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Original Article

The association between poly unsaturated fatty acids intake, body mass index and waist circumference among female youths in Isfahan, Iran

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ABSTRACT

Objective: To determine the association between poly unsaturated fatty acid (PUFA) intake on obesity and abdominal adiposity in female youths in Isfahan, Iran.

Methodology: This population –based cross –sectional study was conducted on 160 healthy female aged18-30 years, selected randomly from among university students of Isfahan University of medical science. Semi-quantitative FFQ which was validated previously was used to assess the entire dietary component intake. Physical activity was assessed by recording daily physical activities.

Results: The mean values of weight, BMI and waist circumference (WC) were 56.1± 8.32 kg, 21.88± 3.026 kg/m^2 and 70.94 ± 6.39 cm, respectively. The mean daily intake of fat and PUFA were 74.11+/-96 and 17.54+/-13.02 gr respectively. There weren't any significant association between PUFA intake and weight, BMI, waist circumference and the prevalence of obesity and central adiposity.

Conclusions: The current study indicated that there was no significant association between PUFA intake and obesity and abdominal adiposity as well as overweight and obesity in female university students in Iran.

KEY WORD: PUFA, Obesity, Abdominal adiposity, BMI (body mass index).

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INTRODUCTION

The prevalence of obesity and overweight is increasing.[1] Nowadays, about 1.6 billion are overweight and there are at least 400 million obese subjects. The Center of Disease Control and Prevention reported that obesity during 2 past decades have a steady ascending trend among American people.[2,3] In addition, the prevalence of obesity in developing countries is increasing due to socio-economic changes and nutritional transition.[4,5] Obesity is a major problem in the field of public health in Iran.[6] According to results of one study from Iran, 67% of women and 33% of men who are more than 20 years old are centrally obese. This study showed that from 1998 to 2002, the trend of central obesity has increased and it is 6% for men and 9% for women.[7]

In addition to general obesity, excessive fat accumulation in the abdominal region recognized as abdominal obesity, is an independent risk factor for different chronic diseases. Many studies have shown that the pattern of body fat distribution is more important than general obesity.[7] Excessive energy intake is an earliest reason for obesity. In previous years, restriction of energy intake and macronutrients specifically fat, have been

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recommended for obesity prevention. Nowadays it is shown that energy intake and fat restriction are not sufficient for obesity prevention. The effects of dietary fats on Health rely on nature and type of fat. Diet is an environmental factor that can be correlated with abdominal obesity. Among different components of diet, poly unsaturated fatty acids (PUFA) maybe correlated with obesity and central adiposity. Many studies showed the association between PUFA intake and obesity as well as other obesity related morbidities.[8] Oils enriched in n-3 and n-6 PUFA can improve insulin sensivity, increase lean mass and decrease fat mass.[9]

Furthermore PUFA can improve postprandial serum fat and reduce inflammatory response related to obesity and overweight.[10] The results of one study showed that N-3 PUFA, (EPA and DHA) were inversely correlated with BMI, waist circumference and hip circumference in obese persons and PUFA may play an important role in body composition and abdominal adiposity.[11] The other study indicated that supplemental PUFA and CLA (conjugated linoleic acid) prevents abdominal obesity.[12]

However, few studies have focused on this association in Iran. Furthermore, many studies have been done among adults and there are limited data among young population. Therefore, this study was conducted to investigate the relationship between PUFA intake and body mass index and waist circumference among young females in Isfahan, Iran.

METHODOLOGY

Subjects: This cross-sectional study was conducted on 160 female students aged 18-30 years in Isfahan University of Medical Sciences. Students were randomly selected by a multistage cluster random sampling method. Sample size was measured according to this formula: $N= (Z_{1-\alpha/2} + Z_{1-\beta}) S^2/d$.[13] As regards previous studies and financial requirements, the standard deviation was considered as 4.6, d equal to 0.68 and potent of the study was 80%, respectively.[14]

Assessment of dietary intakes: All subjects completed a validated semi quantitative food frequency questionnaire.[15] One of the executive difficulties was the way of FFQ complementation and we resolved this problem by teaching subjects how to fill the form and then checked their understanding. After completing the forms, if there was a mistake in questionnaire, the forms were returned to subjects to correct it.

