Original Article

Association between Dietary Inflammatory Index with Bioelectrical Impedance Parameters and Characteristics Health in Overweight/Obese Women: A Cross-Sectional Study

Abstract

Background: Diet quality has been suggested as an important factor in disorders such as obesity and mental health as it controls inflammatory biomarkers. This study aimed to investigate the association between dietary inflammatory index (DII) with bioelectrical impedance parameters and characteristics of health in overweight\obese women. **Methods:** In this cross-sectional study, we calculated DII for 301 participants from their food frequency questionnaire (FFQ). Body composition was assessed through a multifrequency bioelectrical impedance analyzer (BIA). Depression, anxiety and stress scale-21 (DASS-21) was used to assess the level of characteristics of health. **Results:** The mean percentage ± SD of fat-free mass (FFM) and fat mass (FM) was 46.81 ± 5.65 and 34.05 ± 8.69, respectively. In this study, 49% (95% CI: 40.8–57.2) of participants had positive DII. Linear regression analysis revealed that FFM ($P = 0.004$) and total body water (TBW) ($P = 0.004$) were significantly associated with DII. **Conclusions:** A significant relationship was found between DII with FFM and TBW in overweight\obese women, supporting the hypothesis that an anti-inflammatory diet is associated with elevated FFM and TBW.

Keywords: *Body composition, inflammation, mental health, obesity*

Negin Badrooj, Seyed Ali Keshavarz, Mir Saeed Yekaninejad[1], Khadijeh Mirzaei[2]

Department of Nutrition Science, Faculty of Science and Medical Technology, Islamic Azad University, Sciences and Research Branch, Tehran, Iran, [1]Department of Epidemiology and Biostatics, School of Public Health, Tehran University of Medical Sciences, Tehran, Iran, [2]Department of Community Nutrition, School of Nutritional Sciences and Dietetics, Tehran University of Medical Sciences (TUMS), PO Box 14155-6117, Tehran, Iran

Introduction

The evaluation of body composition is necessary for the characterization of metabolic status.[1]

Researchers have reported that individuals with the same age, weight, and height can have different body shapes, body composition, and metabolic profiles. It is accepted that body composition can affect health, independently.[2]

When adipose tissue extends, bone and muscle tissue decrease, thus, we can observe an increase in proinflammatory and a reduction in anti-inflammatory adipokines, chemokines, and cytokines. These changes lead to local and systemic inflammation.[3]

Depression represents one of the main causes of disability worldwide. According to WHO (World Health Organization) mental health action plan (2013–2020), depression accounts for 4.3% of the total global burden of diseases.[4] The increasing prevalence of depression makes the search for an extended understanding of the etiology and pathophysiology of depression, highly significant.[5,6]

Current evidence suggests that inflammation may play a role in the pathophysiology of depression.[7] The pathogenic host defense theory supports the link between inflammation and depression.[8] Anxiety has often been linked to comorbidities and other mood disorders such as depression; therefore, it remains unclear that higher anxiety alone contributes to elevated inflammation.[9]

Stress, along with depression and anxiety, are common mental disorders.[10] Stress can seriously influence development and performance.[11] There is strong evidence that stress is linked to various lifestyle factors, the most important of which is diet.[12,13] Mental stress is associated with increased levels of inflammatory markers.[14]

The inflammatory response in the body includes a series of immunological and behavioral responses. These reactions have an important role in promoting healing body contact with pathogens. This is related

Address for correspondence:
Prof. Khadijeh Mirzaei, Department of Community Nutrition, School of Nutritional Sciences and Dietetics, Tehran University of Medical Sciences, No. 44, Hojjat-dost Alley, Naderi Street, Keshavarz Boulevard, Tehran, Iran. E-mail: mirzaei_kh@tums.ac.ir

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to the theory of sickness behavior.[15,16] While this host defense is essential for survival, long-term inflammation can lead to chronic inflammation.[17]

Recently, there has been increasing interest in the role of nutrition in protecting and modifying the process in usual mental disorders due to its influence on inflammatory pathways.[18] Many studies have shown the influence of diet on chronic inflammation which can lead to chronic diseases.[19-23] Consequently, it can affect the quality of life and mortality rate.[24]

