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Abstract

Background: Obesity is common worldwide, especially in low- and middle-income countries.

Aims: To update data on the prevalence of overweight, obesity and central obesity, and to measure incidence rates for such outcomes in adults living in the south-east of the Islamic Republic of Iran.

Methods: We enrolled 9997 adults (aged 15–80 years) between 2014 and 2018 (phase 2); 2820 of whom had participated in phase 1 (2009–2011). Participants were examined for overweight, obesity, central obesity, diabetes, hypertension, low physical activity, and dyslipidaemia. Univariate and multivariate logistic regression models were used to determine

the potential predictors of overweight, obesity and central obesity, and adjusted odds ratios (AOR) were obtained. Incidence rate of overweight, obesity and central obesity was reported among those who had none of these outcomes in phase 1.

Results: The prevalence was 35.8% (37% men, 35% women) for overweight, 22.3% (16% men, 26.3% women) for obesity, and 31.1% (15.6% men, 41.2% women) for central obesity. The prevalence of overweight/obesity was significantly associated with age (AOR = 2.8–7.4), higher education (AOR = 1.7), female gender (AOR = 1.4), low physical activity (AOR = 1.3), smoking (AOR = 0.55) and opium use (AOR = 0.79). The prevalence increased from 33.3% to 35.8% for overweight and from 15.4% to 22.3% for obesity between phases 1 and 2. The incidence rate per 100 person-years was 5.5 for overweight, 4.7 for obesity and 2.9 for central obesity.

Conclusion: Prevalence of overweight and obesity increased over 5 years. Middle-aged participants, women, and those with low physical activity were at higher risk for overweight/obesity.

Keywords: overweight, obesity, risk factors, prevalence, incidence

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Introduction

Abnormal body mass index (BMI), which can be in the form of overweight and obesity, has been

one of the greatest health challenges worldwide. Recent studies have indicated that the worldwide prevalence of obesity nearly tripled between 1975 and 2016 (1,2). Obesity has been associated with many diseases such as type 2 diabetes mellitus, cardiovascular disease (CVD), hypertension, and cancer (3). According to the World Health Organization (WHO) in 2018, ~13% of the global adult population was obese in 2016 (4). The problem of obesity affects many Asian and Persian Gulf countries, especially the Islamic Republic of Iran, and it has become one of the top health challenges in such countries (5,6). WHO has also reported that the prevalence of overweight and obesity in Middle East countries is 54.2% in women and 31.4% in men (7,8). Studies in the Islamic Republic of Iran have shown the upward trend in obesity prevalence in all age groups > 15 years (9–11). Due to the plentiful differences in sociocultural issues in all Iranian provinces, and considerable variations in lifestyle and dietary/nutritional culture, a varied pattern of overweight and obesity prevalence has been observed in recent years. A systematic review revealed a prevalence of overweight between 27% and 38.5% and a prevalence of obesity between 12.6% and 25.9% (12). To our knowledge, there is little information about the prevalence of obesity and overweight and their predictors in Southeastern Iran. In a population-based study (Kerman Coronary Artery Disease Risk Factors Study; KERCADRS) conducted from 2009 to 2011 on 5900 adults aged 15–75 years, the prevalence of overweight and obesity was 29.6% (29.5% men, 29.7% women) and 13.0% (9.3% men, 16.9% women), respectively (13).

The present study is the second phase of KERCADRS conducted on a larger sample size of 9997 individuals from 2014 to 2018. The study had 2 main objectives: (1) to determine the prevalence and predictors of overweight and obesity, and their affecting factors [e.g., level of physical activity, anxiety, depression, cigarette smoking, and opium addiction] in the population aged 15–80 years; and (2) to compare the findings of the second phase with the first phase (2009–2011) to explore the incidence rate and trend in changes in prevalence of overweight and obesity. This will provide a better insight into the severity and growth rate of these two important CVD risk factors in this region in the past 5 years.

