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Original Article

The association between sarcopenic obesity (SO) and major dietary patterns in overweight and obese adult women

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ABSTRACT

Aim: No studies have evaluated the contribution of major dietary patterns to Sarcopenic Obesity (SO) in obese and overweight people based on quintile of skeletal muscle mass (SMM) and fat mass (FM). This study was conducted to examine the association between major dietary patterns and SO.
Method and material: A total of 301 overweight and obese women were included in the cross-sectional study. Body composition was measured by body composition analyzer. Resting metabolic rate was measured by indirect calorimetry. The usual food intake was evaluated by a semi-quantitative FFQ. Serum HDL-c, LDL-c, TG, FBS, total cholesterol and hs-CRP were measured.
Result: The prevalence of sarcopenia (is referred to as two lower quintiles of SMM) and obesity (is referred to as two highest quintiles of FM) and SO was 19.6%, 20.4% and 9.9% respectively. We used the principal component analysis and three major dietary patterns were determined: the DASH, western and unhealthy dietary pattern, they covering 30.63% of total dietary pattern of our population. Participants in the in the upper category of DASH dietary pattern had lower odds of SO (OR = 0.27, 95% CI = 0.08 to 0.96, P = 0.04). After adjustment for age, physical activity and total energy intake, the association between the DASH and SO, was still significantly negative (OR = 0.20, 95% CI = 0.05 to 0.77, P = 0.01) and the risk of sarcopenia reduced by 80%.
Conclusion: The present evidence indicates, adherence of the DASH Diet, has a significant effect on reducing the risk of SO.

1. Introduction

Obesity is currently one of the most important metabolic diseases around the world [1,2]. According to the latest world health organization (WHO) report, the population of obese and overweight people is growing [3]. By the year 2030, the number of obese and overweight people will reach 1.12 and 2.16 billion respectively in the world [4,5]. According to the WHO report in 2016, the prevalence of overweight and obesity was 65% and 25% respectively in Iran [5].

Obesity is a phenomenon that arises from the interaction of genetics and behavioral components. Behavioral components include diet and physical activity that are influenced by social, cultural and environmental conditions [6,7]. Obesity is a mild chronic inflammation that is associated with an increased risk of coronary heart disease, cancer, diabetes, dyslipidemia and higher mortality rates [1,8–10].

In some obese people, the skeletal muscle mass (SMM) is reduced and the fat mass (FM) is increased, which is referred to as sarcopenic obesity (SO). SO is defined in various ways that we use in our study the definition of Asian Working Group [11]. According to this definition, SO is referred to as two lower quintiles of SMM and two highest quintiles of FM [11]. The prevalence of SO is different according to the definitions that are used [12]. There are many factors that can affect SO, including inflammation, insulin resistance, physical inactivity, high energy intake and type of dietary pattern [13].

Dietary pattern plays an important role in the development of obesity. Recent studies have shown evidence of a relationship between dietary pattern and obesity and the risk of chronic illness [14]. Because dietary pattern reflects the individual's eating habits and shows the person's usual intake, the evaluation of the association between dietary pattern and diseases is important [16–18].

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From a scientific point of view, it seems that the study of the relationship between major dietary patterns and the cause of obesity and obesity related illnesses will be useful. The purpose of the present study is to evaluate the association of SO and major dietary patterns in adult obese and overweight women.

2. Methods and materials

2.1. Study population

This cross-sectional study included 301 overweight and obese adult women. The age range of the participants was 18–48 years, which were referring to health centres in Tehran, Iran. Participants were good in general health with a body mass index (BMI) in the range of 25/03–40/09 kg/m2. This study was supported by grants from the Tehran University of Medical Sciences (TUMS), Tehran, Iran (Grant's ID: 96-01-161-34479, 96-01-159-34988) and all participants signed a written informed consent that was approved by this committee prior to enrollment in the study. The exclusion criteria that participants were chosen for the study were as follows: history of hypertension, impaired renal and liver function, cardiovascular disease, diabetes mellitus, menopause, intake of alcohol, smoking, pregnancy or lactation period. Furthermore, we excluded those women with chronic disease that affecting their diet, and also those who had been following a particular diet or had any body weight fluctuations over the last year.

