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Original Article

Using Multinomial Logistic Regression for Modeling Obesity and Overweight Among People in Urban Area of Ardabil City, Ardabil, Iran

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ARTICLE INFO ABSTRACT

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Introduction: Overweight and obesity are defined as abnormal or excessive fat accumulation that may impair health and increase the risk of more diseases in future. Body mass index (BMI) is a good method for measure the overweight and obesity and waist to hip ration is a good index for measure the abdominal obesity.
Methods: This cross-sectional study was done on 1316 people who selected randomly from Ardabil city. Demographic data and anthropometric parameters such as age, sex, height, weight, waist circumference and hip circumference were measured by interviewers. Data were analyzed by statistical methods such as t-test, chi-square test, Pearson correlation and multinomial logistic regression model in SPSS version 21.
Results: The mean age of the people was 28.5±7.4 years of them, 63.1% were in age group 20-30 years. The mean height of the samples was 162.7±8.6 cm in range 110-194 and the mean weight of them was 68.9±11.7 kg in range 43-111. The mean BMI of patients was 25.7. According to BMI, 35.6% of all samples had overweight and 18.6% had obesity. According to the WHR, 28.1% of male and 22.1% of female had high WHR (abdominal obesity). The prevalence of abdominal obesity based WHR was 25.2%.
Conclusion: By using Multinomial Logistic Regression we showed that the relation between BMI and Age was positive and significant and by increasing one year at age of people, the rate of overweight increased 13% and the rate of obesity increased 17% in compare with normal patients.
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Introduction

Obesity is a complex, multifactorial, and major public health problem world-wide which could be increasing the risk of cardiovascular and cerebrovascular diseases in worldwide and its control could be important to prevent chronic diseases among people in society in future (1-2). Obesity in future will be changed to epidemic and happens in all age groups, races and also in developed and non-developed countries in worldwide.

Body mass index (BMI), weight to hip ratio (WHR) and fat distribution are some indices which used to measure obesity, overweight and body fat in many studies (3). BMI is defined as a person's weight in kilograms

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divided by the square of his height in meters (kg/m^2). For adults, WHO defines overweight and obesity as follows: Overweight is a 25 ≤BMI <30; and Obesity is classified in three groups based on BMI amounts. BMI in 30-35 defined as class I obesity, 35-40 class II obesity and ≥40 defined class III obesity. By 2030, approximately 38% of the world's elderly population will be obese (2-4). WHR is an index which was used to measure the abdominal obesity which defined as ≥0.9 for men and ≥0.85 for women as unhealthy group and for people less than these amounts they classified in healthy groups. WHR is defined as the ratio of waist circumference (WC) to hip circumference.

Obesity and being overweight are increasing rapidly in the developed and developing countries (5). It is estimated that by 2030, up to 57.8% of the world's elderly people would suffer from being overweight or obese. Some factors such as increasing the population size of each society, age, urbanization and a noticeable change in their lifestyle had led to an elevated overweight and obesity, especially in developing countries in the future (6).

The aim of this study was to using the Multinomial Logistic Regression for modeling obesity and overweight among people in urban area of Ardabil city.

Methods

Study population

This cross-sectional study was done on a sample people who selected randomly from all over the Ardabil city. This is a population based study with the main objective of modeling the obesity and overweight by using Multinomial Logistic Regression based on BMI and WHR data. For this analysis, we included data from 1316 participants who selected from Ardabil city people from April 2018 to April 2019. All samples selected by random stratified sampling method from four geographic area of Ardabil city according to the city map. The sample size calculated based on 80% power and 95% confidence interval and prevalence rate of obesity and overweight with about 0.33 and d=0.05 in two sexes based on descriptive study sample size formula.

Data collection

Before interview and measurement, written [or Verbal] informed consent was obtained from all subjects. Demographic and anthropometric data were collected for all participants. Weight (kg), height (cm), waist and hip circumferences (cm) were measured by interviewers and recorded in the checklist. Two anthropometric indices which analyzed in this study were body mass index (BMI) and waist-to-hip ration (WHR). A WHR≥0.95 in men and ≥0.85 in women were considered as high WHR (unhealthy groups with abdominal obesity) (7).

All of male and female participants in this study were in age group 20-50 years.

Multinomial Logistic Regression Model

Multinomial Logistic Regression (MLR) is the regression analysis to conduct when the dependent variable is nominal with more than two levels. Multinomial regression is used to explain the relationship between one nominal dependent variable and one or more explanatory variables (8).

