

# Association between Major Dietary Patterns at Breakfast and Odds of Major Depressive Disorder: A Case-control Study

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## Abstract

**Background:** No study was conducted to investigate the association between principal component (PCA) derived meal-based dietary patterns and odds of major depressive disorder. We aimed to explore the association between major dietary patterns at breakfast and odds of major depressive disorder (MDD).

**Methods:** A total of 200 drug-free patients with MDD and 200 healthy individuals were enrolled in this age- and sex-matched case-control study. Dietary intake was assessed using 24-hour dietary recall. PCA was applied to identify meal-based dietary patterns. The Beck Depression Inventory-II questionnaire was used for screening depression in the control group. A trained interviewer documented socioeconomic status and anthropometric measurements using standardized procedures. Conditional logistic regression was performed to find the association between patterns and MDD odds.

**Results:** The mean age of the participants was  $45.4 \pm 10.7$  years and 67.5% (270 participants) were women. We identified 3 major dietary patterns at breakfast including "healthy," "oil and egg," and "legumes and condiments" patterns. High adherence to healthy dietary patterns was associated with decreased odds of MDD (odds ratio (OR), 0.55 (95% CI, 0.32, 0.94);  $P = 0.030$ ). Neither "oil and egg" nor "legumes and condiments" patterns were associated with MDD.

**Conclusion:** Healthy dietary patterns were associated with lower odds of MDD. However, no significant relationship was detected between the "oil and egg pattern" and "legumes and condiments pattern" and the odds of MDD. Recommendations for reducing the odds of MDD can be focused on increasing adherence to healthy dietary patterns at breakfast. It is recommended to conduct prospective design studies to confirm these findings.

**Keywords:** Breakfast Pattern, Meal-based Dietary Pattern, Principal Component Analysis, Major Depressive Disorder, Depressive Symptoms

**Conflicts of Interest:** None declared

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## Introduction

Major depressive disorder (MDD) is among the most prevalent mental health conditions, with an estimated life-

time occurrence of approximately 12% (1, 2). MDD is anticipated to rank as the primary source of disease burden

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### ↑What is "already known" in this topic:

Diet could potentially be a changeable element in preventing major depressive disorder (MDD). Principal component analysis (PCA) is the most frequently utilized statistical method for analyzing dietary intake patterns. No study was conducted to evaluate the association between meal-based dietary patterns identified by PCA and the odds of MDD.

### →What this article adds:

We found an inverse association between healthy dietary patterns at breakfast meals and odds of MDD. However, no significant relationship was detected between the "oil and egg pattern" and "legumes and condiments pattern" and the odds of MDD. To present more useful dietary guidelines, it would be useful to recommend healthy dietary patterns at breakfast meals.

globally through 2030 (3). Various factors—including genetics and environmental factors such as nutrition—play a role in the etiology of mental disorders (4-6). Considering that patients with major depression often have poor medication adherence and a high rate of recurrence, nutrition-related factors may be important in both preventing and treating this illness (7).

According to the recent approaches of epidemiological studies, it is better to identify dietary patterns and their relationship with diseases instead of focusing on the intake of a specific nutrient or food group considering the multidimensional nature of eating behaviors and due to the complex composition of nutrients and the possible effects of food on each other's absorption and metabolism (8, 9). Therefore, examining dietary patterns draws a more comprehensive picture of the intake of foods and nutrients (8, 10).