2.2. Measurement of body composition

Weight, BMI, total body water (TBW), FM, fat-free mass (FFM), body fat % (BF %) and SMM of the participants were acquired by a bioelectrical impedance analyzer (BIA) (Inbody Co., Seoul, Korea) according to guidelines. This BIA calculates the resistance of body tissues to an electrical signal sent through the hands and feet. According to the manufacturer's instructions participants removed extra clothes such as shoes, coat and sweater. Also they removed metal utensils, such as earing, ring and watch and then they stand on the balance scale in bare feet and grasp the handles of the BIA. The examination takes nearly 30 s, and then the result is shown.

2.3. Definition of sarcopenic obesity

According to the definition, sarcopenic obesity in women is referred to as two lower quintiles of SMM and two highest quintiles of FM [11]. In this study we measured SMM and FM by BIA (Inbody Co., Seoul, Korea) according to guidelines.

2.4. Biochemical parameters and hormonal assay

Blood samples were obtained between 8: 00 and 10: 00 a.m. following an overnight fasting between 8: 00 and 10: 00 a.m. The serum was centrifuged, aliquoted, and stored at −80 °C. All samples were analyzed by using a single assay technique. The GOD-PAP method and the GPO-PAP method was used for the measurement of fasting blood sugar (FBS) and triglyceride (TG) levels respectively. Total cholesterol (T-chol) and high density lipoprotein cholesterol (HDL) were measured by enzymatic endpoint method, and enzymatic clearance assay respectively. All measurements were done with the use of a Randox Laboratories kit (Hitachi 902). To measuring high sensitive C reactive protein (hs-CRP), an immunoturbidimetric assay (high sensitivity assay, Hitachi 902) was used.

2.5. Assessment of dietary intake

We used a validated and reliable 147-item food frequency questionnaire (FFQ) to assess dietary pattern of participants. This semi-quantitative questionnaire consists of standard portion sizes for each food item. To determine the frequency of consumption of each food item during the one year ago, based on serving sizes, the participants were asked. In fact, participants were asked to report their intake of each food on a daily, weekly, monthly, and annual according to their intake in last year. The intakes of each individual were reported in household measures and then they were converted to grams of food per day using the nutritionist IV software [19]. We examine the validity and reliability of the FFQ previously. Food items in the FFQ were categorized into 21 groups: cereals, legumes and nuts, fish and poultry, red meat, organ meat, processed foods, low-fat dairy products, high-fat dairy products, sweets and desserts, vegetable oil, animal fat, olive, fruits (fresh fruits + dried fruits + natural juices), vegetables, starch vegetables, seasonings and spices, salt, mayonnaise, snacks, high-energy beverage, tea and coffee. Factor loading below 0.3 were excluded for simplicity, eigenvalues higher than 1.5 and KMO index was 0.72. In fact, we classified food items based on the similarity of their nutrients and according to previous studies [20].

2.6. Assessment of other variables

Physical activity level was measured by a validated questionnaire IPAQ (International Physical Activity Questionnaire-Short Form) that also included leisure, commuting occupational, and housework activities [21]. For height measurements, subjects were in a standing position without shoes, and touch the wall with their head, shoulder, heel and hip and recorded to the nearest 0.1 cm. Weight and BMI was measured by BIA according to guidelines. Obesity and overweight are grading Grade 1, 2 and 3 were defined as $30 \leq BMI \leq 34.9$ kg/m2, $35 \leq BMI \leq 39.9$ kg/m2 and $BMI \geq 40$ kg/m2. Overweight is defined as $25 \leq BMI \leq 29.9$ kg/m2.

2.7. Statistical analyses

All statistical analysis was performed by using the SPSS version 22.0 (SPSS, Chicago, IL, USA). Normal distribution of data was checked by Kolmogorov-Smirnov test. To describe the characteristics of study population by the mean ± standard deviation, minimum and maximum we used descriptive analysis. Comparisons between groups were made by using the chi-square test to investigate categorical variables and independent *t*-test for continuous variables. We used principal component analysis (PCA) to identify major dietary patterns based on the 21 food groups. Varimax rotation was used to derive dominant dietary patterns. Total number of patterns were extracted depend on the assessment of scree plots. Participants were categorized based on dietary pattern scores to DASH (Dietary Approach to Stop Hypertension), western and unhealthy diet. Binary logistic regression was used in crude model and adjusted models to evaluate the associations of SO (dependent variable) and major dietary patterns (independent variable). Adjustments were made for age, physical activity and energy intake. All reported P-values were two-sided and a P-value lower than 0.05 was considered statistically significant.

