International Journal of Nutrition Sciences

Journal Home Page: ijns.sums.ac.ir

ORIGINAL ARTICLE

Association between Dietary Inflammatory Index, Mean Adequacy Ratio, Dietary Energy Density and Mental Health among Iranian Women

Mohammad Vesal Bideshki[1,2], Mohammad-Reza Jowshan[3,4], Navid Sherafati[5], Mehrdad Behzadi[6], Sahar Nejatpoor[5], Fatemeh Ahmadi[5], Maryam Noashadi-Asl[5], Samaneh Moradi-Sheybani[5], Seyed Bahman Panahande[5]*

1. Student Research Committee, Tabriz University of Medical Sciences, Tabriz, Iran
2. Department of Biochemistry and Diet Therapy, School of Nutrition and Food Science, Tabriz University of Medical Sciences, Tabriz, Iran
3. Department of Clinical Nutrition, School of Nutritional Sciences and Dietetics, Tehran University of Medical Sciences, Tehran, Iran
4. Students' Scientific Research Center, Tehran University of Medical Sciences, Tehran, Iran
5. Department of Nutrition, School of Health and Nutrition, Yasuj University of Medical Sciences, Yasuj, Iran
6. Student Research Committee, School of Nutrition and Food Science, Shiraz University of Medical Sciences, Shiraz, Iran

ARTICLE INFO

Keywords:
Dietary inflammatory index
Dietary energy density
Mental health
Depression
Anxiety

**Corresponding author:*
Seyed Bahman Panahande, PhD,
Department of Nutrition,
School of Health and Nutrition,
Yasuj University of Medical
Sciences, Yasuj, Iran.
Tel: +98 9120281499
Email: panahande.b@gmail.com
Received: December 13, 2023
Revised: March 5, 2024
Accepted: March 15, 2024

ABSTRACT

Background: Depression and anxiety are on the rise, especially among women. By its inflammatory characteristics and energy density, diet may affect the occurrence of mental disorders. This study investigated the relationship between the dietary inflammatory index (DII), mean adequacy ratio (MAR), dietary energy density (DED) and mental health.

Methods: This cross-sectional study was conducted on 202 women of reproductive age (18-50 years) referred to health centers in Yasuj, Iran. Participants were randomly sampled from these centers. We assessed diet through a 148-item food frequency questionnaire (FFQ). Then, DII, MAR, and DED scores were calculated for participants. Furthermore, the Hospital Anxiety and Depression Scale (HADS) questionnaire was used to assess anxiety and depression.

Results: No significant association was found between the DII, ED, MAR indexes and obesity, anxiety, or depression, even after adjusting for confounders ($p>0.05$). Additionally, there was no association between the number of pregnancies or children with anxiety and depression ($p>0.05$). Younger participants consumed foods with higher ED index ($p<0.001$). Higher weight and BMI were related to tertile 1 of ED ($p=0.03$ and $p=0.003$, respectively).

Conclusion: In the present study, no association was observed between DII, MAR, DED and mental health in women of reproductive age. However, further studies are needed to confirm these findings.

Please cite this article as: Bideshki MV, Jowshan MR, Sherafati N, Behzadi M, Nejatpoor S, Ahmadi F, Noashadi-Asl M, Moradi-Sheybani S, Panahande SB. Association between Dietary Inflammatory Index, Mean Adequacy Ratio, Dietary Energy Density and Mental Health among Iranian Women. Int J Nutr Sci. 2024;9(2):109-117. doi: 10.30476/IJNS.2024.101191.1296.

Introduction

Depression and anxiety are mental health disorders that have an alarming rate of increasing prevalence in both developed and developing countries, and they also impose a heavy economic burden and disability on society (1). Based on World Health Organization (WHO) data, depressive and anxiety disorders annually cost the universal economy around 1 trillion dollars in lost productivity (2). Among Iranian people, the prevalence of depression and anxiety was estimated to be approximately three in ten (34.26%) and one in ten (15.6%), respectively (3). Likewise, some studies indicated that the pervasiveness of depression in the age range of 15 to 44 was more prevalent and higher among women (4).

Previous studies have investigated the association between risk factors such as an unhealthy diet and common mental health disorders (5, 6). Overall, diet plays a major role in regulating chronic inflammation. An unhealthy diet rich in fat and refined carbohydrates is associated with high levels of inflammatory factors, including C-reactive protein (CRP), and proinflammatory cytokines, such as tumor necrosis factor-alpha (TNFα) and interleukin-6 (IL-6) (7). Furthermore, a healthy diet that is rich in fruits and vegetables can prevent oxidative stress and inflammation (8). There are several tools to assess inflammation. One of the tools for experts to evaluate the inflammatory potential of the diet is the Dietary Inflammatory Index (DII), which is used to evaluate the inflammatory capacity of foods and diet (9). Notably, a previous study showed a J-shaped relationship between DII and depression (10).