Chrono-nutrition examines how biological rhythms interact with nutrition and explores how these elements affect human health (11). Instead of consuming foods and nutrients separately, people consume food combinations as meals and snacks (11). It may be possible to clarify significant diet-disease relationships by having a better understanding of the nutritional makeup of meals and how various meal patterns affect diet quality (12). Furthermore, a meal-based strategy could supplement the current dietary recommendations, which help populations meet the suggested daily intake of foods and nutrients through the use of a food-based framework (13). In other words, offering dietary advice in the context of meals could make it easier for people to prepare their daily meals, which would make it a more useful and noticeable method of encouraging people to follow dietary recommendations (14). Principal component analysis (PCA) has emerged as the most widely utilized statistical method for analyzing dietary intake patterns (15). This technique accounts for correlations or covariances among food groups, generating uncorrelated linear combinations referred to as components or patterns (16). So far, studies have focused on eating breakfast or skipping it and the risk of depression (17). In this regard, the results of a systematic review and observational meta-analysis showed that not eating breakfast had a positive relationship with the possibility of depression, stress, and anxiety in all age groups, as well as with anxiety in adolescence, which emphasized the effect of breakfast on mental health (17). Some studies have also measured the effect of consuming certain foods in breakfast on the risk of depression (18, 19). We hypothesized that adherence to healthy, oil and egg patterns, and legumes and condiment patterns at the breakfast meal is associated with lower MDD odds. In the present study, we aimed to identify the major dietary patterns at breakfast and their relationship with the odds of MDD in patients compared with the control participants.

## Methods

### Study Participants

The study was conducted using a case-control observational design (July 2022-June 2023). In this study, patients with MDD were diagnosed by psychiatrists through struc-

tured interviews, based on the criteria found in the Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition (DSM-IV) (20), which has been standardized in Iran (21). Participants were gathered from 2 psychiatric hospitals in Tehran: Ziaeeian and Imam Khomeini clinics.

Cases and controls were frequency-matched based on their sex and 5-year age group. Age categories for matching were 18-24, 25-30, 31-35, 36-40, 41-45, 46-50, 51-55, and 56-60 years. The ratio of cases to controls was 1 to 1. For the case group, those with MDD aged between 18 and 65, who resided in Tehran met the inclusion criteria. People in the case group had to be drug-free so that their diet could not change under the influence of the course of the disease. In this study, we defined those people as drug-free who had not taken any neuroleptics for at least 3 months since they were diagnosed with depression. An individual without depression who lived in Tehran, was between the ages of 18 and 60, was sent to other departments of Ziaeeian and Imam Khomeini hospitals, and had no prior history of depression or other psychiatric diseases was considered an eligible control.

Selection of the control group is of high importance and sensitivity, and it is necessary to select people who are suffering from depression and other neurological and mental diseases but whose disease has no positive or negative relationship with their diet. Since dietary exposures are related to a wide range of diseases, we limited the selection of the control group to the outpatient clinic, orthopedic department, oral and maxillofacial surgery, and ophthalmology departments. Also, all control participants were asked to complete the Beck II questionnaire to ensure that they were free of any major depression. The cutoff of this questionnaire for depression is a score of  $\geq 9$ , but those who scored  $>6$  in this questionnaire were excluded from the control group.

Several exclusion criteria were as follows: those diagnosed with cognitive impairments or other psychotic disorders by a mental health professional; those unable to cooperate or respond to questions; participants who started taking any antidepressants or underwent treatment; those with hormonal disorders such as Addison's disease, Cushing's syndrome, hyperthyroidism, hypothyroidism, or hyperparathyroidism; and those with chronic illnesses such as cancer, fibromyalgia, kidney or liver failure, multiple sclerosis, or Parkinson's disease. Additional exclusions included a history of trauma, injuries, fractures, bleeding, burns, or accidents that led to unconsciousness or hospitalization within the past 3 months, those with chronic and infectious diseases like HIV, mononucleosis, tuberculosis, viral hepatitis, or pneumonia in the past 2 weeks, and current or past substance abuse issues (alcohol or drugs) within 3 months. Also excluded were participants with a body mass index (BMI) of 40 kg/m<sup>2</sup> or higher, those who were pregnant or breastfeeding at the time of the study or in the previous year, anyone following a special diet in the past 2 months, or adhering to a special diet for  $>2$  months in the past year. Last, those who did not respond to  $>80\%$  of the questionnaire and those who consumed  $<800$  or  $>4200$  calories per day were also excluded (22).