Multinomial logistic model is the extension of the binary logistic regression model to outcome measure with j=1, 2, 3, …,k nominal outcomes. Therefore, the association between multinomial response variable Yi and explanatory variables such as X1, X2, X3, … ,Xk can be represented with the following multiple binary logistic model:

$$g(x) = \log it(p(x)) = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + ... + \beta_k x_k$$

Dependent variable

The response variable in dataset of our study was BMI of patients which divided into three

groups: Normal (18.5≤BMI<25), Overweight (25≤BMI<30) and Obesity (BMI≥30).

Independent Variables

In this study we have a group of variables such as gender, age and WHR.

Binary logistic regression

In Binary logistic regression the dependent variable was binary (0, 1) and by this model, we estimated the probability of a dichotomous response (which of course is also its mean) for various values of explanatory variables proposed by Willy (1996). We fit a following model of the form:

$$e(Y) = \frac{e^{\beta_0+\beta_1 x}}{1+e^{\beta_0+\beta_1 x}}$$

The term of the right side of the equation, called a logistic function. Hence, the binary logistic regression model can be written as:

$$g(x) = logit\big(p(x)\big) = ln\frac{p(x)}{1-p(x)} = \beta 0 + \beta 1 x$$

Statistical analysis

Collected data were analyzed in SPSS version 21 and Stata-15 by using descriptive statistical methods such as number, percentage, and Mean±SD. Also, T-test were used for compare mean of quantitative variables between two groups and chi-square test have been used to determine the relation between two categorical variables, respectively. We also used the person correlation and scatter plot for determine the relation between BMI and age and WHR.

Also, we used the Multinomial Logistic Regression model by backward stepwise (Wald) method to determine the association between BMI and explanatory variables such as gender, age and WHR. The P<0.05 was considered as significant. The results of the multinomial logistic regression analysis have been shown by odds ratios (ORs) with 95% confidence interval (CI).

Results

The study population consisted of 1316 participants (686 men and 630 women). The mean age of participants was 28.3±7.4 years (range 20 to 49). All of participants were from urban population who lived in Ardabil city.

Prevalence of overweight and obesity based on gender and age

The overall prevalence of overweight (25≤BMI<30 kg/m2) was 35.6 % (95%Confidence Interval (CI): 29%-41%). Of all participated people with overweight, 52.4% were male and 47.6% were female and based on non-parametric chi-square test the difference between two sexes wasn't significant. The overall prevalence of obesity (BMI≥30 kg/m2) was 18.6% of them, 46.9% were male and 53.1% were female and the prevalence of overweight in men slightly higher than women but not significant (P=0.52). Most of men (47.5%) and most of women (44%) had normal weight and the mean difference of BMI between two sexes based on t-test wasn't statistically significant. Of all women, 20.6% and of all men, 16.8% had obesity and we could resulted that the prevalence of obesity in Ardabil healthy women was a few more than men but the difference between two sexes wasn't significant (Table 1).

Table 1. The relation between BMI and gender of patients

BMI (kg/m²)	*Male*		*Female*		*p-value*
	n	*%*	*n*	*%*	
Normal (18.5≤BMI<25)	326	47.5	277	44	
Overweight (25≤BMI<30)	245	35.7	223	35.4	
Obesity (BMI≥30)	115	16.8	130	20.6	0.17
Total	686	52.1	630	47.9	

The prevalence of overweight in all of participants were approximately similar but the prevalence of obesity in elderly groups (≥40 years) in compare to younger age groups (20-40 years) based on chi-square test was significantly higher (P=0.016) (Figure 1).

Correlation between WHR and BMI based on gender and age

Of all participated people, 332 cases (25.2%, %95CI: 20%-30%) had high WHR (abdominal obesity) too. The prevalence of abdominal obesity in men was significantly higher than women (58.2% vs. 41.8%, P=0.005). Of all people with obesity, 85 cases