3. Results

3.1. Characteristics of study population

Normal distribution of data was checked by Kolmogorov-Smirnov test. Body composition, blood parameters, demography

Table 1
Characteristics of study population.

Variables	Minimum	Maximum	Mean	Std. Deviation
Demography				
Age (years)	18.00	48.00	36.52	8.32
Weight (kg)	57.75	119.50	78.75	11.51
Height (cm)	147.50	179.00	161.37	10.14
Body Composition				
BMI (kg/m2)	25.00	40.70	30.33	3.65
RMR (kcal/day)	952.00	2467.00	1566.50	253.49
RMR/Kg(kcal/day/kg)	0.81	32.50	19.59	3.26
Body fat (%)	15.00	53.10	41.29	5.26
SMM (kg)	18.90	37.90	25.59	3.22
FM (kg)	19.40	53.20	33.43	7.60
W.C (cm)	80.10	123.20	98.45	9.24
W.H.R	0.81	1.08	0.93	0.05
N.C (cm)	31.00	34.50	37.47	7.54
FMI	6.90	21.20	12.91	2.96
FFMI	14.60	47.80	18.32	7.78
Blood Parameters				
FBS (mmol/L)	67.00	202.00	88.57	11.38
TG (mmol/L)	37.00	512.00	118.39	64.54
T-chol (mmol/L)	104.00	433.00	185.61	38.48
HDL-C (mg/dL)	18.00	84.00	47.77	10.87
LDL- C (mg/dL)	34.00	282.00	96.98	26.88
Inflammation				
hs-CRP (mg/l)	0.03	22.73	4.05	4.55
Blood pressure				
Systolic (mmHg)	90.30	159.00	92.03	41.02
Diastolic (mmHg)	50.80	111.0	64.19	28.89

BMI: body mass index; RMR: resting metabolic rate; RMR/kg: resting metabolic rate/kilogram; SMM: skeletal muscle mass; FM: fat free mass; WC: waist circumference; WHR: waist to hip ratio; NC; neck circumference; FMI; fat mass index; FFMI: fat free mass index; FBS: fasting blood sugar; TG: triglyceride; Total-Chol: total cholesterol; HDL-C: high density lipoprotein cholesterol; LDL-C: low density lipoprotein cholesterol; hs-CRP: high-sensitivity C-reactive protein.

and clinical characteristics of women are presented in Table 1. The mean age, height, weight of the study participants was 36.52 (SD = 8.32) years, 161.37 (SD = 10.14) cm, 78.75 (SD = 11.51) kg, respectively. (Table 1). In our study the prevalence of SO was 9.9%. The prevalence of sarcopenia (who had two lower quintiles of SMM) and obesity (who had two highest quintiles of FM) was 19.6% and 20.4% respectively.

3.2. Characteristics of SO and non-SO subjects

Total of participants were categorized based on statue of SMM and FM. If participants were in two lower quintiles of SMM and two highest quintiles of FM, they belong to SO group and if they were not in two lower quintiles of SMM and two highest quintiles of FM, they belong to non-SO. In comparison with non-SO participants, SO subjects had higher weight, BMI, BF%, FM, waist circumference (W.C), neck circumference (N.C) and fat mass index (FMI). Furthermore, as far as body composition is concerned, these results demonstrated that there was a statistically significant difference, even after controlling for confounder factors, in terms of BMI ($P < 0.0001$) (95% CI = −3.98 to −1.90), BF %($P < 0.0001$) (95% CI = −8.98 to −6.79), FM ($P < 0.0001$) (95% CI = −8.50 to −4.99), WC ($P = 0.02$) (95% CI = −5.39 to −0.29) and FMI ($P < 0.0001$) (95% CI = 0.80 to 0.98) between the two groups. SO subjects showed lower resting metabolic rate/kilogram (RMR/kg) and it was significant ($P = 0.02$). non-SO subjects showed more favorable lipid profiles, such as mean serum TG, T-chol and LDL, and T-chol was significant ($P = 0.03$). Mean serum FBS in the SO was about higher than other participants ($P = 0.03$). Also, SO subjects had higher hs-CRP and DBP compared to non-SO subjects, however, there was no significant difference between two groups ($P > 0.05$). Characteristics of the study participants across adherence categories of the

Table 2
Characteristics of SO and non-SO subjects.