The sample size in this study was calculated based on

previous studies and dietary exposures that were related to the odds of depression in the analyses (23, 24). We calculated the sample size using the following formula: 
$$= \frac{(1+\phi)^2}{\phi} \frac{(Z_{1-\alpha/2} + Z_{1-\beta})^2}{\ln OR^2 \times (P_{average} \times (1 - P_{average}))} \quad (25),$$
 taking into account 90% power, 2-sided confidence, a 0.05 level, a ratio of 1 control to 1 case, 25% of controls exposed, 40% of cases exposed, and an OR of 2.

A sample size of 398 was obtained. Finally, we recruited 400 participants—including 200 patients with depression and 200 control participants. A convenience sampling method was applied.

### Ethical Approval

The study protocol and informed consent document were approved by the ethical committee of Iran University of Medical Sciences (Ethic Number: IR.IUMS.REC.1401.334). Before participating in the study, all patients were provided with detailed written information about the study's background and procedures, and they signed a written consent form indicating their agreement.

### Data Collection

The demographic characteristics of the participants were obtained through a face-to-face interview using a prespecified general form. A trained interviewer completed a questionnaire designed to assess the demographics of the participants, including age (year), sex (male, female), educational level (illiterate, under diploma, diploma, educated), income (low, middle, high), marital status (single, married, divorced, widowed), occupation (employed, retired, housekeeper, or unemployed), smoking status (never smoked, former smoker, currently smoked), depression family history (yes, no), medical condition (healthy or underlying disease), lifestyle (living alone, with someone), menstrual status, and average sleep hours. We employed a validated and reliable form of the International Physical Activity Questionnaire (IPAQ) to assess each participant's physical activity levels over the previous week (26). Through the IPAQ, we evaluated various activities such as vigorous and moderate exercise, walking, and sitting time. To calculate the total weekly physical activity for each individual, we determined the metabolic equivalents (METs) expressed in MET minutes per week. Participants were then categorized into 1 of 3 groups: very low (<600 MET-minutes/week), low (600-3000 MET-minutes/week), moderate, and high (>3000 MET-minutes/week) (27). All questionnaires were completed by a single individual, the principal investigator, ensuring consistency in responses.

### Anthropometric Assessment

Participants' weight was measured using a digital scale (Seca 707; Seca GmbH & Co) while they were lightly dressed and barefoot. Height was assessed with a stadiometer (Seca) in a standing position, and recorded to the nearest 0.5 cm. The BMI was determined by dividing weight (kg) by the square of height (m<sup>2</sup>). Waist circumference was measured with a tape measure, taken from the iliac crest to

the lowest rib during exhalation. The maximum circumference around the buttocks was measured below the iliac crest, and the waist-to-hip ratio (WHR) was calculated.

### Dietary Assessment

Three 24-hour dietary recalls were used to evaluate the participants' dietary intakes. During the initial visit to each health center, trained dietitians conducted a face-to-face interview to complete the first 24-hour dietary recall. The other two 24-hour dietary recalls were conducted over the phone on random days, one of which was a weekend. Daily intakes of all food items from 24-hour dietary recalls were calculated for dietary analysis, and household measures were used to convert the results into grams (28). The food intakes for each of the 3 days were added up and then averaged.

### Meals Definition

A meal consumed between 5 AM and 11 AM was classified as breakfast (29).

### Assessment of Depression Severity and Screening

The Beck Depression Inventory-II (BDI-II) questionnaire was utilized to assess the severity of depression in those diagnosed with the disorder, as well as to screen for depression in the control group (30). The criteria for this assessment have been standardized in Iran (31). The BDI-II consists of 21 questions, each offering 4 potential responses based on the severity of depressive symptoms, with total scores ranging from 0 to 63 points. We classified the levels of depression as follows: 0-6 (no depression), 7-19 (mild depression), 20-28 (moderate depression), and 29-63 (severe depression) (30). Each of the 21 items is scored from 0 to 3. The Iranian adaptation of the BDI-II demonstrated strong internal consistency (Cronbach's alpha = 0.87) and satisfactory test-retest reliability ( $r = 0.74$ ) (31).