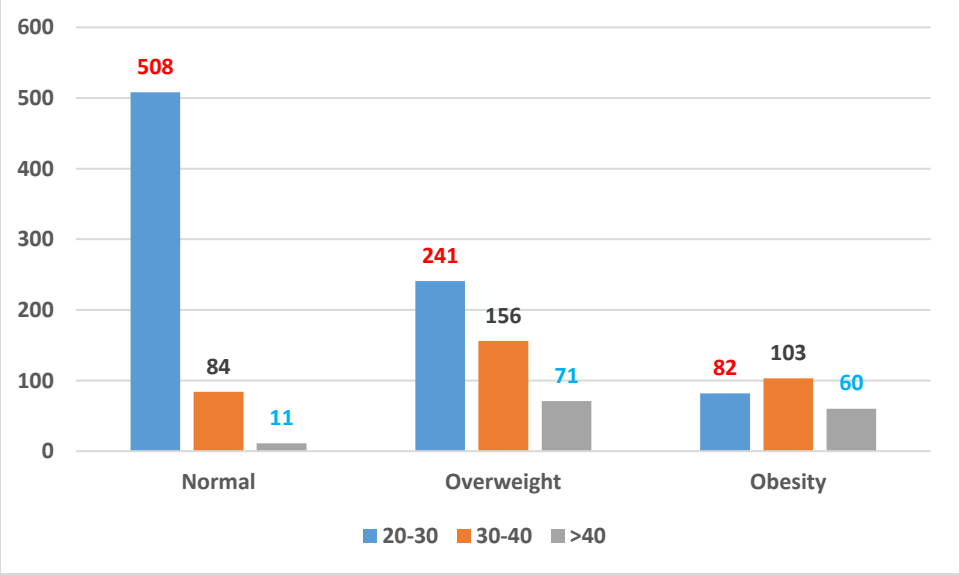

Figure 1. Prevalence of obesity and overweight in all studied patients by age groups

(34.7%) had either high WHR. Of all cases with higher WHR, 85 people (25.4%) had either obesity. The correlation between BMI and WHR was positive and statistically significant (r=0.24, P=0.001). Also, there was a positive and significant correlation between BMI and Age among all participants (r=0.49, P=0.001) (Figure 2).

The findings of the multinomial regression model revealed that for a one unit increase in age of people the risk of increasing overweight and obesity in participated people were estimated about 13% and 17%, respectively. By control the gender of people, the equation for overweight as:

$$Log(\frac{p(overweight)}{p(normal)}) = \mathbf{0.018} + \mathbf{1.03gender} + \mathbf{1.14\ age}$$

And the equation for obesity as:

$$Log(\frac{p(obesity)}{p(normal)}) = \mathbf{0.002} + \mathbf{1.25\ gender} + \mathbf{1.2\ age}$$

. (Table 2)

Table 2. The results of Multinomial Logistic regression model

BMI-Class	RRR	Std.Err	z	P>z	[95% Conf.Interval]	
Normal	Base outcome					
Overweight						
Age	1.14	0.013	11.8	0.001	1.12	1.17
Gender	1.02	0.135	0.22	0.827	0.795	1.33
constant	0.019	0.0069	-14.01	0.001	0.009	0.0385
Obesity						
Age	1.19	0.015	13.93	0.001	1.17	1.23
Gender	1.25	0.208	1.35	0.176	0.9	1.74
constant	0.0017	0.0007	-14.01	0.001	0.0007	0.0041

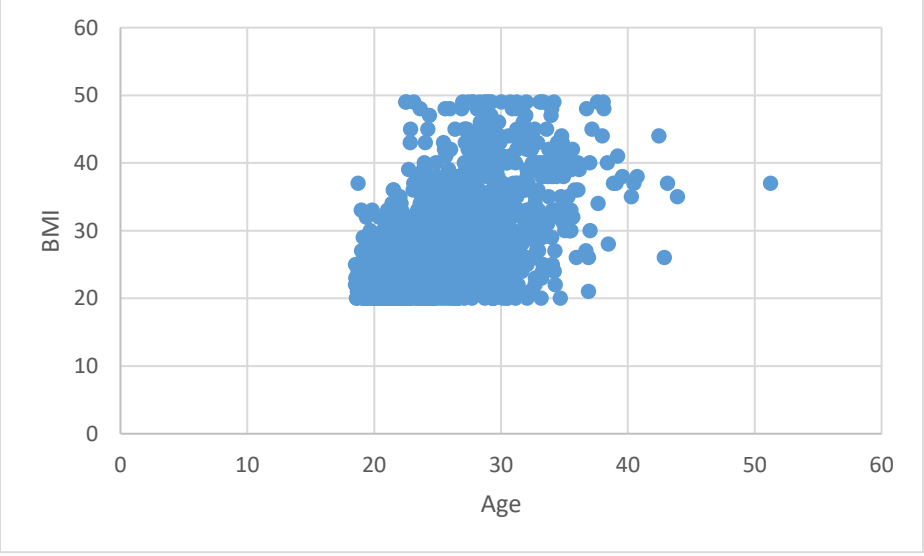

Figure 2. The scatter plot between WHR and BMI in all participants

Discussion

In this study, the overall prevalence of overweight (25≤BMI<30 kg/m2) and obesity (BMI≥30) was 34.5% and 18.1%, respectively. In Fallahzadeh *et al.* (2017) study, the prevalence of obesity and overweight was 8.5% and 17.5%, respectively and this overall prevalence rate was lower than our study results (9).

Ghadiri-Anari et al in a study on people aged > 30 years showed that, the prevalence of obesity and overweight were 9.5% and 29%, respectively which was lower than our study results because in our study the prevalence of overweight and obesity was 62.4% and 41.7% respectively (10).