Variables	SO (n = 27) Mean ± SD	Non- SO (n = 274) Mean ± SD	P-value*	95%CI
Demography				
Age (years)	38.28 ± 8.14	36.01 ± 8.24	0.18	−5.62 to 1.17
Weight (kg)	81.50 ± 4.85	79.80 ± 11.35	0.15	−4.44 to 0.44
Height (cm)	156.32 ± 3.82	161.95 ± 5.72	<0.0001	0.66 to 9.54
Body Composition				
BMI (kg/m2)	33.40 ± 2.34	30.42 ± 3.69	<0.0001	−3.98 to −1.90
RMR (kcal/day)	1482.40 ± 223.60	1574.20 ± 274.41	0.07	−9.25 to 1.95
RMR/Kg(kcal/day/kg)	18.27 ± 3.16	19.75 ± 3.24	0.02	0.16 to 2.79
Body fat (%)	48.47 ± 2.30	40.55 ± 4.91	<0.0001	−8.98 to −6.79
SMM (kg)	22.74 ± 1.29	25.87 ± 3.29	<0.0001	2.48 to 3.77
FM (kg)	39.57 ± 3.76	33.77 ± 7.52	<0.0001	−8.50 to −4.99
W.C (cm)	101.04 ± 5.70	98.16 ± 9.49	0.02	−5.39 to −0.29
W.H.R	0.93 ± 0.04	0.93 ± 0.05	0.88	−0.02 to 0.01
N.C (cm)	38.28 ± 6.83	37.38 ± 7.35	0.64	−4.71 to 2.95
FMI	16.23 ± 1.73	12.55 ± 2.84	<0.0001	−4.42 to −2.98
FFMI	17.18 ± 0.97	18.42 ± 8.16	0.44	−1.90 to 4.40
Blood Parameters				
FBS (mmol/L)	91.76 ± 13.29	86.97 ± 9.36	0.03	−9.16 to −0.42
TG (mmol/L)	129.52 ± 84.56	120.60 ± 27.67	0.57	−39.81 to 21.99
T-chol (mmol/L)	199.10 ± 35.91	182.16 ± 35.09	0.03	−32.57 to −0.95
HDL-C (mg/dL)	46.61 ± 10.61	46.40 ± 10.55	0.92	−4.90 to 4.59
LDL- C (mg/dL)	98.90 ± 27.08	94.26 ± 23.45	0.39	−15.22 to 6.17
Inflammation				
hs-CRP (mg/l)	5.27 ± 4.19	4.12 ± 4.62	0.28	−3.24 to 0.96
Blood pressure				
Systolic (mmHg)	109.39 ± 14.50	111.46 ± 13.39	0.48	−3.73 to 7.82
Diastolic (mmHg)	78.73 ± 11.22	77.64 ± 9.52	0.60	−5.25 to 3.03

BMI: body mass index; RMR: resting metabolic rate; RMR/kg: resting metabolic rate/kilogram; SMM: skeletal muscle mass; FM: fat free mass; WC: waist circumference; WHR: waist to hip ratio; NC; neck circumference; FMI; fat mass index; FFMI: fat free mass index; FBS: fasting blood sugar; TG: triglyceride; Total-Chol: total cholesterol; HDL-C: high density lipoprotein cholesterol; LDL-C: low density lipoprotein cholesterol; hs-CRP: high-sensitivity C-reactive protein. *$P < 0.05$ is significant. (n = 301).

dietary patterns scores are shown in Table 2.

3.3. Characteristics of the study participants across adherence categories of the dietary pattern scores

We used the PCA method for analyze of data related to food intake. Factor loading below 0.3 were excluded for simplicity, eigenvalues was higher than 1.5, KMO index was 0.72. Three major dietary patterns were determined, the DASH, western and unhealthy dietary pattern. This three dietary patterns covering 30.63% of total our population and % of variance of each dietary pattern was 11.97%, 9.63% and 9.02% respectively. In fact, we classified food items based on the similarity of their nutrients and according to previous studies [20].