Another scale that we investigated, which is a valid and novel indicator of the total quality of the diet, is Dietary Energy Density (DED), which has attracted a great deal of attention and is defined as the amount of energy in a unit of food or beverage weight (kcal/gram) (11). Various studies have found conflicting results regarding the use of DED for depression and anxiety (12, 13), while women were more often affected by problems with their eating behaviors, such as high energy intake, which can lead to a higher rate of mental health disorders (14). The mean adequacy ratio (MAR) is another indicator that represents the population's overall nutritional adequacy and indicates various aspects of a healthy diet, including variety, moderation, and the specific intake ratio to the recommended amounts of nutrients according to current standards (15). Few studies have been performed on this index and its relationship to mental disorders, especially for women around the world (16, 17). Only a limited number of studies have examined the relationship between DII and depression (18-20). Although most of them revealed a positive relationship between the inflammatory index of the diet and the risk of depression, some of them did not find a significant relationship (19, 20). In a prospective study during 12 years, Adjibade *et al.* found that, unlike the male population, no association was visible in the female population (18). Depression risk has received the primarily attention, while anxiety and other mental health parameters have received less attraction (20). This study was undertaken to evaluate the association between dietary indexes with depression and anxiety in women of reproductive age.

Materials and Methods

A cross-sectional analytical study involving 202 women aged 18 to 50 was conducted to determine the association between dietary inflammatory index, MAR, dietary energy density and mental health. MAR, DII, and DED were measured as part of the study. Using a simple random sampling method from the health centers of Yasuj, Iran, the sample size was calculated by the formula of qualitative attributes (Z=1.96, P=15%, e=0.05) (21).

$$n = \frac{z^2 \times p \times (1 - p)}{e^2}$$

Exclusion criteria from this study were being pregnant or menopause, a high blood pressure, being an immigrant, suffering from cancer, diabetes, liver and kidney diseases, thyroid diseases, cardiovascular diseases, using drugs that affect weight and blood sugar and lipid levels, and receiving glucocorticoids.

Subjects were properly informed about the research objectives and methodology before enrollment. Participants were requested to complete a formal written consent form. The Yasuj University of Medical Sciences Ethical Board approved the investigation methodology in accordance with the Helsinki Declaration (IR.YUMS.REC.1399.119). The demographic questionnaire of our previous study was utilized to provide information about age, gender, weight, marital status, educational level, medical history, recent use of antidepressants, nutritional supplements, weight loss drugs, smoking history, and economical condition of participants (22).

Nutritional status was evaluated by the Food Frequency Questionnaire (FFQ), which has 148 items. In this questionnaire, the surveyed people were asked to specify the frequency of their consumption for each food item according to their annual consumption. Checking the validity of this questionnaire by past studies showed that FFQ had

acceptable validity and reliability (23). Nutritional intake was analyzed by "Nutritionist 4" software. After analyzing the questionnaires, if people's intake was less than or more than 3 standard deviations (SD) of the average consumption for all participants (or more than 3500 or less than 500 calories), the person was excluded from the study (24).

To calculate the DII score, first the Z score was calculated by subtracting the global standard average from the actual food volume and thus dividing the difference by the international standard deviation. For each subject, we converted Z scores to central percentile scores that were multiplied by the effect of food parameter score to obtain the DII score. A larger score indicated a pro-inflammatory diet and a smaller score indicated an anti-inflammatory diet. This study used a 148-item semi-quantitative questionnaire, while some of the food items that needed calculation of the DII were not measured. Therefore, only 25 food items were enrolled to measure the DII. Nutrient adequacy was measured by computing the MAR. The following formula was used to determine MAR: The nutrient adequacy ratio (NAR) was used for 12 nutrients (vitamin A, calcium, iron, zinc, phosphorus, riboflavin, thiamine, vitamin C, magnesium, protein, potassium, and fat) and energy. The NAR was obtained by dividing the daily intake of the mentioned nutrients by the standard recommended amounts for the age and gender groups of people. The NAR was evaluated based on the estimated average requirements (EAR) for vitamins and minerals, and for those nutrients that EAR was not available, adequate intakes (AI) were used.

$$\text{MAR} = \frac{\sum \text{NAR}}{\text{number of nutrients}}$$

To assess DED, the reported daily energy intake of each person (d/kcal) was divided by the total weight of food consumed (g/d).

The Iranian version of the Hospital Anxiety and Depression Scale (HADS) questionnaire was used to assess anxiety and depression (25). This short and useful questionnaire evaluated psychological disorders and the severity of anxiety and depression symptoms. It included 14 items (7 questions related to the level of anxiety and 7 questions related to the level of depression), while a four-point scale (0, 1, 2 and 3) was considered for each item. Finally, from the total of 21 acquisition points in each part, the samples were categorized into low levels (score 0 to 7 revealing the person to be healthy), medium levels (score 8 to 10 showing an intermediate disorder; score 11 to 14 demonstrating a moderate disorder) and high levels (score 15 to 21 illustrating the suspected severe disorder). A score of 11 was considered the cutoff point, and scores higher than 11 were regarded to be clinically important.

Statistical analysis was conducted using SPSS software for Windows (version 23; SPSS, Chicago, IL, USA). For normal distributed continuous data, the mean and standard deviation (SD) were presented, and for non-normal distributed data, the median and interquartile range were displayed. Categorical items were shown as absolute values and frequencies (%). Subjects with DII, MAR, and DED were classified into tertile categories. To assess the variation in characteristics between tertiles, one-way analysis of variance (ANOVA) was employed as quantitative variables, and the $\chi 2$ test was performed for qualitative data. The Chi-squared test was applied to determine the prevalence of depression and anxiety according to the number of pregnancies and number of children. The level of significance was determined as $p<0.05$.