Methods

Study design

This was a serial cross-sectional study that recruited participants in two phases (2014–2018 and 2009–2011) and was conducted according to the Declaration of Helsinki. The study protocols were approved by the Ethics Committee of Kerman University of Medical Sciences (ethics code: IR.KMU.REC.1392.405). Written informed consent was obtained from all subjects.

Study population

Phase 2 of KERCADRS was conducted from 2014 to 2018 on 9997 adults aged 15–80 years in Kerman, the largest city in Southeastern Iran. Kerman is the capital city of Kerman Province with a population of ~750 000 and is located ~1000 km from the capital, Tehran. People are

mostly busy with white-collar jobs in the government sector, agriculture, and trade. Lifestyle patterns are typically aggregated in families. The methodology and more detailed description of the selected variables have been published elsewhere (14). We used a non-proportional-to-size one-stage cluster sampling household survey, and randomly selected 420 zip codes, each representing a house (called a seed). Social mobilizers approached the seed household and invited all eligible people to participate in the study. Recruitment was continued until 24 persons were recruited in each cluster and an overall target sample size of close to 10 000 was achieved.

Data collection

The study participants were examined by a physician for various coronary artery disease (CAD) risk factors using a standard structured questionnaire (14). The questionnaire consisted of sociodemographic data; level of education [1, illiterate; 2, primary to high school; and 3, above high school (college level)]; cigarette smoking (1, never smoked; 2, current smoker); and opium use [1, nonuser; 2, occasional user, and 3, dependent (continuous use)]. Level of depression and anxiety were assessed using the Beck Depression Inventory and Beck Anxiety Inventory, respectively. For depression, scores > 30 and for anxiety, scores > 26 were identified as disease states (14). The Global Physical Activity Questionnaire was used to evaluate the level of physical activity. The total metabolic equivalent of task (MET) was calculated for the status of activity in work-, transport- and recreation-related physical activity. MET is the rate of energy used by a person while sitting. Moderate physical activity is considered as consuming energy > 4 times, and high physical activity is energy consumption > 8 times the energy used while sitting (15).

Measurements

Height, weight and waist circumference (WC) were measured by standard methods (14). WC > 88 cm for women and > 102 cm for men was considered as central obesity. Height was measured in standing position without shoes, and weight was measured by a standard weighing balance (Seca, Hamburg, Germany). BMI was classified as normal (18.5–24.9 kg/m2), overweight (25–29.9 kg/m2) and obese (≥ 30 kg/m2). Laboratory measurements (10–12 hours of fasting) included fasting plasma glucose, triglyceride and total cholesterol. Cholesterol and triglyceride values > 200 mg/dl were considered abnormal. All individuals with previously diagnosed diabetes, taking insulin or antidiabetic drugs, or with fasting plasma glucose ≥ 126 mg/dl were considered to have diabetes. Blood pressure was measured with a standard mercury manometer (Richter, Speichersdorf, Germany). All individuals with previously diagnosed hypertension, taking antihypertensive drugs, or with resting systolic/diastolic blood pressure ≥ 140/90 mmHg were considered to have hypertension.

Incidence of overweight/obesity

We used the same method to calculate the incidence rate of overweight, obesity and central

obesity. Therefore, we only present the method for calculation of incidence rate of overweight. To calculate the incidence rate of overweight, we used data from those who participated in both study phases, and who had normal BMI in phase 1, and therefore, were at the risk of becoming overweight during follow-up (Supplementary Figure 1). Therefore, 48.7% of the 5900 participants (2873 cases) in phase 1 who were already overweight were excluded from calculation of incidence rate. Out of the remaining 3027 participants, 207 (6.8%) were lost to follow-up. The number of new overweight cases (among the 3027 cases) identified during the follow-up period was designated the numerator. For those who had normal BMI in phase 1, the time difference (in years) between the visits in phases 1 and 2 was calculated as person-years at risk. Therefore, the denominator was the sum of the time each person was followed (person-year), totalled for all 3027 persons who were at risk of becoming overweight. For those who were lost to follow-up, we assumed that they had followed up for an average 2.5 years (half of the overall follow-up time between phases 1 and 2), and were then lost to follow-up. Incidence rate was calculated using the formula (16):

$$\text{Incidence rate} = \frac{\text{Number of new cases of overweight during 5 years}}{\text{Total person-years for all persons at risk}} \times 100$$

