The Relationship between Empirical Dietary Inflammatory Pattern with Anthropometric Measures in Women with Overweight and Obesity: A Cross-Sectional Study

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Abstract

Background: The increasing trend of obesity prevalence is a serious health warning for people worldwide. Evaluation of anthropometric measures is essential for explaining individual's health status. Studies have investigated the effect of diet on inflammation. Empirical Dietary Inflammatory Pattern (EDIP) was recently developed to empirically create a score for overall inflammatory potential of diet. This study aimed to investigate the relationship between EDIP with anthropometric measures in women with overweight and obesity.

Methods: In a cross-sectional study, the EDIP score was calculated for 301 participants from their food frequency questionnaire, who referred to health centers in Tehran, Iran in 2018. Anthropometric measures was assessed through multi-frequency bioelectrical impedance analyzer.

Results: 49% (95% CI: 40.8 - 57.2) had positive EDIP score. A significant relationship was found between EDIP quartiles with weight (P=0.004), BMI (P=0.012), FM (P=0.013), WC (P=0.003) and WHR (P=0.031). Those individuals in the lowest group of EDIP score had significantly lower weight, Body Mass Index, Fat Mass, Waist Circumference and Waist to Hip Ratio, compared to those with highest inflammation score.

Conclusion: A significant relationship was found between EDIP with anthropometric measures in women with overweight and obesity, supporting the hypothesis that an anti-inflammatory diet is associated with decreasing trend of weight, Body Mass Index, Fat Mass, Waist Circumference and Waist to Hip Ratio.

Keywords: Inflammation; Anthropometric measures; Women's health; Iran

Introduction

The incidence of obesity has increased greatly throughout the last decades (1). Increasing prevalence of obesity is a worldwide health alarm because abnormal weight gain causes an increased risk for several diseases (2). By the year 2030, the number of people with overweight and obesity will reach 1.12 and 2.16 billion respectively in the world (3).

Evaluation of anthropometric measures as one of the tools to determine the health status of indi-

viduals is needed (4). Individual with same age, weight, and height can differ in body composition, associated with different metabolic profiles. Body composition can independently affect individual's health, which is an accepted issue (5, 6).

Inflammation involves a variety of immune responses that play an important role in maintaining the body's health against pathogenic, invasive, and allergic agents linked to the theory of disease behavior (7, 8). Although this host defense is necessary to maintain human health and well-being, long-term inflammation can turn into chronic inflammation (9).

Many studies have investigated the effect of diet on chronic inflammation (10-13). In fact, diet contains a number of compounds that produce inflammatory or anti-inflammatory properties. The rich dietary patterns of wine, coffee, tea, yellow and leafy vegetables and fruit juice have been shown to be associated with low concentrations of inflammatory mediator markers (14, 15). The Empirical Dietary Inflammatory Pattern (EDIP) was recently developed to empirically create a score for overall inflammatory potential of whole diets defined using food groups (16). While a few studies have investigated associations of EDIP with metabolic syndrome (17, 18), no study has yet looked at associations of EDIP with body composition.

The aim of this study was to investigate the association between the inflammatory potential of diet (as measured by EDIP) with anthropometric measures in a group of women with overweight and obesity. We hypothesized that diets with a greater inflammatory potential would be associated with greater measures of general obesity (weight, body mass index [BMI]), greater measures of central obesity (waist circumference [WC], waist-to-hip ratio [WHR]), and greater fat mass (FM) as measured by bioelectrical impedance.

Materials and Methods

Participants and sampling

This cross-sectional study included 301 adult women with overweight and obesity, aged 18 to 56 yr, referred to health centers in Tehran (capital of Iran) in 2018. Multistage cluster random sampling method was used to select certain regions from among all the regions of the city; finally, 20 clusters were chosen to select the obese and overweight participants (BMI: 25-40 kg/m2).

Criteria for entering the study included having a BMI between 25 and 40 kg/m^2 and being at least 18 yr old. The exclusion criteria that participants were chosen for the study were as follows: history of any diseases, menopause, intake of alcohol, smoking, pregnancy or lactation period. Furthermore, we excluded those who had been following a specific diet over the last year.

Eligible participants in this study received written informed consent upon confirmation of entry into the study. We followed the guidelines of the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement for cross-sectional studies. The Ethics Committee of the School of Nutritional Sciences and Dietetics, Tehran University of Medical Sciences, Tehran, Iran approved research reported in this publication.

Dietary assessment

Food intake was based on a reliable and valid food frequency questionnaire (FFQ). We used FFQ consisting of 147 food items typically used in Iran with standard serving sizes (of validated FFQ) (19). This semi-quantitative questionnaire consists of standard portion sizes for each food item. Participants of this study reported their frequency intake daily, weekly, monthly or yearly for each food item in the questionnaire. Daily frequencies were computed for each item. 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 (20).