Two models were constructed using logistic regression to examine the association between DII, MAR and DED with obesity, depression and anxiety as model 1: Adjusted for energy intake (kcal/g) and age (years), and model 2: A change for smoking (Smoker/non-Smoker), number of pregnancies, economical status (low/average/high), owning house and car, marital status (single/married/divorced/widow), educational level (illiterate/under diploma/diploma/higher education), estrogen and multivitamin usage, and occupation (employed/housekeeper/unemployed). In this study, obesity was defined as BMI≥30 kg/m^2 or waist circumference >88 cm for females (26). As a reference, the first tertiles of DII, MAR, and DED was used for both models. Also, DII, MAR and DED tertiles were considered as continuous variables to determine the P trend in binary logistic regression models.

Results

In the present study, 38.2% of the study participants were categorized as moderate and severe depressed ones (n=76). Additionally, 51.8% showed moderate and severe anxiety (n=103). The DED score ranged from 4.35 to 5.15, the DII score from -2.96 to 1.08, and the MAR score from 0.82 to 2.37. Table 1 presents the general characteristics of the study subjects in the tertiles of DED, DII, and MAR scores. Compared with those in the lower tertile, participants in the upper tertile of DED score were younger and with lower BMI and weight levels. The marital status, occupation, and number of pregnancies were significantly associated with the DED score. The MAR score also exhibited a significant relationship with being a home owner.

Table 1: General characteristics of the participants across tertiles of energy density, dietary inflammatory index, and mean adequacy ratio.

(n)	Energy density				DII				MAR			
	T1 (67)	T2 (68)	T3 (67)	*P* value	T1 (67)	T2 (68)	T3 (67)	*P* value	T1 (67)	T2 (68)	T3 (67)	*P* value
Age (y)	32.3±8.87	25.7±8.41	24.1±6.79	<0.001	28.8±9.13	26.1±8.8	27.2±8.35	0.19	27.7±8.45	26.6±8.76	27.8±9.23	0.69
Height (cm)	163±6.36	163±5.41	164±4.77	0.39	163±6.16	164±5.5	163±4.98	0.62	163±5.27	164±5.63	162.7±5.72	0.3
Weight (kg)	71.4±12.1	67.4±13.6	65.5±13.5	0.03	70.3±12.3	67.4±13.5	66.6±13.8	0.24	67.1±14.2	68.5±12.9	68.7±12.8	0.73
BMI (kg/m^2)	26.9±4.11	25.3±4.43	24.3±4.65	0.003	26.5±4.49	25.1±4.42	24.9±4.52	0.07	25.1±4.57	25.4±4.25	26±4.74	0.54
Anxiety and depression	14.1±7.09	14.6±6.69	15.1±7.3	0.7	13.7±6.88	15.1±7.32	15.1±6.82	0.42	15.5±6.95	14.8±7.43	13.5±6.57	0.26
DED (kcal/g)	4.45±0.1	4.66±0.05	4.94±0.21	<0.001	4.63±0.19	4.69±0.22	4.73±0.29	0.06	4.72±0.28	4.69±0.19	4.64±0.23	0.14
DII	-1.19±1.38	-0.96±1.2	-0.7±1.14	0.08	-2.32±0.64	-0.97±0.31	0.43±0.65	<0.001	0.19±0.86	-0.9±0.79	-2.15±0.8	<0.001
MAR	1.51±0.5	1.36±0.4	1.48±0.53	0.15	1.87±0.44	1.44±0.33	1.03±0.22	<0.001	0.98±0.16	1.37±0.1	1.98±0.39	<0.001
Marital status (%)				<0.001				0.70				0.86
Single	16 (23.9)	40 (58.8)	43 (64.2)		31 (46.3)	37 (54.4)	31 (46.3)		32 (47.8)	34 (50)	33 (49.3)	
Married	49 (73.1)	27 (39.7)	22 (32.8)		34 (34.7)	29 (29.6)	25 (35.7)		33 (49.3)	33 (48.5)	32 (47.8)	
Divorced	2 (3)	1 (1.5)	1 (1.5)		1 (1.5)	2 (2.9)	1 (1.5)		2 (3)	1 (1.5)	1 (1.5)	
Widow	0	0	1 (1.5)		1 (1.5)	0	0		0	0	1 (1.5)	
Education (%)				0.51				0.84				0.73
Illiterate	2 (3)	0	1 (1.5)		1 (1.5)	0	2 (3)		2 (3)	0	1 (1.5)	
Under-diploma	28 (41.8)	40 (58.8)	36 (53.7)		33 (49.2)	40 (58.8)	31 (46.2)		33 (49.2)	34 (50)	37 (55.2)	
Diploma	27 (40.3)	23 (33.8)	25 (37.3)		26 (38.8)	23 (33.8)	26 (38.8)		23 (34.3)	29 (42.6)	23 (34.3)	
High education	10 (14.9)	5 (7.4)	5 (7.5)		7 (10.4)	5 (7.4)	8 (11.9)		9 (13.4)	5 (7.4)	6 (9)	
Number of pregnancy (%)				0.001				0.56				0.68
0	20 (29.9)	42 (62.7)	48 (73.8)		31 (47)	40 (59.7)	39 (59.1)		39 (59.1)	39 (57.4)	32 (49.2)	
1-2	27 (40.3)	16 (23.8)	12 (18.5)		21 (31.8)	18 (26.8)	16 (24.3)		16 (24.3)	21 (30.9)	18 (27.6)	
3-4	17 (25.3)	8 (12)	3 (4.6)		11 (16.7)	7 (10.5)	10 (15.1)		11 (16.7)	6 (8.8)	11 (16.9)	
>4	3 (4.5)	1 (1.5)	2 (3.1)		3 (4.5)	2 (3)	1 1.5)		0	2 (2.9)	4 (4.6)	
Smoking (%)				0.42				0.41				0.41
Smoker	0	1 (1.5)	2 (3)		3 (4.5)	0	0		0	0	3 (4.5)	
Non-smoker	67 (100)	67 (98.5)	65 (97)		64 (95.5)	68 (100)	67 (100)		67 (100)	68 (100)	64 (95.5)	
Occupation (%)				<0.001				0.30				0.25
Employed	16 (23.9)	33 (48.5)	20 (29.8)		21 (41.3)	28 (41.2)	20 (29.8)		26 (39.8)	27 (39.7)	16 (23.9)	
Housekeeper	40 (59.7)	22 (32.4)	20 (29.9)		28 (41.8)	24 (35.3)	30 (44.8)		28 (41.8)	24 (35.3)	30 (44.8)	
Unemployed	11 (16.4)	13 (19.1)	27 (40.3)		18 (26.9)	16 (23.5)	17 (25.4)		13 (19.4)	17 (25)	21 (31.3)	
Economic status (%)				0.32				0.54				0.95
Low	5 (7.5)	6 (8.8)	3 (4.5)		4 (5.9)	5 (7.3)	5 (7.5)		5 (7.5)	4 (5.9)	5 (7.4)	
Average	3 (4.5)	10 (14.7)	4 (6)		3 (4.5)	(7.4)	9 (13.4)		7 (10.4)	6 (8.8)	4 (6)	
High	59 (88.1)	52 (76.5)	60 (89.6)		60 (89.6)	58 (85.3)	53 (79.1)		55 (82.1)	58 (85.3)	58 (86.6)	