Statistical analysis

Numerical variables were described as mean and standard deviation and categorical/ordinal variables as n (%). Data management and all statistical analyses were conducted using STATA version 14. Data were analysed using the survey data analysis package. To account for the clustering effect, we used the survey data package analysis, in which we set clusters as the primary sampling units. Because of the non-proportionate-to-size sampling method, the total estimates were standardized based on the real age distribution of the target population (national census of Kerman population size in 2016). We reported weighted prevalence (17) for overweight, obesity and central obesity. We ran the bivariate analysis to assess the association between all covariates and the study outcome (overweight, obesity and central obesity binary outcomes), one at a time. We included all covariates with P

Results

Overweight, obesity and central obesity

Overall mean BMI was 27 kg/m2 in phase 2 (Supplementary Table 1), which was higher than 25.6 kg/m2 obtained in phase 1 (Figure 1A). Overall mean WC was 89.8 cm in phase 2, which was also higher than 85 cm obtained in phase 1 (Figure 1B). BMI and WC, overall and for both

genders, were significantly higher in phase 2 than in phase 1 (P

The overall prevalence of overweight and obesity was 35.8% and 22.3%, respectively (Table 1), whereas the corresponding values in phase 1 were 33.3% and 15.4%, respectively (Figure 2). The prevalence of central obesity was 31.1% in phase 2 (Table 1) and 18.2% in phase 1

(Figure 2). All three variables, overall and in each gender, were significantly higher in phase 2 than in phase 1. The overweight prevalence increased from 15.5% (phase 1) and 20.6% (phase 2) in subjects aged 15–24 years to peaks at 43.2% (phase 1) among those aged 35–44 years and 42.6% (phase 2) among those aged 45–54 years (Figure 2D). Obesity among the first age group was 5.1% (phase 1) and 10.3% (phase 2), which significantly increased with age to a maximum of 25.8% (phase 1) among those aged 45–54 years and 31.0% (phase 2) among those aged 55–64 years (Figure 2E). Both obesity and central obesity were higher in all age groups in phase 2 compared with the same values in phase 1.

The prevalence of obesity and central obesity showed a decreasing trend with education and cigarette smoking and in dependent opium users (Table 1). Depression and anxiety had almost no significant effect. People with higher physical activity had a lower prevalence of overweight, obesity and central obesity.

Predictors of abnormal BMI and WC

The odds of combined overweight and obesity significantly increased with age, in people with hypertension, patients with diabetes, higher education levels, female gender, and those with low physical activity (Table 1). Conversely, AOR for overweight/obesity significantly decreased among cigarette smokers, opium users and those with depression. In terms of central obesity, AOR of abnormal WC showed a trend similar to overweight/obesity. The corresponding results for phase 1 showed that AOR for overweight/obesity significantly increased with age, education level, lower physical activity and female gender (13).

Comorbidities with overweight and obesity

On the whole, with increasing BMI, the prevalence of diabetes mellitus increased from 9.1% in people with normal weight to 21.5% in those with obesity and from 10.3% in people with normal WC to 24.1% in those with abnormal WC (Table 2). Similarly, the prevalence of hypertension increased from 13.7% to 35.4% in participants with obesity and from 16.7% to 35.7% in those with central obesity. The corresponding values for diabetes changed from 7.0% to 11.6% for participants with obesity and from 7.7% to 12.8% for central obesity in phase 1 (13). With regard to hypertension, these values were 22.6% to 37.4% for participants with obesity and 16.5% to 40.9% for those with central obesity in phase 1 (13). Almost all values were higher in phase 2

compared to phase 1. Hypercholesterolaemia and hypertriglyceridaemia were also important comorbidities accompanying overweight, obesity and central obesity (Table 2).