Participants with high adherence to DASH diet had lower weight (P = 0.04), higher RMR/kg (P = 0.03), lower SMM (P = 0.02), SBP (P < 0.0001) and DBP (P < 0.0001). Individuals with high adherence to unhealthy diet had higher T-chol (P = 0.02) and participants with high adherence to western diet had higher TG (P = 0.04), SBP (P = 0.01) and DBP (P = 0.03). There was significant relationship between last quartile adherence of DASH diet and SO (P = 0.02), indeed 31.2% of those who had not SO followed DASH diet, while 11.5% of those who had SO followed DASH diet. There was not significant relationship between last quartile adherence of western diet and SO (P = 0.30) and 15.4% of those who had SO followed western diet. Also the relationship between last quartile adherence of unhealthy diet and SO was not significant (P = 0.50) and 26.9% of those who had SO followed unhealthy diet (Table 3).

3.4. Association between major dietary patterns and SO

Three major dietary patterns were determined, including the DASH, western and unhealthy dietary pattern. DASH diet associated with high intake of starchy vegetables, vegetables, fruits, legumes and nuts, low-fat dairy, meat, and olives. Western dietary pattern associated with higher intake of high-energy beverages, snacks, fast food, mayonnaise, sweets, cereals, and condiments. Unhealthy dietary pattern associated with higher intake of animal oil, high-fat dairy, red meat, liver, brain and kidney, tea and coffee, and lower intake of vegetables oil. We evaluate the association between major dietary patterns and SO. Participants were converted into last quartile and other groups. 31.2% of those who had not SO followed DASH diet, while 11.5% of those who had SO followed DASH diet and there was significant relationship between last quartile adherence of DASH diet and SO (P = 0.02), indeed. There was not significant relationship between last quartile adherence of western (P = 0.30) and unhealthy diet with SO (P = 0.50).

3.5. Correlation between adherence of DASH diet and SO in crude and adjusted model

We evaluated the association of adherence of DASH diet and SO in crude and adjusted models by binary logistic regression. In crude model there was negative relationship between DASH diet and SO (OR = 0.28, 95% CI = 0.80 to 0.98, P = 0.04), and the risk of sarcopenia reduced by 72%. Then adjustments were made for age. In adjusted model for age the relationship between DASH diet and SO was positive (OR = 0.27, 95% CI = 0.08 to 0.96, P = 0.04). But in

Table 3
Characteristics of the study participants across adherence categories of the dietary pattern scores.

