

Dietary Approach to Stop Hypertension (DASH) and Obesity Among Iranian Adults: Yazd Health Study-TAMYZ and Shahedieh Cohort Study

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Research

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Abstract

Objectives: Established data revealed a relationship between obesity and increasing the risk of mortality and morbidity of chronic diseases. There are conflicting data regarding the association between adherence of Dietary Approach to Stop Hypertension (DASH) and obesity. Therefore, this study intends to investigate this relationship among a large sample of Iranian adults.

Methods: This cross-sectional study was carried out on the data collected by two prospective studies executed in urban and suburb parts; in the urban population: TAgzhieh Mardom-e-Yazd (Yazd Nutrition Study) (TAMYZ), which was conducted on Yazd Health Study participants, and in the suburb region: Shahedieh cohort study. Final analysis was performed by 10693 individuals; Shahedieh (n=3943) and YaHS (n=6750). Dietary intake was evaluated by using a validated Food Frequency Questionnaire (FFQ). In all participants, anthropometric indices including body mass index were measured. The DASH score was considered utilizing gender-specific quintiles of DASH items. To evaluate the relationship of DASH diet and obesity, multivariate logistic regression analysis was used.

Results: By adjusting confounders, participants in highest quintiles of DASH dietary patterns compared to the lowest have lower odds of obesity in suburb area (OR: 0.78; 95% CI: 0.63, 0.96), in urban (OR: 0.71; 95% CI: 0.52, 0.99), and in whole population of both studies (OR: 0.75; 95% CI: 0.63, 0.90). Besides, more compliance of women to this diet in urban (OR: 0.64; 95% CI: 0.48, 0.85) and population of both studies (OR: 0.77; 95% CI: 0.62, 0.96) were associated with reduced odds of central obesity. However, in suburb study, no significant relationship was observed between adherence to DASH diet and odds of central obesity.

Conclusions: DASH dietary pattern could decrease odds of obesity in both urban and suburb area, and central obesity in urban area only. Further prospective studies are needed for causal conclusion.

1. Introduction

The global prevalence of overweight and obesity among adults is 39% and 13%, respectively [1]. Worldwide obesity by increasing more than six-fold during recent decades [2] and influencing over 650 million adults throughout the world [1] is a complex health issue related to the set of interaction between the environment, genetic factors, and human behavior [3]. In addition to its impacts on increasing the risk of chronic diseases [4], including coronavirus [5], cardiovascular disease, diabetes, cancer, and kidney disease, obesity is related with large burden on the health care system globally [6], which has made it a prominent challenge for public health [7].

Therefore, it is necessary to identify the factors that can be corrected in prevention of obesity. These include lifestyle factors, especially diet as behavioral contributor [8, 9] which associated with an increased risk of chronic conditions, such as obesity [10]. In Iran the rapid social and economic transition has been accompanied by cultural, nutritional habits and physical activity changes [11]. The prevalence of adulthood obesity in Iran is reported to be more than 50% [12]. Diet is known as the most important

and prominent modifiable risk factor to reduce risk and prevent onset of obesity [13]. In this regard, the Dietary Approach to Stop Hypertension (DASH) which is rich in fruits, vegetables, lean dairy products, whole grains, fish, poultry, and nuts and lower intake of red and processed meat and sugary drinks [14, 15] may be a useful strategy for the prevention and treatment of obesity [16]. But there are conflicting and limited information about the role of this dietary pattern in weight control and prevention of obesity.

Previous studies among different number of Iranian adult women; 48 women with obesity [17], 60 women with polycystic ovary syndrome [18], 227 [19], 267 [20], and 420 [21] healthy women emphasized that more adherence to the DASH diet significantly could reduce the risk of obesity. Also, another studies among 60 Iranian [17], 211 Chinese [22], 1493 Irish [23] adults besides a meta-analysis [16] confirmed this result. However, some other studies showed more adherence of the DASH diet did not significantly reduce the risk of obesity [24–26]. The dietary components that are considered to determine the score of the Dash diet and the method of data collection may be the reason for these inconsistencies. The aim of this study is to evaluating the relationship between adherence of DASH diet and obesity among a large sample of Iranian adults living in urban and suburb areas.