Assessment of anthropometric measurements: Weight was measured with a standard scale nearest to 0.1 kilogram. During weight measurement, subjects wore light clothes, and were without shoes. Height was measured by using a tape in a standing position beside the wall and without wearing shoes. Waist and hip circumference were measured by using a non elastic tape nearest to 0.1 centimeter. Waist circumference was measured at the narrowest area of the waist and at the end of a normal expiration. Hip circumference was quantified at the largest part of the hip. During anthropometric measurements, the tape didn't impose pressure to body. We asked subjects to put their clothes off, if clothes induced any change formation to the waist or body shape.[14]

Assessment of other variables: For assessing physical activity, we requested subjects to record their activity during 24 hours and then their activity level was reported as MET.h/day. Other variables such as age, smoking habits, medical history and current use of medications were collected by a predesigned questionnaire that is also used in previous studies.

Statistical Analyses: We used the correlation test to assess the relationship between PUFA intake and BMI and waist circumference.

To investigate the association between PUFA intake and anthropometric measurements (BMI, waist circumference), multiple linear regression (Enter model) was used while we adjusted the effect of confounders. Obesity, abdominal adiposity and overweight were separately examined and then for complementary analyses, overweight and obesity were considered as one group (BMI≥25 kg/m^2). All subjects completed the informed written consent forms.

RESULTS

Table-I shows the minimum, maximum and mean± standard deviation of age, weight, height, BMI, waist circumference (WC), hip circumference

Table-I: General characteristics of female youths in Isfahan, Iran (n=160).

Variables	*Mean ± SD*	*Min-Max*
Age	20.73±1.661	19-29
BMI (kg/m^2)	21.88±3.026	14.51-32.03
Waist circumference (cm)	70.94±6.39	52-89
Systolic blood pressure (mmhg)	104.66±9.76	82-130
Diastole blood pressure (mmhg)	74.59±9.93	42-100
Height (m)	1.607±5.79	1.48-1.79
Weight (Kg)	56.21±8.32	40-83
Hip circumference (cm)	94.86±6.72	67-117

[1]- Values are mean ± SD

Table-II: Dietary intake of young female students in Isfahan University of Medical Sciences (n=160).

	Mean ± SD	*Min-Max*
Energy (Kcal)	2289.03±736.221	723.8-4378
Carbohydrate (gr)	331.53±96.30	125.7-581.7
Protein (gr)	92.40±29.73	21.52-223.10
Fat (gr)	74.11±40.96	15.39-262.7
Saturated fat (gr)	23.71±16.05	3.93-95.2
Poly un saturated fat (gr)	17.54±13.02	2.82-127.4
Linoleic acid (gr)	13.57±8.72	2.304-78.19
n-3 EPA (gr)	0.01±7.21	0-0.64

[1]- Values are mean±SD

and blood pressure. According to Table-I, the mean of weight, BMI, and waist circumference were 56.21 (kg), 21.88 (kg/m^2), and 70.94 (cm), respectively.

As regards physical activity, 13.8% of population had very light, 52.5% to light, 31.9% to moderate and 1.9% to high levels of physical activity. None of the participants were married. From all female students that enrolled to this study, 9.4% were overweight, 2.5% were obese and 1.3% was abdominally obese.

Table-II exhibits the dietary intakes of young female students in Isfahan University of Medical Sciences. Total energy intake was 2289.03±736.22 Kcal per day. In this population, total fat intake was 74.11±40.96 grams. Saturated fat, poly unsaturated fat and linoleic acid intakes were 23.71±16.05, 17.54±3.02 and 13.57±8.72 grams, respectively.

Table-III shows the relationship between PUFA intake with obesity and abdominal adiposity. The association between PUFA intake and obesity and abdominal obesity according to linear regression model is shown in Table-IV. There was no association between PUFA consumption, obesity and abdominal adiposity and no relationship between fat intake and anthropometric measurements. All P-values were above 0.05, while significance level was less than 0.05.