Variables	DASH			Unhealthy			Western		
	Low adherence	high adherence	P- value*	Low adherence	high adherence	P-value*	Low adherence	high adherence	P-value*
	Mean ± SD	Mean ± SD		Mean ± SD	Mean ± SD		Mean ± SD	Mean ± SD	
Demography									
Age (years)	37.95 ± 7.89	36.02 ± 8.42	0.05	35.95 ± 9.09	36.71 ± 8.04	0.47	34.41 ± 8.82	37.19 ± 8.05	<0.001
Weight (kg)	80.86 ± 11.75	78.04 ± 11.36	0.04	80.15 ± 11.10	78.27 ± 11.63	0.17	77.89 ± 10.51	79.03 ± 11.81	0.42
Height (cm)	161.83 ± 5.36	160.61 ± 11.31	0.32	161.36 ± 5.25	160.77 ± 11.35	0.63	160.89 ± 6.13	160.93 ± 11.13	0.97
Body Composition									
BMI (kg/m2)	30.87 ± 4.02	30.14 ± 3.50	0.09	30.77 ± 3.85	30.18 ± 3.57	0.17	30.15 ± 3.81	30.39 ± 3.60	0.59
RMR (kcal/day)	1552.01 ± 262.84	1572.12 ± 250.22	0.55	1598.95 ± 211.48	1556.78 ± 268.90	0.27	1575.00 ± 221.65	1564.18 ± 261.98	0.6
RMR/Kg(kcal/day/kg)	18.95 ± 3.52	19.85 ± 3.11	0.03	19.96 ± 3.11	19.44 ± 3.31	0.22	19.87 ± 2.55	19.52 ± 3.42	0.38
Body fat (%)	40.66 ± 5.72	41.55 ± 5.04	0.19	41.69 ± 5.83	41.12 ± 5.01	0.40	41.92 ± 4.65	41.11 ± 5.41	0.28
SMM (kg)	26.25 ± 3.32	25.31 ± 3.14	0.02	25.48 ± 3.12	25.63 ± 3.26	0.70	25.38 ± 2.93	25.65 ± 3.29	0.55
FM (kg)	33.76 ± 8.26	33.29 ± 7.32	0.62	34.28 ± 8.00	33.08 ± 8.42	0.22	33.78 ± 7.57	33.33 ± 7.62	0.68
W.C (cm)	99.36 ± 10.48	98.07 ± 8.67	0.31	99.37 ± 9.29	98.07 ± 9.29	0.28	98.35 ± 9.27	98.47 ± 9.26	0.93
W.H.R	0.93 ± 0.05	0.93 ± 0.04	0.60	0.93 ± 0.04	0.92 ± 0.05	0.10	0.92 ± 0.05	0.93 ± 0.05	0.55
N.C (cm)	36.83 ± 2.43	37.74 ± 8.76	0.42	37.00 ± 4.05	37.05 ± 8.44	0.57	38.84 ± 14.06	37.02 ± 3.09	0.36
FMI	13.06 ± 3.20	12.84 ± 2.87	0.57	13.31 ± 3.15	12.74 ± 2.88	0.14	13.02 ± 3.01	12.88 ± 2.96	0.73
FFMI	19.76 ± 14.22	17.72 ± 1.32	0.19	17.81 ± 1.39	18.59 ± 9.18	0.48	17.70 ± 1.38	18.48 ± 7.75	0.48
Blood Parameters									
FBS (mmol/L)	87.16 ± 7.76	89.09 ± 12.41	0.17	87.36 ± 8.45	88.96 ± 12.16	0.28	87.86 ± 8.23	88.81 ± 12.17	0.49
TG (mmol/L)	124.89 ± 75.93	115.98 ± 59.77	0.27	109.96 ± 55.42	121.08 ± 67.77	0.18	104.78 ± 50.91	122.44 ± 67.63	0.04
T-chol (mmol/L)	184.70 ± 35.07	158.94 ± 39.73	0.80	177.06 ± 36.77	188.34 ± 38.06	0.02	183.97 ± 36.62	186.09 ± 39.07	0.67
HDL-C (mg/dL)	47.69 ± 11.20	47.92 ± 10.76	0.68	47.29 ± 9.83	47.92 ± 11.19	0.66	48.12 ± 11.15	47.67 ± 10.80	0.75
LDL- C (mg/dL)	94.62 ± 24.18	97.86 ± 27.88	0.34	93.14 ± 29.62	98.21 ± 25.96	0.14	95.41 ± 23.47	97.47 ± 27.71	0.56
Inflammation									
hs-CRP (mg/l)	3.95 ± 4.81	4.09 ± 4.44	0.80	3.81 ± 3.78	4.13 ± 4.76	0.58	4.81 ± 5.07	3.83 ± 4.36	0.13
Blood pressure									
Systolic (mmHg)	103.98 ± 28.71	87.98 ± 43.86	<0.0001	102.70 ± 32.07	88.37 ± 43.12	<0.0001	82.31 ± 43.98	95.15 ± 39.61	0.01
Diastolic (mmHg)	71.39 ± 19.75	61.73 ± 31.10	<0.0001	71.87 ± 22.31	61.56 ± 30.43	<0.0001	57.82 ± 31.13	66.24 ± 27.88	0.03
SO[a]	88.5%	11.5%	0.02	73.1%	26.9%	0.50	84.6%	15.4%	0.30

BMI: body mass index; RMR: resting metabolic rate; RMR/kg: resting metabolic rate/kilogram; SMM: skeletal muscle mass; FM: fat free mass; WC: waist circumference; WHR: waist to hip ratio; NC; neck circumference; FMI; fat mass index; FFMI: fat free mass index; FBS: fasting blood sugar; TG: triglyceride; Total-Chol: total cholesterol; HDL-C: high density lipoprotein cholesterol; LDL-C: low density lipoprotein cholesterol; hs-CRP: high-sensitivity C-reactive protein. (n = 301).
*P < 0.05 is significant.
[a] Chi-square.

Table 4
Correlation between adherence of DASH and SO in crude and adjusted model.

Models	B ± SE	OR (95% CI)	P-value*
Crude model[a]	−1.24 ± 0.62	0.28 (0.80−0.98)	0.04
Adjusted model 1[b]	0.28 ± 0.63	0.27 (0.08−0.96)	0.04
Adjusted model 2[c]	−1.45 ± 0.65	0.23 (0.06−0.84)	0.02
Adjusted model 3[d]	−1.55 ± 0.66	0.20 (0.05−0.77)	0.01

[a] Unadjusted model.
[b] Adjusted to age.
[c] Adjusted to age and physical activity.
[d] Adjusted to age, physical activity and energy intake. *P < 0.05 is significant.

adjusted model for age and physical activity the relationship between DASH diet and SO was adverse too (OR = 0.23, 95% CI = 0.06 to 0.84, P = 0.02) and in final adjusted model for age, physical activity and energy intake the relationship between DASH diet and SO was still negative significant (OR = 0.20, 95% CI = 0.05 to 0.77, P = 0.01) and the risk of sarcopenia reduced by 80% (Table 4).