(n)	Energy density				DII			MAR			
	T1 (67)	T2 (68)	T3 (67)	*P* value	T1 (67)	T2 (68)	T3 (67)	*P* value	T1 (67)	T2 (68)	T3 (67)	*P* value
Hose owner (%)	43 (64.2)	52 (76.5)	46 (68.7)	0.29	53 (79.1)	42 (61.8)	46 (68.7)	0.09	42 (62.7)	44 (64.7)	55 (82.1)	0.03
Car owner (%)	52 (77.6)	52 (76.5)	56 (83.6)	0.55	52 (77.6)	60 (88.2)	48 (71.6)	0.06	51 (76.1)	59 (86.8)	50 (74.6)	0.16
Estrogen usage (%)	21 (31.3)	28 (41.2)	34 (50.7)	0.07	26 (38.8)	31 (45.6)	26 (38.8)	0.65	25 (37.3)	34 (50)	24 (35.8)	0.18
Multivitamin usage (%)	45 (67.2)	44 (64.7)	42 (62.7)	0.86	50 (74.6)	40 (58.8)	41 (61.2)	0.18	41 (61.2)	48 (70.6)	42 (62.7)	0.47

Values were presented as mean±standard deviation. P values result from ANOVA for quantitative variables and χ^2 test for qualitative variables. Abbreviations: DII: Dietary Inflammatory Index, MAR: Mean Adequacy Ratio, ED: Energy Density, T: Tertile, BMI: Body Mass Index.

In addition to the score tertile, no significant difference was noticed for other variables.

Crude and multivariate-adjusted odds ratios (ORs) and 95% CIs for obesity, depression, and anxiety across tertile of DII score were presented in Table 2. In a full adjusted model, participants in the highest tertiles of DII scores demonstrated a lower odds ratio of obesity (OR: 0.36; 95% CI: 0.1–1.31), depression (OR: 1.39; 95% CI: 0.15–12.6), and anxiety (OR: 0.84; 95% CI: 0.28-2.56) when compared to those in the lowest tertile. However, this association was not statistically significant. Additionally, in the crude model or the first adjusted model (for energy intake and age), no significant association was found.

Crude and multivariate-adjusted odds ratios and 95% CIs for obesity, depression, and anxiety across tertiles of MAR score were presented in Table 3. In a full adjusted model, participants in the highest tertile of the MAR score showed higher odds of obesity (OR: 3.98; 95% CI: 0.73–21.8) and lower odds of depression (OR: 0.83; 95% CI: 0.08–10.1) and anxiety. (OR: 0.25; 95% CI: 0.05-1.12), in comparison to those in the lowest tertile; however, this association was not significant. In the crude model or the first adjusted model (for energy intake and age), no significant association was seen. Crude and multivariate-adjusted odds ratios and 95% CIs for obesity, depression, and anxiety across tertiles of DED score were presented in Table 4. In a full adjusted model, participants in the highest percentile of DED scores illustrated higher odds of obesity (OR: 2.04; 95% CI: 0.67–6.26), depression (OR: 1.64; 95% CI: 0.29–9.19), and anxiety (OR: 1.03; 95% CI: 0.4-0.66) when compared to those in the lowest tertile; even this association was not significant. In the crude model or the first adjusted model (for energy intake and age), no significant association was found too.