2. Material And Methods

2.1 Study design and population

The present cross-sectional study adhered to the data collected from two cohort studies (Shahedieh and Yazd Health Study -YaHS). Dietary foods and supplements have been investigated in the YaHS sub-study, called Yazd Nutrition Survey (YNS), locally known as TAMYZ in Persian. This component of YaHS involved administration of a food frequency questionnaire (FFQ) including of 178 food items and 551 questions [27]. All participants of YaHS were recruited in TAMIZ, which was began in December 2015 [28]. Detailed data about the design and primary population of YaHS study was published previously [28]. Based on above-mentioned sub-studies, the exclusion criteria were being on a weight loss or specific diet and having a history of diseases such as diabetes, cardiovascular diseases, stroke, fatty liver, hypertension, cancer, and thyroid, since such diseases may change the participants' diet. Moreover, we excluded individuals with a total daily energy intake of less than 800 or higher than 6500 kcal.

2.2 Dietary assessment

We used the semi-quantitative food frequency questionnaire (FFQ) to assess the dietary foods and supplements. The original semi-quantitative FFQ containing 168 items, but 10 more questions were added on intake of Yazd-specific frequently consumed food items, which made a total of 178 food items. This validated semi-quantitative FFQ among the Iranian population [27] was filled by trained interviewers. Participants were asked to report the amount and frequency of consuming each food item per month, week, or day in the past year. In addition, we used a food photo book as a reference for all participants, so that they could approximately find out the portion size of foods as a unit. Participants were also expected to report their intake frequency regarding the all-food items based on 10 multiple-choice frequency response assortments ranging from 'never or less than once a month' to '10 or more times per day'.

Finally, the amount of food used at each intake was approximated using questions with five predefined answers.

2.3 Anthropometric assessment

We gauged contributors' body weight in standing position with light clothing. We measured all anthropometric indicators three times; before the interview, after completing one-third of the questionnaire, and after completing two-thirds of the questions. We also gauged contributors' height to the nearest centimeter with barefoot while their heads, shoulder blades, buttocks, and heels were rested against the wall. We calculated BMI (kg/m^2) using weight and height mensuration based on the following formula: $\text{weight (kg)} / \text{height squared (m}^2\text{)}$. We recorded waist circumference to the nearest 0.5 cm using non-stretch tape placed midway between iliac crest and lowest rib while contributors were in the standing position [29].

2.4 Assessment of covariates

Age, gender, marital status, smoking, socioeconomic status (SES) and diseases were collected as demographic information and medical history from all companies. The SES score was measured to specify the participants' SES according to the infrastructure facilities (source of drinking water and sanitation facility), housing condition (e.g., the number of rooms, type of home ownership), durable assets' ownership (e.g., dishwasher, car, television), and education level [30]. Then, the total SES score, ranging from 0 to 3, was measured by adding up the assigned scores; a score of 3 showed high SES. Moreover, we applied the Iranian version of International Physical Activity Questionnaire (IPAQ) to computed the contributors' physical activity [31] and participants with more than 1 h of activity per week were supposed as physically active.

2.5 Calculation of DASH diet score

The DASH diet score was calculated based on the procedure explained in Fung et al., where assignment of scores (from 1 to 5) was according to consumption in order of most intake for fruits (all fruits and juices), vegetables (all vegetables except potatoes and legumes), nuts and legumes (nuts and peanut butter, beans, peas, tofu), low-fat dairy products (milk, yogurt, and low-fat cheese) and whole grains (brown rice, whole grain breads, baked cereals, whole grains, other grains, popcorn, wheat germ, bran) [32]. Red and processed meats (beef, pork, mutton, offal, hot Dog, Bacon), sweetened beverages (carbonated and non-carbonated sweetened beverages), free sugar and sodium (total sodium of all foods in the Food Satisfaction Questionnaire) were assigned 1–5 points in order of least consumption. Based on this algorithm the total DASH score confined between 8 (lowest adherence) and 40 points (highest adherence) [32]. Later, the participants were categorized based on the dietary pattern scores' quintiles (quintile 1: low consumption, quintile 5: high consumption of a given food pattern). Next, the participants' characteristics were measured across quintiles of each dietary pattern and the data were calculated by mean \pm standard deviation for continuous variables and percentage for categorical variables.