DISCUSSION

The present study showed no significant relationship between PUFA consumption, obesity and abdominal adiposity among female students. There is limited nutritional information about this young population in Iran, so we selected female students to assess their fat intakes and its relationship with the prevalence of obesity and anthropometric values.

According to our knowledge, there are few studies regarding dietary intakes and prevalence of chronic diseases in young population in our country. Prevention of chronic diseases such as metabolic syndrome, obesity and abdominal obesity is important among young people to prevent the development of these diseases in elderly ages. In addition, we defined central adiposity based on ATP III (Adult Treatment Program III), while IDF (International Diabetes Federation) proposed lower cut offs for central adiposity and thus the prevalence of central obesity may increase. Zainuddin et al showed that the prevalence of metabolic syndrome and central obesity according to IDF, are higher than ATP III among Malaysian Adults.[16]

One of food groups that play an important role in the diet of youths is fats. Several studies have been done regarding the association between various kinds of oils and body composition. A cross-sectional study compared vegetarian diet and athletic diet (low consumption of meat and high fat dairy and high consumption of fish, olive oil, fruit and vegetables) with omnivorous western diet. Results of this study showed that high saturated fat to unsaturated fat ratio in non-vegetarian western diet, resulted in insulin sensitivity reduction and higher prevalence of obesity. Higher ratio of saturated fat to unsaturated fat was positively related to overweight and obesity, independent of the amount of fat intake. In addition, lower ratio of saturated fat to unsaturated as well as non-essential to essential fatty acids in vegetarian diet was related to lower prevalence of obesity, diabetes and cardiovascular disease.[17]

A cross-sectional study by Esmaillzadeh et al on 468 Tehranian females aged 40-60 years showed high consumption of partially hydrogenated vegetable oils (PHVO) was related to higher concentration

Table-III: Correlation coefficients regarding the relationship between different kinds of fat intake and anthropometric measurements.

	Body weight	*BMI*	*WC*	*WHR*
Fat	-0.1[1,2] P=0.187	-0.006 P=0.936	-0.396 P=0.62	-0.04 P=0.556
Saturated fat	-0.01 P=0.877	-0.01 P=0.893	-0.044 P=0.457	-0.054 P=0.492
Polyunsaturated fat	-0.12 P=0.129	-0.02 P=0.74	-0.04 P=0.547	0.04 P=0.614
Linoleic acid	-0.15 P=0.058	-0.06 P=0.431	-0.09 P=0.253	0.78 P=0.324
n-3 EPA	-0.07 P=0.347	-0.004 P=0.955	-0.01 P=0.812	0.12 P=0.12

[1]- Values are correlation coefficients.

[2]- All correlation coefficients are reported after adjusting for energy intake

Table-IV: Regression values regarding the association between total fat intake as well as poly unsaturated fatty acid intake and anthropometric measurements.

	β values[1]	*(R^2)*[2]	*P*[3]
Fat intake-body weight	-0.09	0.008	0.258
Fat intake-WC[4]	-0.072	0.005	0.367
Fat intake-BMI	-0.071	0.005	0.374
PUFA intake-body weight	-0.125	0.016	0.115
PUFA intake-WC	-0.074	0.005	0.353
PUFA intake-BMI[5]	-0.066	0.004	0.408
Saturated fat intake-body weight	-0.044	0.004	0.584
Saturated fat intake-WC	-0.075	0.006	0.346
Saturated fat intake-BMI	-0.068	0.005	0.395

[1]- Represent for β values of linear regression
[2]- Represent for R^2 of linear regression
[3]- Represent for P values of linear regression
[4]- WC means waist circumference
[5]- BMI means Body Mass Index

of inflammatory markers (CRP, serum amyloid A and TNF-α), and high intake of non hydrogenated vegetable oils (non-HVO) was correlated with lower levels of these biomarkers.[15] In another cross-sectional study conducted by Esmaillzadeh et al, high consumption of PHVO was related to additional risk for dyslipidemia and hypertension, and non-HVO ingestion was inversely associated with dyslipidemia and diabetes.[18] Several studies have investigated the association between PUFA intake and body weight as well as fat mass. Results of an experimental trial that was conducted in 2009 showed that there are no weight differences between two treatment group that one of them received 3.6% of energy from vegetable and marine N-3 PUFA and another one that received 5% of energy from vegetable N-3 PUFA.[19]