Discussion

This cross-sectional study investigated the relationship between the DII, MAR, DED and mental health. ED showed the correlation with age; while younger participants consumed foods with a higher ED index. ED demonstrated a correlation with weight and BMI too, while higher weight levels and BMI displayed association to T1 of ED. The number of pregnancies was significantly associated with the DED score. Despite adjusting for confounding factors, the DII, ED, and MAR indexes revealed no significant association with obesity, anxiety, or depression. In line with our results, two studies indicated that ED values were inversely associated with age (27, 28). However, more studies are necessary to find out the potential impacts of misreporting on estimated ED values.

Table 2: Odds ratio of obesity, depression and anxiety across tertile of DII.

	T1		T2		T3		*P* trend*
	Reference	*P* value	OR (95% CI)	*P* value	OR (95% CI)	*P* value	
Obesity							
Crude model	1	0.41	0.6 (0.25-1.44)	0.25	0.61 (0.25-1.47)	0.27	0.25
Model 1	1	0.39	0.58 (0.22-1.55)	0.28	0.47 (0.15-1.46)	0.19	0.19
Model 2	1	0.28	0.5 (0.16-1.57)	0.23	0.36 (0.1-1.31)	0.12	0.12
Depression							
Crude model	1	0.31	2.85 (0.72-11.2)	0.13	1.72 (0.39-7.52)	0.47	0.52
Model 1	1	0.26	3.25 (0.74-14.2)	0.12	1.96 (0.34-11.4)	0.45	0.52
Model 2	1	0.13	4.72 (0.72-30.9)	0.11	1.39 (0.15-12.6)	0.77	0.95
Anxiety							
Crude model	1	0.53	1.47 (0.66-3.25)	0.34	1 (0.43-2.3)	1	1
Model 1	1	0.44	1.56 (0.66-3.66)	0.31	0.98 (0.35-2.73)	0.97	0.97
Model 2	1	0.22	1.78 (0.7-4.54)	0.23	0.84 (0.28-2.56)	0.76	0.75

Data were presented as ORs and 95% CIs. Model 1: Adjusted for age and energy intake. Model 2: Additionally, adjusted for smoking, number of pregnancies, economical status, owning a house or a car, marital status, educational level, estrogen and multivitamin consumption, and occupation. *Obtained from binary logistic regression. Abbreviations: DII: Dietary Inflammatory Index, OR: Odds Ratio, CI: Confidence Interval, T: Tertile.

Table 3: Odds ratio of obesity, depression and anxiety across tertile of MAR.

	T1		T2		T3		*P* trend*
	Reference	*P* value	OR (95% CI)	*P* value	OR (95% CI)	*P* value	
Obesity							
Crude model	1	0.77	1.2 (0.48-3)	0.7	1.4 (0.56-3.47)	0.47	0.47
Model 1	1	0.36	1.72 (0.61-4.86)	0.31	2.91 (0.67-12.6)	0.15	0.15
Model 2	1	0.24	2.35 (0.73-7.58)	0.15	3.98 (0.73-21.8)	0.11	0.1
Depression							
Crude model	1	0.79	0.97 (0.3-3.17)	0.96	0.66 (0.18-2.44)	0.53	0.54
Model 1	1	0.76	0.91 (0.25-3.33)	0.88	0.5 (0.07-3.76)	0.5	0.55
Model 2	1	0.94	1.12 (0.23-5.41)	0.88	0.83 (0.08-10.1)	0.88	0.93
Anxiety							
Crude model	1	0.11	1.4 (0.65-2.99)	0.39	0.57 (0.24-1.37)	0.21	0.24
Model 1	1	0.04	1.32 (0.49-2.62)	0.77	0.27 (0.07-1.04)	0.06	0.12
Model 2	1	0.04	1.2 (0.49-2.95)	0.69	0.25 (0.05-1.12)	0.07	0.16

Data were presented as ORs and 95% CIs. Model 1: Adjusted for age and energy intake. Model 2: Additionally, adjusted for smoking, number of pregnancies, economical status, owning a house or a car, marital status, educational level, estrogen and multivitamin usage, and occupation. *Obtained from binary logistic regression. Abbreviations: MAR: Mean Adequacy Ratio, OR: Odds Ratio, CI: Confidence Interval, T: Tertile.

If individuals consistently under-reported or over-reported all types of foods, there would likely be little influence on energy density values. Also, under-reporting high-energy-dense foods or over-reporting low-energy-dense-foods could cause energy density estimations to be lower than actual values and could mask associations with health outcomes. This may be especially problematic among individuals who were older (29). A number of cross-sectional and cohort studies have revealed a direct causal link between DII and mental disorders like anxiety and depression (30, 31).