2.6 Statistical analysis

Analysis of variance was run to describe the mean differences of the continuous variables and the chi-squared test was applied to determine the difference between categorical variables. Multivariable logistic regression analysis was also used to study the association of dietary patterns with obesity in different models. Initially, the confounder variables were adjusted: age, energy intake (kcal/d), gender, smoking status (non-smoker, ex-smoker, current smoker), SES (weak, moderate, high), marital status (married, single, widowed, divorced), physical activity level (never, < 1 h/week, > 1 h/week), and diseases. With regard to all analyses, we considered the first quintiles of dietary pattern scores as the reference. The quintile categories were also considered as ordinal variables in the analyses to calculate the overall trend of odds ratios (OR) across increasing quintiles of dietary pattern scores. The IBM SPSS version 20.0 was run to analyze the data and the significant P value was set at < 0.05.

Finally, the relationship between DASH dietary pattern with odds of obesity as well as central obesity in the general population of both studies (Shahedieh + YaHS), was examined with meta-analysis (fix method) by comprehensive meta-analysis software.

3. Result

3.1 Study population characteristic in urban area

In YaHS and TAMYZ studies, 74.8% of the participants were in the age range of 20–49 years and 25.1% were above 50 years old. Prevalence of obesity was 21.2% (men, 8.6%; women, 12.6%). Also, the general characteristics of the participants in the DASH diets' quintiles in YaHS and TAMYZ study are shown in Supplementary Table 1. A significant increase was observed between more adherence of participants to DASH diet and SES ($P = 0.01$).

3.2 Study population characteristic in suburb area

In Shahedieh cohort study, 73.3% of the participants were in the age range of 35–49 years and 26.6% were above 50 years. Prevalence of obesity was calculated as 26.7% (men, 10.1%; women, 16.6%). The participants' characteristics according to DASH diets' quintiles are represented in Supplementary Table 2. In this regard, more adherence to the DASH diet is accompanied by significant increase in smoking ($P = 0.02$) and SES ($P = 0.01$), but significant decrease in age ($P = 0.001$), BMI ($P = 0.03$), and physical activity ($P = 0.003$).

3.3 DASH dietary pattern and general obesity

3.3.1 DASH dietary pattern and general obesity in urban area

Multivariable-adjusted OR for obesity across quintiles of DASH diets' score for YaHS and TAMYZ studies are indicated in Table 1. Findings showed that more adherence to the DASH diet after adjusting for confounding factors including age, gender, energy intake, physical activity, education, marital status,

smoking, SES and history of other diseases accompanied by reducing odds of obesity by 29% in the YaHS and TAMYZ study (OR: 0.71; 95% CI: 0.52, 0.99).

Table 1

Odds ratio (95 % CI) for **general obesity** according to quintiles (Q) of DASH dietary pattern in a sample of Iranian adults (n = 3943); and also stratified by gender (n = 6750) in YaHS cohort study (urban area)¹

“DASH” dietary pattern				
	Q1	Q3	Q5	P trend
Whole population				
Model I ^a	1	0.96 (0.80–1.14)	1.04 (0.88–1.24)	0.97
Model II ^b	1	0.72 (0.53–0.98)	0.71 (0.52–0.99)	0.65
Men				
Model I	1	1.02 (0.81–1.29)	1.10 (0.87–1.39)	0.61
Model II	1	1.00 (0.79–1.27)	1.08 (0.84–1.39)	0.49
Women				
Model I	1	0.87 (0.66–1.14)	0.97 (0.74–1.27)	0.59
Model II	1	0.85 (0.63–1.14)	0.92 (0.69–1.23)	0.48
¹ Data are OR (95 % CI).				
^a Model I: adjusted for age; and total energy intake.				
^b Model II: in addition to age and total energy intake additionally adjusted for gender; smoking status; Socioeconomic Status; marital status; physical activity level; diseases.				

