<0.001). In the total population, the age-adjusted mean±SE BMI was 23.7±0.04 kg/m^2 in never-married, 26.0±0.02 in married, and 26.3±0.09 in formerly-married subjects. The age-adjusted mean±SE WC was 83.8±0.12, 89.3±0.05, and 89.3±0.24 cm, respectively. The mean±SE age was 39.2±0.07 years.

Risk of obesity/abdominal obesity with marital status

An analysis of the cross-table between marital status and BMI showed that the percentage of overweight (BMI≥25 kg/m^2) or obese (BMI≥30 kg/m^2) individuals were higher in currently- and formerly-married subjects than never-married individuals. Tables 2 and 3 show the prevalnce rates of underweight, overweight, and obesity as well as the abdominal obesity stratified by marital status in men and women.

Compared to never-married women and men, the age-adjusted risk of obesity was significantly higher in those currently- and formerly-married subjects (Tables 2 and 3). The association between overweight and marital status was similar among men who were formerly- and never-married. In women, the age-adjusted risk of overweight was over two-fold higher in those currently-married than those never-married and 68% higher in those formerly-married (Table 3). Marriage was negatively associated with underweight in both men and women (Tables 2 and 3).

In a multivariate model, the additional adjustment for leisure time physical activity, smoking habits, educational level, and area of residence did not significantly alter the relationship between marital status and underweight, overweight, obesity, and abdominal obesity compared with the model adjusted for age alone (Tables 2 and 3).

Discussion

In this first nation-wide cross-sectional study of 89,404 adults aged 15 – 65 years, the ever-married status was associated with a significantly higher

Table 1. Age and age-adjusted characteristics of 43,946 men and 43,651women by marital status, Iran.

Characteristic	Age-adjusted mean (SE)		
	Never married (n=18,920)	Married (n=65,451)	Formerly married (n=3226)
Age (yr)	23.2 (0.08)*	43.2 (0.05)	52.3 (0.20)
Weight (kg)	63.5 (0.12)*	69.2 (0.06)	64.4 (0.25)
Height (cm)	163.8 (0.09)	163.2 (0.04)	156.9 (0.18)*
Waist circumference (cm)	83.8 (0.12)*	89.3 (0.05)	89.3 (0.24)
BMI (kg/m^2)	23.7 (0.04)*	26.0 (0.02)	26.3 (0.09)
	%	%	%
Gender			
Men	54.1	51.0	10.1*
Women	45.9	49.0	89.9
Education (%)			
Primary or below	18.1	60.1	83.1*
Secondary	66.2	31.9	13.9
Matriculation or above	15.7	8.0	3.0
Smoking			
Never-smoker	89.7	74.3	81.8
Current-smoker	7.6*	19.9	12.9
Ex-smoker	2.6	5.8	5.3
Leisure time physical activity			
Yes	44.9	23.6	16.3*
No	55.1	76.4	83.7
Residential area			
Urban	66.2	64.3	67.3*
Rural	33.8	35.7	32.7

*P<0.001.

risk of overweight, obesity, and abdominal obesity in both men and women; the associations for women were stronger. There have been conflicting reports about relationship between marital status and obesity. Several cross-sectional studies of marital status and obesity report that for both men and women, currently- and formerly-married individuals were more obese than those never-married.[15,19,28,33,34] Nonetheless, other studies report different patterns[16,25,26] from no differences in marital staus[22,35] to a different association between the above-mentioned parameters for men and women.[19,27,28] Several longitudinal studies of varying duration have assessed marital status changes and obesity with inconsistent results. These studies suggested that marriage may be associated with weight gain and separation may be related to weight loss.[17, 18, 36–40] However, there are exceptions for that pattern; there are some gender variations within and between studies,[38,41–43] as well as analysis of limited age range,[17,18] and no relationships between change in the marital status and weight.[44] Our study supports some earlier studies that found currently- and formerly-married individuals were more overweight or obese than those never-married. The positive relationship between marital status and overweight, obesity, or