Indeed, the diet consists of diverse bioactive compounds exhibiting proinflammatory or anti-inflammatory properties. A dietary pattern high in rice, fruits, fish, yogurt, pulses, vegetables, pasta, and wine is associated with lower concentrations of intermediary inflammatory markers.[25,26]

The Dietary Inflammatory Index (DII) was recently developed to estimate the inflammatory potential of a diet based on the pro- and anti-inflammatory effects of different dietary components on several inflammatory biomarkers.[27]

Our study aimed to investigate the association between the inflammatory potential of diet (as measured by DII) with bioelectrical impedance parameters and characteristics of health in a group of overweight/obese women.

Methods

Participants and sampling

This cross-sectional study consists of 301 obese and overweight adult women, aged 18 to 56 years, selected by a multistage cluster random sampling method, referring to health centers in Tehran (capital of Iran) was carried out from February to September 2017.

Criteria for entering the study included body mass index (BMI) more than 25, less than 40, and the age range upper than 18 years. Non-admission criteria are menopause, pregnancy, and breastfeeding; catching to cardiovascular disease, diabetes, cancer, kidney diseases, thyroid diseases; catching to acute and chronic diseases; get slimming supplement; adherence to a particular diet during the past year; receive lipid-lowering drugs; receive blood glucose-lowering drugs; diagnosis of depression by a psychiatrist in a recent year; taking antidepressant drugs; the history of the deaths of those who have affected the mood in the last 6 months; the existence of stress such as divorce, financial bankruptcy, love failure, etc. in the last 6 months; and regular use of any medication for the treatment of the disease. 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 ethical 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 consumption 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).[28] 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. Daily grams of food intake was accounted for. After determining the gram of foods consumed, the software will be used to calculate the amount of nutrients received per day by each participant, according to the standard protocol.[29]

Dietary inflammatory index (DII)

The development and validation of the DII are involved reviewing and scoring nearly 2000 scientific articles representing cell culture and laboratory animal experiments, and a variety of human studies in diet field and six inflammatory markers [i.e., CRP, interleukin (IL)-1b, IL-4, IL-6, IL-10, tumor necrosis factor (TNF)-alpha].

Data derived from FFQ dietary were used to account for DII scores for all participants.[12]

Anthropometric assessment and body composition analysis

Bodyweight was determined to the nearest 0.1 kg using digital scales while women were barefoot and with light clothing. Height was measured using a meter in the standing position and was registered to the nearest 0.5 cm. BMI was calculated weight divided by height squared (kg/m^2). Body composition was assessed through a multifrequency bioelectrical impedance analyzer (BIA): InBody 770 Scanner (Inbody Co., Seoul, Korea). Fat-free mass (FFM), fat mass (FM), waist circumference (WC), waist-to-hip ratio (WHR), and total body water (TBW) were measured. The measurements were performed in the morning. Our participants were in fasting condition and urinating just before the body composition analysis to get the exact result.

Assessment of depression, anxiety, and stress score

The Persian version of depression, anxiety, stress Scale-21 (DASS-21) was used to assess the level of depression, anxiety, and stress in our sample. This questionnaire has three subscales; each of them consists of seven items. The score of each subscale is acquired by adding the scores of related questions. The Persian version of the DASS-21 was found to be a reliable and valid tool to test the level of stress among Persian adolescents.[30]

Sociodemographic information

Information about other variables such as demographic data, age, smoking, lifestyle, marital status, menopause,

medical history, drug use, and supplements was collected by responding to the 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, respectively. The DII was categorized into tertiles, the first category was less than the first tertile (<-0.97), the second category was between the first and second tertiles (−0.96 –0.94) and the third category was more than the second tertile (≥0.95). Analysis of variance was used to compare the mean of stress, anxiety, depression, and sleep quality in tertiles of DII. Multiple linear regression analysis was used to find the effect of DII on FFM and TBW, adjusting for weight and physical activity. The sample size was estimated for the association of DII with body composition indices, as the main dependent variables of this study. There was no missing data. All statistical tests were two-sided and P less than 0.05 was considered as statistically significant.