3.3.2 DASH dietary pattern and general obesity in suburb area

Multivariable-adjusted OR for obesity across quintiles of DASH diet score for Shahedieh study are shown in Table 2. Findings showed that more adherence to the DASH diet after adjusting for confounding

factors including age, gender, energy intake, physical activity, education, marital status, smoking, SES and history of other diseases associated with reducing odds of obesity by 32% in the Shahedieh study (OR: 0.78; 95% CI: 0.63, 0.96). In addition, the P-trend was significant for following of DASH diet after adjusting for all confounding variables (P-trend = 0.03). Also, after gender segregation, the findings showed that more adherence to the DASH diet after modifying the mentioned confounding factors attenuated the odds of obesity in men (OR: 0.70; 95% CI: 0.52, 0.95).

Table 2

Odds ratio (95 % CI) for **general obesity** according to quintiles (Q) of DASH dietary pattern in a sample of Iranian adults in suburb area (Shahedieh cohort study: n = 3943)¹

"DASH" dietary pattern				
	Q1	Q3	Q5	P trend
Whole population				
Model I ^a	1	0.95 (0.79–1.15)	0.82 (0.67-1.00)	0.12
Model II ^b	1	0.92 (0.76–1.12)	0.78 (0.63–0.96)	0.03
Men				
Model I	1	0.98 (0.76–1.27)	0.72 (0.54–0.96)	0.08
Model II	1	0.94 (0.72–1.22)	0.70 (0.52–0.95)	0.05
Women				
Model I	1	0.91 (0.68–1.20)	0.89 (0.66–1.20)	0.49
Model II	1	0.91 (0.57–1.21)	0.85 (0.62–1.15)	0.29
¹ Data are OR (95 % CI).				
^a Model I: adjusted for age; and total energy intake.				
^b Model II: in addition to age and total energy intake additionally adjusted for smoking status; Socioeconomic Status; marital status; physical activity level; diseases.				

3.3.3 DASH dietary pattern and general obesity in whole population

Table 3 represents the multivariable-adjusted OR for obesity across DASH dietary pattern scores' quintiles in whole population of both studies (Shahedieh and YaHS - TAMYZ). Findings revealed that more compliance to the DASH diet after adjusting for confounding factors including age, gender, energy intake, physical activity, education, marital status, smoking, SES and history of other diseases accompanied by decreasing odds of obesity by 25% in whole population (OR: 0.75; 95% CI: 0.63, 0.90).

Table 3

Odds ratio (95 % CI) of for **general obesity** according to quintiles (Q) of DASH dietary pattern les in the whole population of both urban and suburb studies (Shahedieh + YaHS; n = 10693)¹

"DASH" dietary pattern					
	Q1	Q3	P-value	Q5	P-value
Whole population					
Model I ^a	1	0.95 (0.84–1.08)	0.48	0.94 (0.82–1.07)	0.35
Model II ^b	1	0.85 (0.72–1.01)	0.06	0.75 (0.63–0.90)	0.02
Men					
Model I	1	1.00 (0.84–1.19)	0.96	1.10 (0.77–1.11)	0.42
Model II	1	0.97 (0.81–1.16)	0.75	0.90 (0.74–1.09)	0.30
Women					
Model I	1	0.88 (0.73–1.08)	0.24	0.93 (0.76–1.14)	0.49
Model II	1	0.86 (0.67–1.11)	0.26	0.88 (0.71–1.09)	0.26
¹ The relationship between DASH dietary pattern with odds of general obesity in the whole population of both studies (Shahedieh + YaHS), with meta-analysis in fix method by comprehensive meta-analysis software was examined. Data are OR (95 % CI).					
^a Model I: adjusted for age; and total energy intake.					
^b Model II: in addition to age and total energy intake additionally adjusted for gender; smoking status; Socioeconomic Status; marital status; physical activity level; diseases.					