According to findings of several studies, women with a high DII score were more likely to experience depressive symptoms and anxiety (31-33). Nevertheless, one large prospective study in 2017 did not observe any significant association within any specific age subgroup among women (18). Therefore, we designed our study on women to investigate this relationship. The DII was shown to be a better predictor of depression in older people (2). Our participants were younger than the study population of previous studies (30-32), which may explain the differences between our results and the others. In line with our findings, Maddahi *et al.* observed no significant association between ED and anxiety or depression (11).

In a study by Grossniklaus *et al.* on adults, increased depressive symptoms were related to increased food and beverage energy density (13).

Table 4: Odds ratio of obesity, depression and anxiety across tertile of DED.

	T1		T2		T3		*P* trend*
	Reference	*P* value	OR (95% CI)	*P* value	OR (95% CI)	*P* value	
Obesity							
Crude model	1	0.68	0.74 (0.31-1.78)	0.51	0.69 (0.28-1.68)	0.41	0.4
Model 1	1	0.84	1.2 (0.46-3.12)	0.71	1.35 (0.49-3.73)	0.56	0.56
Model 2	1	0.42	1.11 (0.38-3.27)	0.85	2.04 (0.67-6.26)	0.21	0.23
Depression							
Crude model	1	0.63	1.84 (0.51-6.6)	0.35	1.31 (0.34-5.12)	0.69	0.71
Model 1	1	0.46	2.35 (0.61-9.07)	0.21	1.87 (0.42-8.26)	0.41	0.43
Model 2	1	0.41	2.76 (0.6-12.8)	0.19	1.64 (0.29-9.19)	0.57	0.58
Anxiety							
Crude model	1	0.91	0.85 (0.38-1.88)	0.68	0.88 (0.4-1.96)	0.76	0.75
Model 1	1	0.95	1.02 (0.44-2.37)	0.96	1.14 (0.47-2.75)	0.77	0.77
Model 2	1	0.93	0.87 (0.36-2.13)	0.76	1.03 (0.4-2.66)	0.95	0.96

Data were presented as ORs and 95% CIs. Model 1: Adjusted for age and energy intake. Model 2: Additionally, adjusted for smoking, number of pregnancies, economical status, owning a house or a car, marital status, educational level, intake of estrogen and multivitamin, and occupation. *Obtained from binary logistic regression. Abbreviations: ED: Energy Density, OR: Odds Ratio, CI: Confidence Interval, T: Tertile.

Additionally, Atlantis *et al.* did not find any association between ED and depression in their study on Australian men (34). Diets with high energy density and rich in fat (11) in Dutheil *et al.*'s study revealed high-fat diets to be associated with higher anxiety levels via disrupting insulin signaling and increasing inflammatory cytokines and corticosterone level (35). Some studies have shown that low diet quality is a serious risk factor for depression. These studies states that the diet of depressed people had low quality and its contents were poor in terms of protein, vitamins, and minerals and rich in simple carbohydrates and saturated fat (36, 37). The newest study showed that MAR score was significantly higher in individuals without depressive symptoms (15). Additionally, one study demonstrated this relationship only in women (16).

Our study has some potential limitations that should be noted. The first weakness of our study was the sample size, which was too small. Additionally, we used the FFQ to determine the participants' usual diet and then calculated dietary indexes. The limitations of the FFQ were linked to a fixed list of foods and the conceptual abilities related to the recall of the frequency and amount of food intake patterns during an extended period. As with other methods based on interviews, they can also be subjected to interviewer bias. It is important to acknowledge that the DII had some restrictions; for instance, the DII was primarily based on literature evaluating the effect of specific dietary components on inflammation, which might result in a less significant association when comparing it to the diet (31). The study also had several strengths. The samples in this study were more specific than in previous surveys, while we investigated on a specific women population. Additionally, we used a 148-item FFQ that was more complete and covered more DII items. Besides, we adjusted our results for several confounders, such as smoking, number of pregnancies, economical status, owning a house or a car, marital status, educational level, estrogen and multivitamin consumption, and the occupation.

Conclusion

Our results revealed no association between dietary indexes and obesity, anxiety and depression even after adjusting for confounders. According to the differences in the findings of recent studies, more investigations utilizing a prospective design with a greater sample size are needed. Moreover, future randomized controlled trials are necessary to clarify the relationship between DII and mental disorders. Although individuals in the highest tertile of DED score had a lower BMI and weight and were younger, we did not observe any other significant differences in other variables, such as depression, anxiety, and obesity. Further

larger scale prospective cohort studies with low measurement errors seem necessary to confirm the current findings.

Acknowledgment

The authors appreciate the Vice-Chancellor Yasuj University of Medical Sciences for their financial support. The researchers also extend their sincerest appreciation to all subjects, who served as samples of this study.

Authors' Contribution

Conception and Design: M.R.J., M.V.B., S.B.P., Acquisition of Data: S.N., F.A., M.N.A, S.M.S. Analysis and Interpretation of Data: M.R.J., S.B.P. Drafting the Manuscript: M.R.J., M.B., N.S., M.V.B. Revising Manuscript for Intellectual Content: M.R.J., M.V.B. All authors have read and approved the final manuscript.