Incidence rate of overweight, obesity and central obesity

Overall, the 5-year incidence rate (persons per 100 person-years) was 5.5 for overweight, 4.7 for obesity and 2.9 for central obesity (Table 3). The lowest incidence rate of obesity belonged to those who were dependent opium users, while the highest incidence rate of obesity was in the age group of 25–34 years. Higher incidence rates of overweight, obesity and central obesity were observed in women compared to men. Also, people in the age group of 35–44 years had the highest incidence rate of overweight. Cigarette smokers and opium users had a lower incidence rate of overweight and obesity. Also, there was a reverse relationship between the level of physical activity and incidence rates of overweight, obesity and central obesity; i.e., the people with high physical activity had lower incidence rate of overweight, obesity and central obesity.

Discussion

The findings of this study showed that currently one fourth to one third of the population in Southeastern Iran was overweight, obesity or central obesity, which were all significantly more prevalent in phase 2 compared to phase 1. These measures show a high current prevalence and a sharp rise in the prevalence of these unsafe metabolic variables during the 5-year period. In addition, all of the measures were higher in women than in men. People with low physical activity had a high incidence rate and those with high physical activity had a low incidence rate. Middle-aged people had the highest incidence of overweight, obesity and central obesity.

In a recent systematic review, in subnational studies, the prevalence of overweight and obesity among adults ranged from 12.8% to 76.4% and from 2.4% to 35.4%, respectively, while in national studies, it was reported as 27.0–38.5% and 12.6–25.9%, respectively (12). There was a significant relationship between the 2 baseline variables of female gender and age and occurrence of overweight and obesity. The authors believe that the main reasons for the higher prevalence of obesity in these baseline subgroups included improper lifestyle such as low physical activity and tendency towards unhealthy dietary habits. The data obtained in phase 1 showed that low physical activity was significantly higher in women (15). The global prevalence of obesity is greater in women compared with men (18). Most of the studies in the Islamic Republic of Iran have shown higher prevalence of overweight and obesity among women (9,13,19,20), and low physical activity could be one of the main reasons for this difference between men and women (15,21). According to our study published in 2016, 16.9% of women and 9.3% of men were classified as obese and 7.5% of men and 21.5% of women were reported as overweight (13). A study by Saadatifar et al. (9) showed that the prevalence of obesity was 12.3% in men and 18.9% in women in Northeastern Iran. In a nationwide study by Janghorbani et al. (22), the age-adjusted prevalence of overweight and obesity was 42.8% and

11.1% in men and 57.0% and 25.2% in women, respectively. In this regard, advanced age, low physical activity, low education, marriage, and urban residence were strongly associated with obesity (22).

The prevalence of hypertension in participants with obesity was about 3 times that of normal-weight individuals. Also, the prevalence of diabetes in those with obesity/central obesity was more than double that of individuals with normal weight. Corresponding values for both diabetes and hypertension were about 1.5 times higher than those in phase 1 of the study (13). These findings show that obesity steeply increases the risk of other CAD risk factors, and this association has increased in the community during the 5-year interval between the 2 phases of the study.

Prevalence of overweight and obesity decreased with education level. This may be explained by the fact that those with a higher socioeconomic status have more appropriate lifestyle regarding daily activities and dietary behaviour, as well as a lower tendency towards smoking and alcohol consumption. Cutler and Lleras-Muney found that people with more years of schooling are less likely to smoke, consume excess alcohol, be overweight or obese, or use illegal drugs (23). In addition, the more-educated individuals are more likely to exercise. In the study by Veghari et al. in Isfahan, the risk of central obesity increased in illiterate people (24).

Cigarette smokers had a lower prevalence of overweight and obesity in our study. It has been shown that nicotine greatly increases energy expenditure, and it could reduce appetite, which could explain why smokers tend to have lower body weight (25). In terms of opium consumption, we found that the prevalence of obesity in dependent opium users was lower than it was in nonusers. Our previous study in diabetic patients also revealed lower BMI and prevalence of overweight and obesity in opium addicts compared to nonaddicted people (26).