3.4 DASH dietary pattern and central obesity

3.4.1 DASH dietary pattern and central obesity in urban area

The odds of central obesity and 95% CI according to the DASH diets' quintiles for the YaHS and TAMYZ studies are shown in Table 4. The findings showed that more compliance of women to this diet after adjusting for confounding factors including age, gender, energy intake (OR: 0.69; 95% CI: 0.53, 0.89) as

well as other confounders including physical activity, education, marital status, smoking, SES and history of other diseases (OR: 0.64; 95% CI: 0.48, 0.85) associated with reduced odds of central obesity. Moreover, P-trend for women, before adjustment for confounding variables (P-trend = 0.01) and after adjustment for confounding variables including age, gender, energy intake (P-trend = 0.003), and also after adjusting for other confounding variables (P-trend = 0.002) was significant.

Table 4

Odds ratio (95 % CI) for **central obesity** according to quintiles (Q) of DASH dietary pattern in a sample of Iranian adults (n = 6750); and also stratified by gender in YaHS cohort study (urban area)¹

"DASH" dietary pattern				
	Q1	Q3	Q5	P trend
Men*				
Model I	1	0.83 (0.63–1.10)	0.98 (0.75–1.29)	0.83
Model II	1	0.88 (0.65–1.19)	0.92 (0.68–1.24)	0.72
Women*				
Model I	1	0.74 (0.56–0.97)	0.69 (0.53–0.89)	0.003
Model II	1	0.74 (0.55–0.98)	0.64 (0.48–0.85)	0.002
¹ Data are OR (95 % CI).				
^a Model I: adjusted for age; and total energy intake.				
^b Model II: in addition to age and total energy intake additionally adjusted for gender; smoking status; Socioeconomic Status; marital status; physical activity level; diseases.				
*Central obesity with waist circumference was defined as ≤ 102 cm in men and ≤ 88 cm in women.				

3.4.2 DASH dietary pattern and central obesity in suburb area

The odds of central obesity and 95% CI according to the DASH diets' quintiles for the Shahedieh study are indicated in Table 5. In the suburb area (Shahedieh study), no significant relationship was observed between adherence to DASH diet and odds of central obesity.

Table 5

Odds ratio (95 % CI) for **central obesity** according to quintiles (Q) of DASH dietary pattern in a sample of Iranian adults (n = 3943); and also stratified by gender in Shahedieh cohort study (suburb area)¹

"DASH" dietary pattern				
	Q1	Q3	Q5	P trend
Men*				
Model I	1	0.97 (0.71–1.33)	0.79 (0.56–1.13)	0.23
Model II	1	0.92 (0.67–1.27)	0.79 (0.55–1.13)	0.19
Women*				
Model I	1	1.13 (0.82–1.56)	1.03 (0.74–1.43)	0.54
Model II	1	1.21 (0.87–1.69)	1.02 (0.72–1.44)	0.63
¹ Data are OR (95 % CI).				
^a Model I: adjusted for age; and total energy intake.				
^b Model II: in addition to age and total energy intake additionally adjusted for gender; smoking status; Socioeconomic Status; marital status; physical activity level; diseases.				
*Central obesity with waist circumference was defined as ≤ 102 cm in men and ≤ 88 cm in women.				

3.4.3 DASH dietary pattern and central obesity in whole population

The odds of central obesity and 95% CI according to the DASH diets' quintiles for both studies are shown in Table 6. Addressing the results of whole population of both studies (urban and suburb) showed that more women adhered to this diet after adjusting for confounding variables such as age, gender, energy intake (OR: 0.80; 95% CI: 0.65, 0.96) as well as other confounders (OR: 0.77; 95% CI: 0.62, 0.96) is associated with a significant reduction in the odds of central obesity.