Results

In Table 1, the mean $\pm$ SD age of participants was 36.49 ± 8.38 years and the range of age was 18–56 years. Their mean $\pm$ SD BMI was 31.04 ± 4.31 kg/m². The percent of overweight and obese women were 45.7% (139) and 53.3% (162), respectively.

The mean percentage ± SD of FFM and FM was 46.81 ± 5.65 and 34.05 ± 8.69, respectively. The mean percentage ± SD of TBW was 34.39 ± 4.15. In our participants, the mean percentage ± SD of WC and WHR was 0.93 ± 0.05 and 0.93 ± 0.05, respectively. The prevalence of depression, anxiety, and stress were estimated to be 47.5% (95% CI: 41.7–53.3), 50.4% (95% CI: 44.6–56.2) and 51.1% (95% CI: 45.3–56.9), respectively. In this study, 49% (95% CI: 40.8– 57.2) of participants had positive DII.

Table 2 shows the distribution of characteristics across tertiles of DII scores. A significant relationship was found between DII with FFM (P = 0.004) and TBW (P = 0.004). We did not found any significant relationship between

DII with FM, WC, WHR, depression, anxiety, and stress (P > 0.2).

Regression coefficients and 95% CI for DII tertiles were reported for two separate linear regression models with FFM and TBW as outcome variables [Table 3]. Linear regression analysis revealed that FFM was significantly associated with DII, after adjustments for weight and International Physical Activity Questionnaire (IPAQ), those in the first and second tertile of DII had higher FFM compared to those in the third tertile group (b = 1.12, 95% CI: 0.04–2.20, P = 0.041 and b = 1.09, 95% CI: 0.02–2.16, P = 0.046, respectively). Likewise, TBW was significantly associated with DII, after adjustments for weight and IPAQ, those in the first and second tertile of DII had higher TBW compared to those in the third tertile group (b = 0.81, 95% CI: 0.03–1.59, P = .043 and b = 0.78, 95% CI: 0.00–1.55, P = .049, respectively).

Figure 1 shows the decreasing pattern of FFM and TBW as DII increases. The reduction is more from second to the third tertile compared to the decrease from first to the second tertile.

Discussion

Our study showed a significant association between DII with FFM and TBW. We found that lower DII score, which means less inflammation caused by diet, could lead to an elevated level of FFM and TBW. To our knowledge, this is the first study to examine the association between DII scores with TBW.

However, no significant association was observed between DII with other body composition factors and characteristics of health.

María Correa-Rodríguez *et al.* revealed that a diet with low inflammatory potential is associated with higher values of FFM after adjusting for age, sex, and total energy. This result is supporting the benefits of an anti-inflammatory diet on obesity-related parameters.[31]
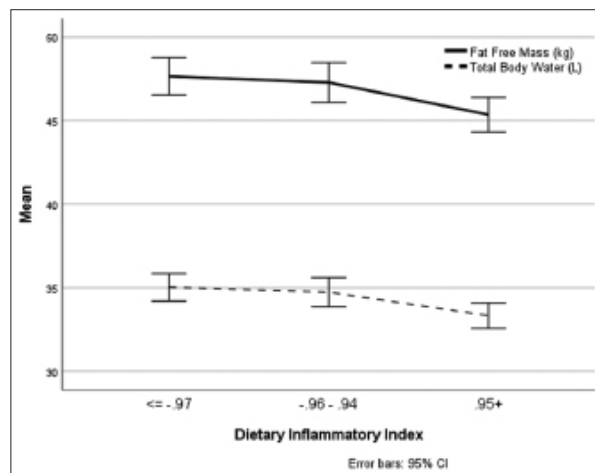
Table 1: Characteristics of participants	
Variables	
Age (years)	
Mean (SD)	36.49 (8.38)
Min-Max	18-56
BMI* (kg/m²)	
Mean (SD)	31.04 (4.31)
Min-Max	25.10-39.8
n (%)	
Overweight	139 (45.7%)
Obese	162 (53.3%)