Assessment of EDIP Scores

The aim of developing of the EDIP score was to empirically create a score for overall inflammatory potential of whole diets defined using food groups. The EDIP score is the weighted sum of 18 food groups, with higher (more positive)

scores indicating pro-inflammatory diets and lower (more negative) scores indicating anti-inflammatory diets. EDIP score was calculated based on 18 food parameters. We used two groups due to their inflammatory potential: 1) Pro-inflammatory group, including processed meat (sausage), red meat (beef, or lamb), organ meat (beef, calf, or chicken liver), other fish (canned tuna, or fish), other vegetables (mixed vegetables, green pepper, cooked mushroom, eggplant, zucchini, or cucumber), refined grains (white bread, biscuit, white rice, pasta, or vermicelli), high-energy and low energy beverages (cola with sugar, carbonated beverages with sugar, fruit punch drinks), and tomatoes 2) Anti-inflammatory group, including tea, coffee, beer, wine, dark yellow vegetables (carrots, squash), leafy green vegetables (cabbage, spinach, or lettuce), snacks (cracker, or potato chips), fruit juice (apple juice, cantaloupe juice, orange juice, or other fruit juice), pizza (16).

Anthropometric assessment and body composition analysis

Weight, BMI, Fat Free Mass (FFM), FM, WC, WHR and total body water (TBW) of the participants were obtained by a bioelectrical impedance analyzer (BIA) (Inbody Co., Seoul, Korea) according to guidelines. The measurements were performed in the morning. Our participants were in fasting conditions and urinated just prior to their body composition analysis to obtain accurate results.

Socio-demographic information

Data about other variables including demographic data, age, smoking, lifestyle, marital status, menopause, medical history, drug use and supplements were collected by answering a general questionnaire.

Statistical analysis

Data were represented by percentage and frequency in parenthesis for qualitative variables. Numerical data were represented with mean and standard deviation (SD) or standard error (SE) for descriptive or analytical purposes, respective-

ly. The EDIP score was categorized into four groups by its quartiles, the first category was <4320, the second category was between 4320 and 29662, the third category was from 2966-52834 and the fourth category was more than 52834.

In univariate analysis, all dependent variables were compared in groups of EDIP by analysis of variance (ANOVA). For those outcome variables which had significant association with EDIP score in univariate analysis (weight, BMI, FM, WC and WHR), Multiple linear regression analysis was used to find the effect of EDIP on those outcomes, adjusting for age, energy intake and physical activity as known confounding factors. The normality assumption of error terms in linear regression was checked by Q-Q plot and homoscedasticity assumption was investigated by Brown–Forsythe test. There was no missing data. All statistical tests were two sided and *P*-value less than 0.05 was considered as statistically significant. Statistical analysis was performed using SPSS version 21 (IBM Corp., Armonk, NY, USA).

Results

The mean ± SD age of participants was 36.49± 8.38 yr and the range of age was 18 – 56 yr. Their mean ± SD weight and BMI was 80.89 ± 12.45 kg and 31.04 ± 4.31 kg/m2, respectively (Table 1).

Table 1: Characteristics of participants

Variable	Rate
Age (yr)	
Mean (SD)	36.49 (8.38)
Min – Max	18 - 56
Weight (kg)	
Mean (SD)	80.89 (12.45)
Min – Max	59.50 – 136.60
BMI[a] (kg/m²)	
Mean (SD)	31.04 (4.31)
Min – Max	25.10 – 39.8
Obese, N (%)	162 (53.8)

[a] Body Mass Index

The percent of women with overweight and obesity were 45.7% (139) and 53.3% (162), respectively. The mean ± SD of FFM and FM, TBW, WC and WHR are reported in Table 2. Overall, 49% (95% CI: 40.8 - 57.2) of participants had positive EDIP score. Table 2 shows the distribution of characteristics across quartiles of EDIP score. A significant relationship was found between EDIP quartiles with weight ($P=0.004$), BMI ($P=0.012$), FM ($P=0.013$), WC ($P=0.003$) and WHR ($P=0.031$).

Table 2: Distribution of anthropometric characteristics according to quartiles of EDIP scores.

Variable	Empirical Dietary Inflammatory Pattern				
	≤ first quartile (≤ 4320) Mean (SE)	First quartile _ second quartile 4320 - 29662 Mean (SE)	Second quartile _ third quartile 2966 - 52834 Mean (SE)	≥ third quartile ≥ 52834 Mean (SE)	P
Weight (kg)	76.77 (1.22)	80.50 (1.26)	81.50 (1.38)	84.07 (1.72)	0.004
BMI[1] (kg/m)	29.69(0.47)	31.29 (0.49)	31.27 (0.49)	31.98 (0.56)	0.012
FFM[2] (kg)	45.67 (0.52)	46.51 (0.62)	47.16 (0.73)	47.80 (0.72)	0.120
FM[3] (kg)	31.49 (0.97)	34.29 (0.94)	34.16 (0.89)	36.13 (1.19)	0.013
TBW[4] (L)	33.54 (0.38)	34.16 (0.45)	34.66 (0.53)	35.15 (0.53)	0.104
WC[5] (cm)	95.65 (1.00)	99.19 (1.14)	99.38 (1.15)	101.68 (1.33)	0.003
WHR[6]	0.92 (0.00)	0.93 (0.01)	0.93 (0.01)	0.94 (0.01)	0.031