abdominal obesity can be explained by the fact that people, after marriage have less physical activity, change their dietary pattern, may be less focused on being attractive, have more social support, or may be exposed to other environmental factors. Appearance and education have long been seen as important in marriage for both men and women.[45] Unmarried subjects may intentionally manage their weight in an effort to be more attractive to potential marital partner. Married people have more social support than those who are not married.[46] This marital support can lead to obesity through diet, activity, and social values. The lifestyle of married individuals may provide more stable eating pattern. Shared marital status from living in a common household creates responsibilities for eating together and provides social support. Some people control their weight to attract mate, and once they get married weight control may be less valued so that diet/exercise behaviors for slimness may be de-emphasized or abandoned at al.[47]

Mechanisms through which marital status may influence obesity include the amount of energy intake, energy expenditure, and metabolic changes. We expect that married individuals eat more as part of a role obligation to their spouse and may be

Table 2. Prevalence rates and odds ratio (95% CI) of underweight, overweight, obesity, and abdominal obesity by marital status for 45,082 men, Iran.

Characteristic	Subjects (No.)	Prevalence (%)	Crude odds ratio (95% CI)	Age-adjusted odds ratio (95% CI)	Multivariate-adjusted odds ratio (95% CI)[†]
Underweight	2729	6.3	—	—	—
Never married	1341	13.3	1.00	1.00	1.00
Married	1362	4.1	0.31 (0.29, 0.33)***	0.64 (0.57, 0.72)***	0.59 (0.52, 0.66)***
Formerly married	26	8.1	0.61 (0.42, 0.88)***	1.07 (0.70, 1.66)	1.03 (0.67, 1.60)
Overweight	13914	32.0	—	—	—
Never married	1758	17.5	1.00	1.00	1.00
Married	12071	36.4	2.08 (1.99, 2.18)***	2.03 (1.89, 2.18)***	2.24 (2.08, 2.41)***
Formerly married	85	26.4	1.51 (1.25, 1.82)***	1.24 (0.95, 1.63)	1.34 (1.01, 1.76)*
Obese	4751	10.9	—	—	—
Never married	461	4.6	1.00	1.00	1.00
Married	4250	12.8	2.78 (2.55, 3.07)***	2.53 (2.25, 2.85)***	2.82 (2.51, 3.18)***
Formerly married	40	12.4	2.70 (2.00, 3.67)***	2.02 (1.40, 2.92)***	2.22 (1.53, 3.20)***
Abdominal obesity	5595	12.9	—	—	—
Never married	403	4.0	1.00	1.00	1.00
Married	5142	15.6	3.90 (3.51, 4.27)***	1.92 (1.70, 2.17)***	2.02 (1.79, 2.29)***
Formerly married	50	15.4	3.85 (2.92, 5.03)***	1.68 (1.21, 2.34)**	1.78 (1.28, 2.47)**

Total number of cases is not the same for each variable because of missing values. Category definitions are based on WHO and NHLBI cut-offs.[2,31] Underweight= 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.[8,32] [†]Odds ratio (95% CI) calculated by binary logistic regression analysis adjusted for age, educational level, leisure time physical activity, smoking habits, and area of residence. *$P<0.05$, **$P<0.01$, ***$P<0.001$; CI= confidence interval.

more exposed to snack foods of their children, which would lead to increased parental obesity. Energy expenditure is an important influence upon obesity levels, and daily activities and exercise would be expected to be lower among married people since parents have less time for exercise. Other possible explanations are that in our study married individuals tend to have a lower educational level. Metabolic process play a role in energy balance, with smoking being an important influence upon metabolism which leads to lower body weight among smokers. Married individuals are less likely to smoke than those who are not married,[48] which would lead to more obesity among married people. Married people may have more positive emotional well- being. Problems in emotional status tend to influence weight through decreased appetite.