Yaghoobi *et al.* (2015) in a study on Iranian women showed that the prevalence of obesity and overweight were 11.9% and 22.4%, respectively which was significantly lower than our study results because in our study these rates were 34.5% and 18.1% respectively (11).

The prevalence of abdominal obesity in our study was 24.7%. Zar *et al.* (2017) in a study on girl students in Shiraz university showed that the prevalence of abdominal obesity was 29.6% which upper than our study results which could be related to the difference in race and age groups in selected people (7).

Hosseinpanah *et al.* (2009) in a study showed that the prevalence of abdominal obesity in women was greater than men (76.7% vs. 36.5%) which was in opposite of our study results because in our study the prevalence rate of abdominal obesity in women with 41.5% lower than men with 58.2% (12). This difference in results could be related to the structure of population of Ardabil province and their cultural issues, because in this province men work in out more than women.

Zou et al in a study showed that the prevalence of obesity was 10.1% among adults in urban area. In our study all of cases selected from urban areas and we could not compare our result with other studies. They also revealed that demographic and dietary factors could be associated with obesity among adults and due to not having any information about dietary of participants we could not compare the results (13).

Tabrizi *et al.* (2018) in a study showed that the prevalence of overweight, obesity and abdominal obesity was 39.6%, 24%, and 76.4%, respectively which was upper than our study results in overweight and obesity rate because in our study these indices rates were 34.5% and 18.1% but the abdominal obesity in our study was 24.7% which was lower than this study (14).

Ayatollahi *et al.* (2010) in a study showed that the prevalence of overweight (25≤body mass index <30) was 49.7% in men and 63.9% in women which was upper than our study results in two sexes. The prevalence of obesity (body mass index ≥30) was 10.5% and 22.5% in men and women, respectively which was lower than our study results (15).

Amani *et al.* (2016) in a study showed that, the overall prevalence of overweight and obesity in studied university medical students were 51.3% and 29.6%, respectively which was upper than our study results. The prevalence of overweight and obesity in girls were 53.7% and 81.7% which was significantly higher than boys. Also according to WHR, 27.5% of participants had abdominal obesity of them, 95.5% were girls. Based on WHR results in our study, 24.7% of participants had abdominal obesity which was lower than Amani et al study because this rate was 27.5% (16).

Fattahzadeh *et al.* (2017) in a study showed that, the rate of overweight in high school girls in Ardabil was 8.8% which was significantly lower than our study results that its reasons may be related the studies people age groups and abdominal obesity was 35.1% which was upper than our study results which

this difference could be due to the selected samples in upper age groups in our study (17).

In our study, there was a significant positive correlation between BMI and WHR (r=0.24, p=0.001) but in the study by Dustjalali *et al.* (2016) the correlation between them wasn't significant which was not in line with our study results. Also in our study this correlation in both sexes was significant but in the Dustjalali *et al.* (2016) study, the significant correlation only seen among female people (r=0.623) (18).

Amirul et al in a study entitled" Multinomial logistic regression modelling of obesity and overweight among primary school students in a rural area of Negeri Sembilan" showed that, the obesity and overweight of students are related to gender, religion, sleep duration, time spent on electronic games, breakfast intake in a week, with whom meals are taken, protein intake and similar to above study we concluded that the age of people had significant relation with obesity and overweight (19).

Toriola in a study showed that the rate of obesity and overweight was 4.5% and 18.7%, respectively which was lower than our study results and also by using MLR model results showed that the Physical Activity of university women were related to less likelihood of being overweight and obese among women. Due to non-having data about the Physical Activity of samples, we could not resulted this hypothesis (20).

Dixit et al in a study by using the multinomial logistic regression showed that overweight increased with age and education of women with higher prevalence among urban women. The results of this study is in line with our study results (21).

Along with a number of studies, this study confirmed that fraction of overweight increases with age of people. Similar to the other study results, the multinomial analysis found that women at younger ages are at low risk of overweight and obesity (21-22).

Conclusion

The study found that the problem of overweight and obesity is more of an urban concern among people in each society. Results showed that the prevalence of overweight and obesity in our study participants was in moderate level. By using Multinomial Logistic Regression we showed that the relation between BMI and Age was positive and significant and by increasing one year at age the rate of overweight increased 13% and the rate of obesity increased 17% in compare with normal patients. So, future studies could be suggested for done in future to obtain the relation between BMI with food intake indices and also more another related factors.

Limitation

The limitation of this study was non-registering another demographic data and non-selected samples from rural cases.

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Conflict of Interest

The authors declare no conflict of interest related to this work.

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Author contributions:

All authors have equal effort in this study from design to manuscript.

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