### Statistical Analysis

Principal components analysis (PCA) was performed to extract the dietary patterns of the participants (32, 33). Food items were categorized into 16 groups based on similarities in their ingredients, nutrient content, or cooking uses. The PCA was revised to incorporate these food groups. Before the analysis, the correlation matrix among the 16 food groups was statistically analyzed to support the factor analysis. The results of the Bartlett test showed a significant difference at  $P < 0.05$ , while the Kaiser-Meyer-Olkin test showed  $> 0.6$  and the Anti-image test showed  $> 0.5$ , suggesting that there was enough correlation between the variables to warrant a factor analysis. To make the data easier to interpret, a varimax rotation was used to adjust the factors that were analyzed. To ascertain the number of retained factors about dietary patterns, the eigenvalues and scree plots were considered. Food groups with rotated factor loadings  $> 0.25$  were used to label the derived dietary patterns (34). The factor scores for each pattern were calculated by adding the weighted intakes of the food groups, which were then categorized into tertiles based on the pat-

tern scores. To assess participant characteristics across tertiles of dietary patterns, the pattern scores were categorized into tertiles and compared using the chi-square ( $\chi^2$ ) test for categorical variables and a 1-way analysis of variance for continuous variables. A conditional logistic regression analysis was used to estimate the odds ratios and 95% CIs of MDD in relation to tertiles of dietary pattern scores, controlling for potential confounders—including energy intake, marital status, job status, income, living status, education, drug use, smoking status, physical activity level, family history of major depression, comorbidities, and BMI. Analyses were conducted using SPSS software Version 25 (SPSS Inc). A 2-sided  $P < 0.05$  was regarded as statistically significant.

## Results

In the present age- and sex-matched case-control study, 400 participants—including 200 cases with MDD and 200 controls—were enrolled, of whom 67.5% (270 participants) were women. The mean age of the participants was

$45.4 \pm 10.7$  years and the mean BMI was  $27 \pm 4.16$  kg/m<sup>2</sup>. The characteristics of the participants are presented in Table 1. Patients with MDD were less likely to not smoke than those in the control group.

In addition, a significant difference was observed between the 2 groups regarding physical activity level. No statistically significant differences were observed in terms of other general characteristics between the case and control groups. No significant differences were observed in other variables.

Dietary intakes between the case and control groups are provided in Table 2. Compared to controls, patients with MDD consumed higher amounts of dairy products. No significant differences were observed in terms of intake of other food groups between case and control groups.

The food grouping used in the factor analysis and factor loading matrix for the identified dietary patterns is presented in Table 3. Three major dietary patterns at breakfast were identified (Figure 1) using factor analysis, which explained 31.80% of the total variance in dietary intake

Table 1. General characteristics between cases and controls

	Cases=200	Controls=200	P value*
Age (year)	46.12 $\pm$ 11.03	44.74 $\pm$ 10.35	0.191
Body weight (kg)	72.5 $\pm$ 12.41	72.93 $\pm$ 10.18	0.760
Waist circumference (cm)	92.41 $\pm$ 12.71	92.36 $\pm$ 11.73	0.962
BMI (kg/m <sup>2</sup> )	27.30 $\pm$ 4.44	26.81 $\pm$ 3.85	0.230
Sex, n (%female)	135 (67.5)	135 (67.5)	1.000
Education, n (%educated)	74 (37.0)	65 (32.5)	0.693
Job status, n (%employed)	54 (27.0)	47 (23.5)	0.730
Income, n (% high income)	62 (31.0)	70 (35.0)	0.450
Menstruation status, n (% menopause)	54 (40.0)	38 (28.1)	0.100
Marital status, n (%married)	153 (76.5)	163 (81.5)	0.544
Living status, n (% with someone)	181 (90.5)	177 (88.5)	0.510
Smoking status, n (%non-smoker)	155 (77.5)	178 (89.0)	0.001
Health status, n (% healthy)	100 (50.0)	109 (54.5)	0.951
Physical activity level, n (%high)	1 (0.50)	46 (23.0)	<0.001
Family history of depression, n (% yes)	22 (11.0)	14 (7.0)	0.166

\*P value less than 0.05 was considered significant.

Values are based on mean  $\pm$  standard deviation or reported frequency (percentage).