Figure 1: Fat-Free Mass and Total Body Water trend in Dietary Inflammatory Index tertiles

Table 2: Distribution of characteristics according to the tertiles of DII

	Dietary inflammatory index			
	Mean (SE)			*P*
	Tertile 1	Tertile 2	Tertile 3	
Variable				
Fat Free Mass (kg)	47.66 (0.56)	47.29 (0.60)	45.36 (0.52)	0.004
Total Body Water (L)	35.03 (0.42)	34.73 (0.44)	33.33 (0.38)	0.004
Body Fat Mass (kg)	34.93 (0.95)	33.76 (0.83)	33.42 (0.51)	0.449
Waist Circumference (cm)	99.93 (1.05)	99.35 (1.03)	97.61 (0.99)	0.253
Waist Hip Ratio	0.93 (0.1)	0.94 (0.1)	1.88 (0.96)	0.370
Depression	5.29 (0.47)	5.07 (0.47)	5.35 (0.50)	0.913
Anxiety	5.39 (0.39)	5.25 (0.39)	4.74 (0.46)	0.516
Stress	7.84 (0.53)	8.20 (0.51)	7.70 (0.51)	0.785

Table 3: Linear regression model for evaluating the effect of DII on FFM and TBW adjusting for weight and IPAQ

	Dependent variable			
Variable	FFM(**)		TBW(***)	
	Coefficient (95% CI)	*P*	Coefficient (95% CI)	*P*
DII(*)				
<-0.97	1.12 (0.04-2.20)	0.041	0.81 (0.03-1.59)	0.043
−0.96-0.94	1.09 (0.02-2.16)	0.046	0.78 (0.00-1.55)	0.049
≥0.95	Referent		Referent	

*Dietary Inflammatory Index. **Fat Free Mass. ***Total Body Water

Besides, our findings showed a significant association between DII with FFM. There is limited evidence about the association between DII with obesity indices.[32]

In line with our study, Ruiz-Canela *et al.* showed that the inflammatory potential of diet might play a role in developing obesity.[32] In that study, only BMI, WC, and waist/height ratio were measured. The association between DII with FM, FFM, and TBW has not formerly been investigated.

A study conducted with 3523 participants (aged 35–60 years) from the SU.VI.MAX (Suppl ´ alimentation en Vitamines et Main ear-wax Antioxydants) cohort who did not have any depressive symptoms. A total of 172 cases of incident depressive symptoms were identified over a mean follow-up of 12.6 years. The DII was not associated with incident depressive symptoms in all of the participants. In sex-specific models, men with higher DII had a higher risk of incident depressive symptoms, but this association was only marginally significant.[11] Previous studies have indicated that the higher DII score is associated with over twofold higher odds of depression in fully adjusted models. DII score is also associated with higher odds of frequent distress. This association was not significant for frequent anxiety. The results of this study showed that dietary inflammatory potential is associated with depression.[33]

In a cross-sectional study conducted in Iran, a positive association was observed between stress and intake of saturated oils and inverse associations were shown between stress and consumption of unsaturated oils, fruits and vegetables, meat, and dairy products.[34]

All of our participants in this study were women and we could not analyze sex-specific models like SU.VI.MAX Cohort. Although in SU.VI.MAX Cohort the association was only marginally significant. Furthermore, in a study by Bergmans *et al.* a non-significant association for frequent anxiety was indicated.

Our study had some limitations, which should also be considered when interpreting the results. Firstly, we could not ascertain causality due to the cross-sectional nature of our study. Secondly, the possibility of recall bias. Thirdly, we did not have any information on inflammatory markers; therefore, we could not carry out these analyses, which may be considered as a limitation. Lastly, the single-sex group of the participants. As a suggestion, it is recommended to conduct this study in two separate men/women's groups to compare the results by gender and evaluation of inflammatory markers to increase the validity of results.

Conclusions

A significant relationship was found between DII with FFM and TBW in overweight\obese women, supporting the hypothesis that an anti-inflammatory diet is associated with elevated FFM and TBW. It is suggested that following an anti-inflammatory diet can improve health conditions.

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Conflicts of interest

There are no conflicts of interest.

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