4. Discussion

In this study, we aimed to assess any potential association between SO and major dietary pattern in overweight and obese adult women. This is the first investigation in which SO base on quintile of SMM and FM have been associated directly with major dietary patterns identified by PCA.

In this study, we found that Between SO and non-SO individuals there is statistically significant difference in height, BMI, RMR/kg, body fat%, SMM, FM, WC, FMI, FBS, T-chol. Individuals with high adherence to the DASH dietary pattern had significant negative association with SO. After adjustment for confounder variable such as age, physical activity and total energy intake, there was still significant negative relationship between SO and DASH dietary pattern.

In different countries the prevalence of the sarcopenia is different [22]. Also the prevalence of SO is different according to the definitions that are used [12]. In NHANES III study the prevalence of SO in persons 60 years of age and older was 7−10% [23]. In other studies, the prevalence of SO in persons younger than 70 years was 12% and in older than 80 years was 30% [24,25]. In our study, the prevalence of sarcopenia, obesity and SO was 20.4%, 19.6% and 9.9% respectively.

It was observed that between SO and non-SO are significant differences in height, BMI, RMR/kg, body fat%, SMM, FM, WC, FMI, FBS, T-chol. SO individuals had higher level of BMI, body fat%, FM, WC and FMI and had lower level of height, RMR/kg and SMM. Rangel Peniche showed there is significantly different estimation of body composition especially in appendicular skeletal muscle mass in older people from two regions of Mexico [26]. One study showed SO individuals have better recognize by WC [27]. Also Higher %BF is associated with lower SMM, and with sarcopenia in Finland, Poland, Spain, China, Ghana, India, Mexico, Russia, and South Africa [28].

SO individuals had higher level of FBS. SO seems to be associated with hypertension and [29]. Diabetes mellitus is associated with higher risk of sarcopenia, metabolic disorders and physical inactivity may associate with diabetes [30]. SO group had higher level of T-chol. The prevalence of sarcopenia is directly associated with TG/HDL ratio in elderly Korean males [31]. sarcopenia is associated with cardiovascular risk factors such as BMI, WC, FBS and T-chol [32].

Our study showed, there is negative association between SO and higher adherence of DASH dietary pattern in adult women, whereas there is no significant association between SO with western and unhealthy dietary pattern. Pathogenesis of frailty and sarcopenia is associated with malnutrition (both under nutrition and obesity) [33]. The quality of the diet has a positive relationship with the incidence of SO, indeed total energy and protein intake important role on muscle function [33]. Dietary pattern and Physical activity can affected sarcopenia [34].

This study showed there is significant relationship between high adherence to DASH diet had lower weight, higher RMR/kg, lower SMM, SBP and DBP. Previous study showed the DASH diet may have beneficial effects on the overweight, obesity and blood pressure in adolescence [35]. DASH diet is useful for decrease and control of weight and FM in overweight and obese people [36], so it can increase RMR and RMR/hg. Also Adherence to Mediterranean or DASH diet is associated with metabolically healthy phenotypes in people [37].

In conclusion, this study comprehensively examined the associations of SO and major dietary pattern in overweight and obese adult women. Negative association was found between SO and DASH dietary pattern. Therefore, dietary pattern Can play an important role in incidence of SO.

5. Conclusion

The findings of this study suggest that there is a negative relationship between SO and DASH diet, and adherence io the DASH Diet, has a significant effect on reducing the risk of SO. Further studies, in particular prospective cohorts with long-term follow up, are required to confirm these findings.

Conflicts of interest

There are no competing financial interests in relation to the current study.

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Ethics approval and consent to participate

This study was supported by grants from the Tehran University of Medical Sciences (TUMS), Tehran, Iran. Each individual was informed completely regarding the study protocol and provided a written and informed consent form before taking part in the study.

Consent for publication

All authors approved the final manuscript and consent for publication.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.dsx.2019.06.023.

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