Chi-2 test for categorical variables and Student t test for continuous variables have been used.

BMI: body mass index; Kg/m<sup>2</sup>: kilogram/meter; cm: centimeter; n: number

Table 2. Dietary intakes of study participants between cases and controls

	Cases=200	Controls=200	P value*
Breads and grains (gr/d)	40.40 $\pm$ 26.39	41.94 $\pm$ 31.92	0.590
Legumes (gr/d)	0.33 $\pm$ 2.08	0.36 $\pm$ 2.31	0.868
Cheese (gr/d)	15.84 $\pm$ 10.85	13.93 $\pm$ 9.89	0.060
Egg (gr/d)	7.10 $\pm$ 10.67	8.29 $\pm$ 12.93	0.315
Dairy (gr/d)	19.34 $\pm$ 36.79	12.47 $\pm$ 29.24	0.031
Condiments (gr/d)	0.02 $\pm$ 0.13	0.02 $\pm$ 0.14	0.550
Butter (gr/d)	1.80 $\pm$ 3.02	1.28 $\pm$ 2.51	0.064
Liquid oil (gr/d)	0.57 $\pm$ 1.26	0.77 $\pm$ 1.18	0.100
Solid oil (gr/d)	0.43 $\pm$ 1.82	0.24 $\pm$ 0.96	0.190
Fruits (gr/d)	2.96 $\pm$ 7.14	4.02 $\pm$ 10.75	0.243
Meats (gr/d)	2.61 $\pm$ 13.33	2.14 $\pm$ 9.00	0.680
Vegetables (gr/d)	8.44 $\pm$ 21.25	9.85 $\pm$ 19.81	0.491
Nuts (gr/d)	1.03 $\pm$ 1.75	1.80 $\pm$ 10.71	0.312
Sugar and sweets (gr/d)	38.97 $\pm$ 34.79	38.30 $\pm$ 26.08	0.820
Tea and coffee (gr/d)	154 $\pm$ 68.92	142 $\pm$ 74.30	0.100
Soft drinks (gr/d)	43.81 $\pm$ 96.99	26.56 $\pm$ 56.48	0.311

Values are based on mean  $\pm$  standard deviation

P value less than 0.05 was considered significant

\*obtained from Student t test

gr/d: gram per day



Table 3. Food groups and their loading factors stratified by the type of dietary patterns

Food items	Group details	Dietary Patterns		
		Oil and egg pattern	Legumes and condiments pattern	Healthy pattern
Breads and grains	Lavash bread, baguette bread, rice, pasta, dark breads (e.g., barbari, sangak, taftun), bran breads, others	-0.394	-0.323	
Legumes	Lentils, split pea, beans, chick pea, fava bean, soy, others		0.855	
Cheese	All types of cheese	-0.674		0.383
Condiments	All types of condiments		0.862	
Egg	Egg	0.709		
Dairy	Low-fat milk, skim milk, low-fat yogurt, Kashk, yogurt drink, high-fat milk, high-fat yogurt, cream, dairy fat, ice cream, others			0.229
Butter	animal butter, margarine			-0.381
Liquid oil	vegetable oils	0.659		
Solid oil	Hydrogenated vegetable oils, solid fats (animal origin)			-0.342
Fruits	Melon, watermelon, honeydew melon, plums, prunes, apples, cherries, sour cherries, peaches, nectarine, pear, fig, date, grapes, kiwi, pomegranate, strawberry, banana, persimmon, berry, pineapple, oranges, dried fruits, all juices, others			0.468
Meats	Beef and veal, lamb, minced meat, sausage, deli meat, hamburger, all fish types, heart, kidney, liver, tongue, brain, offal, rennet			-0.447
Vegetables	Cauliflower, carrot, tomato and its products, spinach, lettuce, cucumber, eggplant, onion, greens, green bean, green pea, squash, mushroom, pepper, corn, garlic, turnip, others			0.554
Nuts	Almonds, peanut, walnut, pistachio, hazelnut, seeds, others		-0.133	
Sugar and sweets	Cookies, cakes, biscuits, muffins, pies, chocolates, honey, jam, sugar cubes, sugar, candies, sweet tahini, others			-0.302
Tea and coffee	Tea and coffee	-0.570	-0.255	
Soft drinks	Soft drinks		-0.120	

Absolute values < 0.25 were not listed in the table for simplicity.