Conflict of Interest

The authors report that there are no competing interests to declare.

References

1 Naveed S, Waqas A, Chaudhary AMD, et al. Prevalence of common mental disorders in South Asia: a systematic review and meta-regression analysis. *Front Psychiatry*. 2020;11:573150. DOI: 10.3389/fpsyt.2020.573150. PMID: 32982812.

2 World Health Organization. Mental health in the workplace. http:// www. who. int/ mental_ health/ world- mental- health- day/ 2017/ en/. Accessed 2017.

3 Tahan M, Saleem T, Zygoulis P, et al. A systematic review of prevalence of Depression in Iranian patients. *Neuropsychopharmacol Hung*. 2020;22:16-22. PMID: 32329749.

4 Salari N, Mohammadi M, Vaisi-Raygani A, et al. The prevalence of severe depression in Iranian older adult: a meta-analysis and meta-regression. *BMC Geriatr*. 2020;20:1-8. DOI: 10.1186/s12877-020-1444-0. PMID: 32013895.

5 Quirk SE, Williams LJ, O'Neil A, et al. The association between diet quality, dietary patterns and depression in adults: a systematic review. *BMC Psychiatry*. 2013;13:175. DOI: 10.1186/1471-244X-13-175. PMID: 23802679.

6 White SJ, Sin J, Sweeney A, et al. Global prevalence and mental health outcomes of intimate partner violence among women: a systematic review and meta-analysis. *Trauma Violence Abuse*. 2024;25:494-511. DOI: 10.1177/15248380231155529. PMID: 36825800.

7 Ahluwalia N, Andreeva VA, Kesse-Guyot E, et al. Dietary patterns, inflammation and the metabolic syndrome. *Diabetes Metab*. 2013;39:99-110. DOI: 10.1016/j.diabet.2012.08.007. PMID: 23062863.

8 Behzadi M, Akbarzadeh M, Mohammadi Sartang M, et al. Effect of carotenoid supplementation on blood pressure in adults: a GRADE-assessed systematic review and dose–response meta-analysis of randomized controlled trials. *Nutr Rev*. 2024. DOI: 10.1093/nutrit/nuad172. PMID: 38219250.

9 Shakya PR, Melaku YA, Shivappa N, et al. Dietary inflammatory index (DII®) and the risk of depression symptoms in adults. *Clin Nutr*. 2021;40:3631-42. DOI: 10.1016/j.clnu.2020.12.031. PMID: 33485704.

10 Zhao L, Sun Y, Liu Y, et al. A J-shaped association between Dietary Inflammatory Index (DII) and depression: A cross-sectional study from NHANES 2007–2018. *J Affect Disord*. 2023;323:257-63. DOI: 10.1016/j.jad.2022.11.052. PMID: 36462606.

11 Maddahi NS, Yarizadeh H, Setayesh L, et al. Association between dietary energy density with mental health and sleep quality in women with overweight/obesity. *BMC Res Notes*. 2020;13:189. DOI: 10.1186/s13104-020-05025-1. PMID: 32228677.

12 Zhang X, Chen M, Duan R, et al. The Nutrition and Health in Southwest China (NHSC) study: design, implementation, and major findings. *Eur J Clin Nutr*. 2021;75:299-306. DOI: 10.1038/s41430-020-00703-6. PMID: 32801308.

13 Grossniklaus DA, Dunbar SB, Tohill BC, et al. Psychological factors are important correlates of dietary pattern in overweight adults. *J Cardiovasc Nurs*. 2010;25:450-60. DOI: 10.1097/JCN.0b013e3181d25433. PMID: 20938248.

14 Rahati S, Qorbani M, Naghavi A, et al. Association and interaction of the MC4R rs17782313 polymorphism with plasma ghrelin, GLP-1, cortisol, food intake and eating behaviors in overweight/obese Iranian adults. *BMC Endocr Disord*. 2022;22:234. DOI: 10.1186/s12902-022-01129-w. PMID: 36123585.

15 Hülya Y, Gülperi D. The relationship of diet quality and body composition with depression level in young women. *Acta Scientiarum Health Sci*. 2022;45. DOI: 10.4025/actascihealthsci.v45i1.60410.

16 Kim S. The relationship between lifestyle risk factors and depression in Korean older adults: a moderating effect of gender. *BMC Geriatr*. 2022;22:24. DOI: 10.1186/s12877-021-02729-2. PMID: 34986791.

17 Kang M, Joo M, Hong H, et al. The Relationship

of Lifestyle Risk Factors and Depression in Korean Adults: A Moderating Effect of Overall Nutritional Adequacy. *Nutrients*. 2021;13:2626. DOI: 10.3390/nu13082626. PMID: 34444785.

18 Adjibade M, Andreeva VA, Lemogne C, et al. The Inflammatory Potential of the Diet Is Associated with Depressive Symptoms in Different Subgroups of the General Population. *J Nutr*. 2017;147:879-87. DOI: 10.3945/jn.116.245167. PMID: 28356432.

19 Akbaraly T, Kerlau C, Wyart M, et al. Dietary inflammatory index and recurrence of depressive symptoms: Results from the Whitehall II Study. *Clin Psychol Sci*. 2016;4:1125-34. DOI: 10.1177/2167702616645777. PMID: 28070452.