Another finding that requires further elaboration is the higher prevalence of overweight, obesity ,and abdominal obesity in married women. This may be due to genetic predisposition of Iranian women, lower smoking rates, high fertility rates, high illiteracy rates, or differences in epigenetic programming of Iranian women. The increased BMI and WC in the married women could possibly be associated with parity, since childbearing has been suggested to be an important contributor to the development of obesity.[49–51] Brown et al.[50] and Williamson et al.[52] after controlling for aging, found that women with at least three live births had a higher mean weight than those with fewer live births. Another study suggested that weight gain by women in pregnancy leads to retaining weight,[53] which would physiologically lead to greater maternal obesity in addition to any influences of the parental role. In our study, however, we could not investigate the relationship between BMI and childbearing, since data on parity were not available. These results may also be explained by differences in the level of physical activity. 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. Difference in smoking rates is consistent with other discrepancies between men and women.

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. The study examined data for people aged 15 – 65 years, considering the very early marriage. As a cross-sectional study, the present analysis is however, limited in its ability to elucidate causal relationships between marital status and overweight and obesity. Sequential marriages (where currently- and formerly-married people

Table 3. Prevalence rates and odds ratio (95% CI) of underweight, overweight, obesity, and abdominal obesity by marital status for 44,322 women, Iran.

Characteristic	Subjects (No.)	Prevalence (%)	Crude odds ratio (95% CI)	Age-adjusted odds ratio (95% CI)	Multivariate-adjusted odds ratio (95% CI)†
Underweight	2261	5.2	—	—	—
Never married	1181	13.9	1.00	1.00	1.00
Married	975	3.1	0.22 (0.20, 0.24)***	0.52 (0.47, 0.58)***	0.50 (0.45, 0.56)***
Formerly married	105	3.6	0.26 (0.22, 0.32)***	0.75 (0.59, 0.96)*	0.70 (0.55, 0.89)**
Overweight	14003	32.5	—	—	—
Never married	1625	19.4	1.00	1.00	1.00
Married	11374	35.8	1.85 (1.79, 1.96)***	2.31 (2.16, 2.48)***	2.36 (2.20, 2.53)***
Formerly married	977	33.9	1.75 (1.66, 1.90)***	1.68 (1.49, 1.89)***	1.73 (1.53, 1.94)***
Obese	10582	24.5	—	—	—
Never married	665	7.8	1.00	1.00	1.00
Married	9054	28.5	3.65 (3.38, 3.93)***	3.57 (3.25, 3.92)***	3.64 (3.31, 3.99)***
Formerly married	863	30.0	3.85 (3.29, 3.96)***	2.48 (2.16, 2.85)***	2.55 (2.22, 2.93)***
Abdominal obesity	23128	54.5	—	—	—
Never married	1798	21.2	1.00	1.00	1.00
Married	19416	62.5	2.95 (2.82, 3.07)***	2.86 (2.68, 3.05)***	2.87 (2.69, 3.06)***
Formerly married	1914	66.7	3.15 (2.99, 3.30)***	1.99 (1.79, 2.21)***	2.02 (1.81, 2.25)***

Total number of cases is not the same for each variable because of missing values. Category definitions are based on WHO and NHLBI cut-offs[2, 31]. Underweight= 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.[8,32] †Odds ratio (95% CI) calculated by binary logistic regression analysis adjusted for age, educational level, leisure time physical activity, smoking habits, and area of residence. *P<0.05, **P<0.01, ***P<0.001. CI= confidence interval.

may have gone through prior marriage) were not assessed because the data did not examine repeated marriage, and there was no way to examine the length of time that people were maried. Although we have not carried out any special studies on 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 data set gives us some confidence that the data quality was sufficient for this type of study and that our results provided useful additional evidence on the relationship between marital status and under-weight, overweight, and obesity.

In summary, it appears that marriage is associated with a higher prevalence of overweight, obesity, and abdominal obesity in both men and women in Iran. There is a need to assess the mechanism for this association, whether it be through caloric intake, energy expenditure, social values about overweight and obesity, or a combination of these and other factors.

Acknowledgment

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