Table 6

Odds ratio (95 % CI) of for **central obesity** according to quintiles (Q) of DASH dietary pattern les in the whole population of both urban and suburb studies (Shahedieh + YaHS; n = 10693)¹

"DASH" dietary pattern					
	Q1	Q3	P-value	Q5	P-value
Men*					
Model I	1	0.88 (0.72–1.09)	0.26	0.90 (0.73–1.12)	0.35
Model II	1	0.89 (0.72–1.19)	0.24	0.86 (0.68–1.08)	0.21
Women*					
Model I	1	0.88 (0.71–1.09)	0.25	0.80 (0.65–0.96)	0.03
Model II	1	0.91 (0.73–1.13)	0.42	0.77 (0.62–0.96)	0.02
¹ The relationship between DASH dietary pattern with odds of central obesity in the whole population of both studies (Shahedieh + YaHS), with meta-analysis in fix method by comprehensive meta-analysis software was examined. Data are OR (95 % CI).					
^a Model I: adjusted for age; and total energy intake.					
^b Model II: in addition to age and total energy intake additionally adjusted for gender; smoking status; Socioeconomic Status; marital status; physical activity level; diseases.					
*Central obesity with waist circumference was defined as ≤ 102 cm in men and ≤ 88 cm in women.					

4. Discussion

In the present study, DASH dietary pattern could decrease odds of obesity in both urban and suburb area. In the best of our knowledge, this is the first study evaluated the relationship of DASH diet and obesity in both urban and suburb region of Iranian adults as a Middle Eastern country. In line with our findings, Tabibian and colleagues showed that more adherence of the DASH diet could reduce the odds of obesity in women [19]. Also, findings of another study showed more adherence of Chinese adults to the DASH diet is associated with lower odds of obesity [22]. A randomized clinical trial conducted on overweight and obese women with polycystic ovary syndrome showed that following of DASH diet is accompanied by reducing in weight and BMI significantly [18]. Moreover, in one meta-analysis [16] as well as some other studies [17, 20, 23, 33-36], the results showed that more adherence of DASH diet can significantly reduce the odds of obesity. However, in the present study adherence to the DASH diet has no significant

effect on central obesity in suburb area, unlike in urban area. To addressing the causes of this discrepancy, it may be mentioned that behavioral factors affecting obesity in rural and suburb areas, divided into downstream and upstream. Low levels of education and low SES are upstream factors [37]. Poor diet and lifestyle among the rural and suburb population are downstream factors affecting obesity in these areas [38, 39]. Recent study showed residents of Shahedieh as a suburb region have different diet quality and lifestyle in comparison of the urban region [40]. In suburb region, some dairy products such as milk, cheese, and yogurt as prominent component of DASH diet are traditionally made from local cows which have more fat than pasteurized and commercial packed samples commonly consumed in urban area. Moreover, data confirmed that the lack of medical and primary prevention services, long distance to obtain medical care and reduced welfare facilities (i.e. recreations centers, supermarkets) in these areas are further causes [41-43]. Also, no significant relationship was observed between adherence of this dietary pattern and abdominal obesity in the study of Gharabi et al. [24]. Similarly, in another study, no significant relation was observed between adherence to the DASH diet and weight loss [25]. In addition, in the study of Wong et al., no significant effect was seen between compliance of this dietary pattern and BMI [26].

The mechanisms and beneficial effects of the DASH diet on obesity have not yet been fully elucidated. However; this dietary pattern could exert its beneficial effects on obesity due to the high intake of fruits and vegetables, and whole grains which contain large amounts of antioxidants, magnesium, fiber and potassium [44-47] [48]. Also, fruits, vegetables, and whole grains containing both soluble and un-soluble fiber [49] could reduce obesity through several mechanisms, including appetite control, food intake regulation [50], and increasing chewing time [51]. Soluble fibers also absorb more water, creating a viscosity gel and increasing gastric distance [52]. In addition, fiber by providing low energy and slowing gastric emptying could provide a feeling of satiety and reduce serum insulin secretion [53]. Fermentation of fiber could reduce hunger and appetite through modifying eating pattern of human intestine by producing short-chain fatty acids, releasing intestinal peptides and hormones such as cholecystokinin and glucagon-like peptide 1 [54-56]. Phytochemicals are bioactive compounds found in fruits and vegetables, which include compounds such as polyphenols and their derivatives, carotenoids and thiosulfates, which could reduce obesity by modifying the human intestinal microbiota [57]. In addition, dairy intake is high in this diet and some previous studies investigating beneficial effects of dairy products on weight loss [57, 58] and reduced prevalence of central obesity [59, 60] in adults. The underlying mechanisms of dairy products related to obesity is its effects on improving energy and fat balance [61], fat absorption [62], appetite or metabolic activity of intestinal microbiota [63, 64]. Also, high levels of calcium in dairy products could be effective in weight loss / body fat [25, 47, 65, 66]. Calcium exerts its anti-obesity role through mechanisms such as regulating adipogenesis, inhibiting lipogenesis and increasing lipolysis in fat metabolism, regulating proliferation and apoptosis of fat cells, increasing thermogenesis, increasing secretion and decreasing fat absorption, and modulating intestinal microbiota [66]. DASH diet is rich in foods such as vegetables, fruits, nuts, legumes, and whole grains, which are containing high amount of polyphenols. High intake of such foods reduces obesity [67]. Foods rich in polyphenols are effective on obesity through various mechanisms including the effect of prebiotics on