People with higher physical activity had lower incidence of overweight, obesity and central obesity, and those with lower physical activity had higher incidence of overweight, obesity and central obesity. It has also been reported that low physical activity is associated with hypertension, high cholesterol and high triglyceride (27).

Overall, the rapid increase in the rate of overweight and obesity during the past 5 years, especially in women who are less physically active, predisposes the population to CAD, which is already a major health problem in the region. This risk profile may significantly increase the burden of CVD in the community in the near future if left unaddressed.

Our study had 2 limitations. First, we lost 52% of the participants from phase 1 and were not able to assess the effects of this on incidence rate. The time interval between phase 1 and 2 was 5 years and for incidence rate calculation (the denominator), for those who were lost to follow-up, we assumed they had been lost midway (16). Second, our study was conducted in Southern Iran, which may limit our ability to generalize our findings to the whole nation.

Conclusion

Overall, overweight and obesity affected almost 60% of the participants, and were major public health problems, with a significantly higher prevalence and incidence rate in women, middle aged people, illiterate and less physically active individuals. Obesity increases the risk of other CAD risk factors (e.g., diabetes, hypertension and dyslipidaemia) and this association has increased during the last 5 years. Therefore, it is necessary to assess the efficacy of local and national intervention programmes in managing and controlling the epidemic of overweight/obesity and the consequent rise in CVD in Southeastern Iran.

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Competing interests: None declared.

Point épidémiologique sur la prévalence et l’incidence du surpoids et de l’obésité chez les adultes dans le sud-est de la République islamique d’Iran : résultats de l’étude KERCADR (Kerman Coronary Artery Disease Risk Factors Study)

Résumé

Contexte : L'obésité est un phénomène répandu dans le monde entier, notamment dans les pays à revenu faible et intermédiaire.

Objectifs : Mettre à jour les données sur la prévalence du surpoids, de l'obésité et de l'obésité centrale et mesurer les taux d'incidence de ces résultats chez les adultes vivant dans le sud-est de la République islamique d’Iran.

Méthodes : Nous avons recruté 9997 adultes (âgés de 15 à 80 ans) entre 2014 et 2018 (phase 2), dont 2820 avaient participé à la phase 1 (2009-2011). Les participants ont été examinés afin de détecter le surpoids, l'obésité, l'obésité centrale, un diabète, une hypertension, un manque d'activité physique et une dyslipidémie. Des modèles de régression logistique univariés et multivariés ont été utilisés pour déterminer les facteurs prédictifs potentiels du surpoids, de l'obésité et de l'obésité centrale, et ont permis d'obtenir des odds ratio ajustés (ORa). Le taux d'incidence du surpoids, de l'obésité et de l'obésité centrale a été rapporté parmi ceux qui n'ont présenté aucun de ces résultats lors de la phase 1.

Résultats : La prévalence était de 35,8 % (37 % chez les hommes, 35 % chez les femmes) pour le surpoids, de 22,3 % (16 % chez les hommes, 26,3 % chez les femmes) pour l'obésité et de 31,1 % (15,6 % chez les hommes, 41,2 % chez les femmes) pour l'obésité centrale. La prévalence du surpoids/de l'obésité était significativement associée à l'âge (ORa = 2,8 à 7,4), à un niveau d'éducation supérieur (ORa = 1,7), au sexe féminin (ORa = 1,4), à une faible activité physique (ORa = 1,3), au tabagisme (ORa = 0,55) et à la consommation d'opium (ORa = 0,79). La prévalence est passée de 33,3 % à 35,8 % pour le surpoids et de 15,4 % à 22,3 % pour l’obésité entre les phases 1 et 2. Le taux d'incidence pour 100 personnes-années était de 5,5 pour le surpoids, 4,7 pour l'obésité et 2,9 pour l'obésité centrale.

Conclusion : La prévalence du surpoids et de l'obésité a augmenté sur une période de cinq ans. Les participants d'âge moyen, les femmes et ceux qui avaient une faible activité physique présentaient un risque plus élevé de surpoids ou d'obésité.

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