1. Body Mass Index
2. Fat Free Mass
3. Fat Mass
4. Total Body Water
5. Waist Circumference
6. Waist to Hip Ratio

The effect of EDIP quartiles on numerical outcome variables was assessed in separate multiple linear regression models, adjusting for age, energy intake and physical activity. Regression coefficients and 95% CI for EDIP groups were reported for four separate linear regression models with weight, BMI, FM, WC and WHR as outcome variables (Table 3). After adjusting for confounding factors, those in the first group of EDIP (The lowest inflammation status) had significantly lower weight and BMI compared to the group with highest EDIP score ($P<0.01$). Similarly, the Fat Mass was significantly lower in the first group of EDIP compare to the highest group of EDIP ($P=0.013$). Moreover, the waist circumference ($P=0.002$) and waist to hip ratio ($P=0.017$) was significantly lower in those with lowest inflammation group versus the highest group of inflammation.

Table 3: Linear regression Models for evaluating the effect of EDIP on weight, BMI, FM, WC and WHR adjusting for age, energy intake and physical activity

Dependent variables										
Variables	Weight (kg)		BMI[1]		FM (kg)[2]		WC (cm)[3]		WHR[4]	
	Coefficient (95% CI)	P	Coefficient (95% CI)	P	Coefficient (95% CI)	P	Coefficient (95% CI)	P	Coefficient (95% CI)	P
EDIP[5]										
≤ 4320	-5.92 (-9.91 – -1.92)	0.004	-2.06 (-3.44 – -0.68)	0.003	-3.52 (-6.31 – -0.73)	0.013	-5.06 (-8.33 - -1.79)	0.002	-0.21 (-0.04 - -0.004)	0.017
4320_29662	-2.49 (-6.46 – 1.47)	0.217	-0.55 (-1.93 – 0.84)	0.438	-1.17 (-3.96 – 1.62)	0.412	-1.86 (-5.14 – 1.40)	0.264	-0.01 (-0.03 – 0.01)	0.368
2966_52834	-2.17 (-6.09 – 1.74)	0.277	-0.63 (-1.99 – 0.73)	0.365	-1.50 (-4.25 – 1.24)	0.284	-2.02 (-5.24 – 1.19)	0.218	-0.01 (-0.02 – 0.01)	0.264
≥ 52834	Referent		Referent		Referent		Referent		Referent	

1. Body Mass Index
2. Fat Mass
3. Waist Circumference
4. Waist to Hip Ratio
5. Empirical Dietary Inflammatory Pattern

Discussion

We investigated the association of EDIP with various measures of overall and central obesity, as well as measures of body composition, in a sample of women with overweight and obesity. Our study showed a significant positive association between EDIP with weight, BMI, FM, WC and WHR. A more pro-inflammatory diet may be associated not only with overall obesity but also with a more harmful obesity phenotype characterized by greater fat mass and central obesity.

An alternative to the EDIP that represents inflammatory potential is the Dietary Inflammatory Index (DII), constructed a priori based on the literature (21). A higher DII might play a role in developing of obesity (22); only BMI, WC and waist/height ratio were measured. The DII was associated with higher values of FFM after adjusting for age, sex and total energy. This result was supporting the benefits of anti-inflammatory diet on obesity-related parameters (23). However,

the DII and the EDIP, while both capturing inflammatory potential of the diet, are only moderately correlated, suggesting that they may capture different information (18). Thus, findings using one approach may not necessarily be replicated using the alternative approach.

Our findings showed a significant association between EDIP with weight, BMI, FM, WC and WHR, supporting the hypothesis that a pro-inflammatory diet is associated with a harmful obesity phenotype. Previous work (24) indicated in a multi-ethnic population of women that, while absolute concentrations of inflammatory cytokines were higher in women with overweight and obesity, that associations between the EDIP and cytokines were generally stronger in women with normal weights. Importantly, women in our study exclusively had overweight and obesity; therefore, even in a possible state of existing chronic inflammation, having a diet with greater inflammatory potential was associated with worse obesity-related traits.

The association between EDIP with FM, FFM and TBW have not formerly been investigated. Participants with the highest EDIP scores had a higher risk of metabolic syndrome incidence compared to those with the lowest score in Tehran adults (17). Among the metabolic syndrome components, hyperglycemia, abdominal obesity, and low HDL-C had a significant positive association with EDIP score. We report a positive association not only with increased abdominal obesity and waist to hip ratio, but also with increased fat mass.

Our study had some limitations, also considered when interpreting the results. First, we could not ascertain causality due to the cross-sectional nature of our study. While we used an extensive FFQ to collect multiple food items, there remains the possibility of recall bias. We didn't have any information on inflammatory markers, and thus can only infer the inflammatory potential of the EPID in our study population. Additionally, as our study only included women, the results may not be generalizable to men.

Conclusion

A significant positive relationship was found between EDIP with weight, BMI, FM, WC and WHR in women with overweight and obesity, supporting the hypothesis that a pro-inflammatory diet is associated with worse anthropometric measures.

Journal Ethics considerations

Ethical issues (Including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc.) have been completely observed by the authors.

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Conflict of interest

No conflict of interest was declared.

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