Another clinical trial that investigated the effects of two weight reduction diet (with high PUFA intake vs. low fat and low PUFA intake) on over weight subjects demonstrated that effects of diets on anthropometric indices and visceral adipose tissue are negligible.[20] Another randomized cross-over trial that was performed in 2007 on over weight subjects (BMI=25-30 kg/m^2) reported that consumption of 3.2 gr/d of conjugated linoleic acid (CLA) resulted in body fat loss as well as low prevalence of overweight compare to placebo group.[21] Another experimental trial that was done on 20 extremely obese women showed that a very low calorie diet (2200 kj/d) with 2.8 gr/d N-3 PUFA have a favorable effect on weight loss and hip circumference reduction in compare to low calorie diet without N-3 PUFA and saline solution as placebo. In addition subjects who consumed N-3 PUFA had higher rate of β-hydroxy butyrate and β-oxidation in liver.[22] A randomized clinical trial evaluated the effect of 3 different diets on 160 insulin resistance and overweight women. The first diet was a weight reduction diet plus long chain N-3 PUFA, the second was weight reduction diet with placebo oil and the third was placebo oil without weight reduction diet. After 24 weeks, first and second group had a significant loss in body weight but there was no significant difference between these two groups in body weight and lean mass.[23]

Another randomized experimental trial assessed the effects of 4 different diets on over weight and obese subjects in the age range of 20-40 years 1) Control group received capsules of sun flower oil without marine foods, 2) subjects consumed fish meat, 3) subjects consumed fatty fish and 4) subjects intake fish oil capsules (EPA and DHA). Men, who consumed fish and fish oil beside a weight reduction diet, had 1 kg more weight loss than control group. Furthermore, fourth group's men had more reduction in waist circumference.[24] Another clinical trial investigated the effect of N-3 PUFA (6 capsules of fish oil containing 70 mg EPA and 270 mg DHA) in compare to MUFA intake (6 capsules of MUFA) as a placebo. Each of two groups placed on an extremely low calorie diet for 4 weeks and weight maintenance diet for 10 weeks. In compare to MUFA group subjects who assigned to PUFA intake group, had a significant loss in fat mass. Nevertheless, N-3 PUFA didn't have a beneficial effect on weight maintenance or weight reduction.[25]

Yepuri et al in an experimental study in 2011 investigated the effect of an isocaloric diet with oils enriched with n-3 and n-6 PUFA on dietary equilibrium, body composition and insulin sensivity during mice catch up growth period. They concluded that mice received an enriched diet with PUFA such as linoleic acid and linolenic acid, compared to mice with an enriched diet with pork fat (SFA) and limited in PUFA, had lower levels of insulin resistance and body fat mass and higher muscular tissue.[9] In an experimental study conducted by Hassanali et al in Canada in 2011, 30 obese male mice were fed either a diet with moderate fat (15% total fat, 1% cholesterol, 5% n-3 PUFA) or a diet with a moderate fat and 10% n-3 PUFA. After 3 weeks, those mice that consumed supplemental n-3 PUFA had a significant reduction in postprandial TG levels (45%), Apo lipoprotein B48 (45%), as well as blood cholesterol. The results of this study indicated that moderate dose of n-3 PUFA can reduce body weight in hyper cholestrolemic mice.[10]

In an experimental study that was conducted in United States in 2011, Vara Prasad et al evaluated the effect of dietary fat consumption on expression of 11-beta hydroxy steroid dehydrogenase I gene in adipose tissue in 24 breast feed female mice. Mice were assigned to 3 groups. In each group, there were 8 mice and the calorie of all groups was the same but type of dietary fat was different. The first group received a Trans fat diet (hydrogenated vegetable oil), the second group feed with a SFA diet (palm oil) and the third group received a PUFA diet (sunflower oil). They concluded that a diet with high amount of TFA and SFA, increased the expression of 11-beta hydroxy steroid dehydrogenase I gene compared to a high PUFA diet. Furthermore, results indicated that high TFA and SFA diet increased the glucoccorticoides activity, and the risk of obesity and Insulin resistance development in adipose tissue, compared to a high PUFA diet.[26]