intestinal microbiota, decreased appetite, increased energy consumption by inducing thermogenesis, increasing lipolysis, and stimulation of fat cell apoptosis [68]. Also, legumes in this diet are valuable food group which due to low energy density, could replace high-energy foods that are important in the prevention and management of obesity [69]. In the DASH diet, red meat intake is low. Red meats increase the odds of gaining weight and obesity, because they are rich in saturated fatty acids, cholesterol, sodium and nitrate [70, 71] and are classified as high energy density foods [72]. Also in this dietary pattern, low intake of sweetened beverages, due to their high sugar content, could reduce the odds of obesity [73, 74]. Because these products are a source of liquid sugar, they feel less saturated than solid sources [75]. In addition, sodium intake is low in the DASH diet, a meta-analysis have shown that consuming more sodium is associated with an increased odds of obesity [76]. The reason could be mentioned for this relationship is that higher sodium intake causes thirst and more fluid. Salty foods are often high in fat and energy, and that these foods are enjoyable and motivate people to consume higher amounts of these kinds of foods [76].

4.1 Strengths and Limitations

Regarding this study's strengths, to the best of our knowledge, this was the first research on the relationship of DASH dietary pattern with obesity was performed on a large sample size of Iranian adults that covered both urban and suburb area. Furthermore, administration of a validated semi-quantitative FFQ to collect the study data by a face-to-face interview using trained interviewers ensured the data accuracy. Third, with regard to the reliability, a wide range of potential confounders were adjusted in this study.

Considering this study limitations, the following can be mentioned: in this cross-sectional study, the causal relationship between DASH diet and obesity could not be assessed. Consequently, further prospective studies are required in this area. Second, although a valid food frequency questionnaire was used, but there was a measurement error and an error in the classification of people participating in the study. Moreover, we cannot reject the possibility of residual confounding bias, since unknown or unmeasured confounders may exist that affected our results. Finally, our participants with odds of obesity might have been advised to reduce their fat intake, which led them to alter their dietary habits. However, such possibility cannot be resolved in a cross-sectional study.

Conclusion

In both studies urban and rural area, greater adherence to the DASH diet was associated with a reduced odds of obesity. Besides, the findings showed that more compliance of women to this diet after adjusting for confounding factors in urban area and whole population of both studies associated with reduced odds of central obesity. In order to reflect on the causal relationship between the studies variables, further prospective studies are needed.

Declarations

Ethical approval and consent to participate

The study's protocols and procedures were ethically reviewed and approved by a recognized ethical body (Ethics Committee of Shahid Sadoughi University of Medical Science with ethics code of (IR.SSU.SPH.REC.1397.123)). This study does not involve any human or animal testing. Also, this study conforms to the Declaration of Helsinki, US, and/or European Medicines Agency Guidelines for human subjects.

Consent for publication

Not applicable.

Availability of data and materials

The datasets analyzed in the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

SS-KH and MH made substantial contributions to the conception and design of the manuscript, preparation manuscript, as well as performing statistical analysis and data interpretation. They also approved the final manuscript for submission and critical revision. HM-KH, MM, and AN contributed to data interpretation and also critically revised the manuscript for important intellectual content and approved the final manuscript for submission.

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