20 Bergmans RS, Malecki KM. The association of dietary inflammatory potential with depression and mental well-being among U.S. adults. *Prev Med*. 2017;99:313-9. DOI: 10.1016/j.ypmed.2017.03.016. PMID: 28342730.

21 Sharifi V, Amin-Esmaeili M, Hajebi A, et al. Twelve-month prevalence and correlates of psychiatric disorders in Iran: the Iranian Mental Health Survey, 2011. *Arch Iran Med*. 2015;18:76-84. DOI: 015182/AIM.004. PMID: 25644794.

22 Sherafati N, Behzadi M, Bideshki MV, et al. Global Leadership Initiative on Malnutrition and Mini Nutritional Assessment in Evaluation of Nutritional Status of COVID-19 Patients. *Int J Nutr Sci*, 2024;9:14-22. DOI: 10.30476/ijns.2024.100096.1267

23 Keshteli AH, Esmaillzadeh A, Rajaie S, et al. A dish-based semi-quantitative food frequency questionnaire for assessment of dietary intakes in epidemiologic studies in Iran: design and development. *Int J Prev Med*. 2014;5:29. PMID: 24554989.

24 Rhee JJ, Sampson LK, Cho E, et al. Comparison of methods to account for implausible reporting of energy intake in epidemiologic studies. *Am J Epidemiol*. 2015;181 4:225-33. DOI: 10.1093/aje/kwu308. PMID: 25656533.

25 Montazeri A, Vahdaninia M, Ebrahimi M, et al. The Hospital Anxiety and Depression Scale (HADS): translation and validation study of the Iranian version. *Health Qual Life Outcomes*. 2003;1:1-5. DOI: 10.1186/1477-7525-1-14. PMID: 12816545.

26 Purnell JQ. Definitions, Classification, and Epidemiology of Obesity: MDText.com, Inc., South Dartmouth (MA); 2015. PMID: 25905390.

27 Martí-Henneberg C, Capdevila F, Arija V, et al. Energy density of the diet, food volume and energy intake by age and sex in a healthy population. *Eur J Clin Nutr*. 1999;53:421-8. DOI: 10.1038/sj.ejcn.1600770. PMID: 10403576.

28 Ledikwe JH, Blanck HM, Khan LK, et al. Dietary Energy Density Determined by Eight Calculation Methods in a Nationally Representative United States Population1. *J Nutr*. 2005;135:273-8. DOI: 10.1093/jn/135.2.273. PMID: 15671225.

29 Johansson L, Solvoll K, Bjorneboe GEA, et al. Under- and overreporting of energy intake related to weight status and lifestyle in a nationwide sample123. *Am J Clin Nutr*. 1998;68:266-74. DOI: 10.1093/ajcn/68.2.266. PMID: 9701182.

30 Adjibade M, Lemogne C, Touvier M, et al. The Inflammatory Potential of the Diet is Directly Associated with Incident Depressive Symptoms Among French Adults. *J Nutr*. 2019;149:1198-207. DOI: 10.1093/jn/nxz045. PMID: 31152670.

31 Haghighatdoost F, Feizi A, Esmaillzadeh A, et al. Association between the dietary inflammatory index and common mental health disorders profile scores. *Clin Nutr*. 2019;38:1643-50. DOI: 10.1016/j.clnu.2018.08.016. PMID: 30190117.

32 Salari-Moghaddam A, Keshteli AH, Afshar H, et al. Empirically derived food-based dietary inflammatory index is associated with increased risk of psychological disorders in women. *Nutr Neurosci*. 2021;24:260-8. DOI: 10.1080/1028415X.2019.1621044. PMID: 31370765.

33 Ghazizadeh H, Yaghooti-Khorasani M, Asadi Z, et al. Association between Dietary Inflammatory Index (DII®) and depression and anxiety in the Mashhad Stroke and Heart Atherosclerotic Disorder (MASHAD) Study population. *BMC Psychiatry*. 2020;20:282. DOI: 10.1186/s12888-020-02663-4. PMID: 32503468.

34 Atlantis E, Lange K, Goldney RD, et al. Specific medical conditions associated with clinically significant depressive symptoms in men. *Soc Psychiatry Psychiatr Epidemiol*. 2011;46:1303-12. DOI: 10.1007/s00127-010-0302-3. PMID: 20976591.

35 Dutheil S, Ota KT, Wohleb ES, et al. High-fat diet induced anxiety and anhedonia: impact on brain homeostasis and inflammation. *Neuropsychopharmacology*. 2016;41:1874-87. DOI: 10.1038/npp.2015.357. PMID: 26658303.

36 Wu PY, Chen KM, Belcastro F. Dietary patterns and depression risk in older adults: systematic review and meta-analysis. *Nutr Rev*. 2021;79:976-87. DOI: 10.1093/nutrit/nuaa118. PMID: 33236111.

37 Nicolaou M, Colpo M, Vermeulen E, et al. Association of a priori dietary patterns with depressive symptoms: a harmonised meta-analysis of observational studies. *Psychol Med*. 2020;50:1872-83. DOI: 10.1017/S0033291719001958. PMID: 31409435.