In a cross-sectional study that was performed on 124 adults (21 subjects with normal weight, 40 overweight and 63 obese) in 2009, Micallef et al observed that obese persons had lower plasma levels of n-3 PUFA than subjects with normal weight and there was an inverse association between PUFA intake and BMI, waist circumference and hip circumference in obese participants. They concluded that a high plasma level of n-3 PUFA is associated with normal BMI, waist circumference and hip circumference.[11] In a double blind randomized clinical trial, the effects of omega 3 and omega 6 on body composition and adiponectin were investigated. Sixty subjects (13 young lean males, 20 old lean males, 12 young obese males and 14 old obese males) were enrolled to study. During 12 weeks, the subjects were feed by 6 grams of fat (3 capsules of n-3 and 3 capsules of n-6, each capsule was 1 gram). The results of this study showed that CLA can reduce insulin sensitivity. In addition, supplemental n-3 and n-6 reduced abdominal fat mass in all subjects and increased free fat mass.[12]

In a cross-sectional study that was conducted in 2009, the effect of fat mass composition on metabolic disorders related to obesity was assessed on 20 morbidly obese subjects. EPA, DHA and n-3 PUFA had an inverse relation with HDL and LDL cholesterol and reduced the risk of metabolic disorders. It was concluded that dietary n-3 PUFA has an inverse association with plasma levels of LDL, TG and cholesterol.[27] In a double blind clinical trial that was done on 60 preterm newborns in 2005, after 12 weeks intervention with breast milk or formula in control group and 0.16% DHA and 0.2% arachidonic acid (ARA; 20:4 n-6) plus to breast milk or formula in trial group, it was concluded that there were no differences in weight gaining, head circumference and height growth between groups. But trial group had larger free fat mass and lower fat mass than control group.[28] Another clinical trial that was done on 34 adults with high plasma levels of cholesterol and TG indicated that subjects who consumed fish oil besides physical activity, had lower adipose tissue than control group who didn't use fish oil and had no physical activity.[29]

In another double blind clinical trial which was performed on 20 women and 13 men, subjects were assigned to control and treatment groups. Control group received 4 grams of olive oil per day while trial group received 4 grams/day fish oil. After 10 days of intervention, control group had more reduction in body fat and fish oil consumption had no effect on total fat.[30] The main effect of PUFA was improvement of lipolyse and fatty acid oxidation and lipogenesis prevention. Supplemental DHA increased the plasma concentration of glycerol. EPA therapy improves lipolyses and increase Hormone Sensitive Lipase (HSL) activity. N-3 PUFAs reduce lipogenic gene expression. EPA and DHA increase expression of IL-6, Serum Amyloid A (SAA), TNF-α and IL-1 in adipose tissue and decrease PGE_2 and TNF-α inhibitor.[31]

The association between PUFA intake and obesity is controversial and needs more investigation. In addition the results of this study must interpret with more accuracy and several prospective studies must be done about the relationship between PUFA intake and obesity and body weight regulation. According to the recent researches omega 3 fatty acids which are a kind of PUFA have important role in different metabolic diseases[32,33] which is suggested to be considered in the population of the present study in future. Furthermore, having a diverse diet also important in taking different kinds of fat and therefore might be effective in protecting from cardiovascular diseases.[34]

One of the strengths of this study was using a validated semi quantitative food frequency questionnaire (FFQ) that shows accurate amounts of dietary intakes. We used Nutritionist IV software for dietary intake analysis that was designed for Iranian intakes.

Limitations of the study: Cross-sectional designing was one of the limitations of the present study. So, it is important to perform additional prospective studies in this regard. Misclassification of participants due

to use of FFQ is another limitation. However we tried to control well-known confounding factors in the present study. FFQ which was used in this study might have some bias in assessment of PUFA intake. At last, the results of this study didn't show a significant relationship between PUFA intake and weight, waist circumference, overweight, obesity and abdominal adiposity among young female students of Isfahan University of Medical Sciences.

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