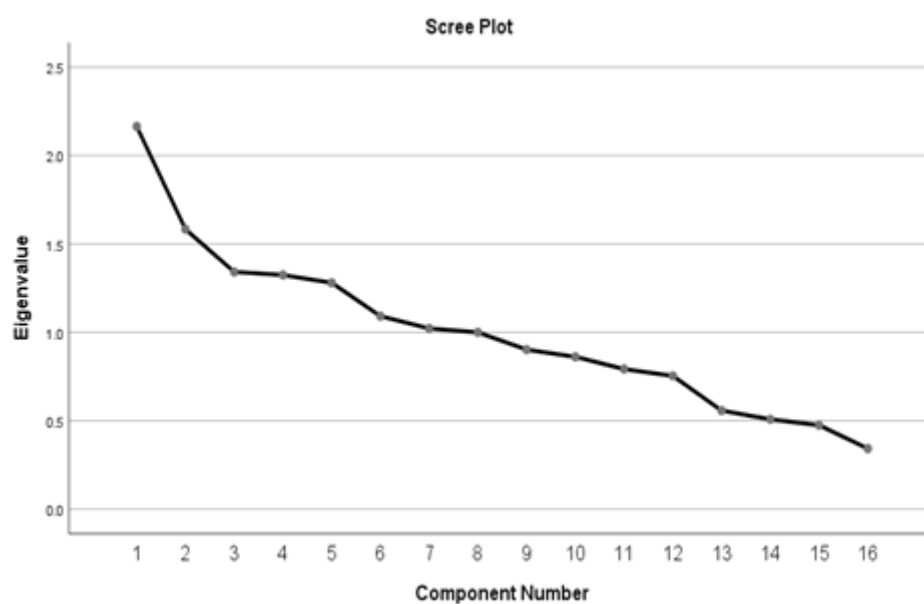


Figure 1. Scree plot for identification of dietary patterns by principal component analysis

amount. The first factor showed the strongest loadings for oil and eggs, thus, it was named the "oil and egg pattern." The second factor had the highest loadings for legumes and condiments, referred to as the "legumes and condiments pattern." Last, the third factor displayed the greatest loadings for cheese, dairy, vegetables, and fruits, which was

called the "healthy pattern."

Odds ratios and 95%CI of MDD according to tertiles of major dietary patterns at breakfast are presented in Table 4. A significant association was seen in crude (OR<sub>third vs first tertile</sub>: 0.53 (95% CI, 0.33-0.87);  $P = 0.010$ ) or the maximally adjusted model, such that those in the top category of the

**Table 4.** Odds ratios (ORs) and 95% confidence intervals (95% CIs) for major depression disorder according to tertiles of major dietary patterns at breakfast

Tertiles of oil and egg pattern				
	T1	T2	T3	P value
Crude	1	0.81 (0.51, 1.31)	0.75 (0.64, 1.21)	0.242
Model 1	1	0.81 (0.51, 1.31)	0.75 (0.64, 1.21)	0.241
Model 2	1	0.73 (0.43, 1.26)	0.76 (0.44, 1.29)	0.312
Model 3	1	0.74 (0.43, 1.26)	0.76 (0.45, 1.29)	0.321
Tertiles of legumes and condiments pattern				
Crude	1	1.04 (0.64, 1.69)	0.83 (0.51, 1.51)	0.463
Model 1	1	1.04 (0.64, 1.69)	0.83 (0.51, 1.51)	0.464
Model 2	1	1.05 (0.62, 1.79)	0.76 (0.45, 1.29)	0.312
Model 3	1	1.05 (0.62, 1.79)	0.75 (0.44, 1.28)	0.301
Tertiles of healthy pattern				
Crude	1	0.94 (0.58, 1.52)	0.53 (0.33, 0.87)	0.010
Model 1	1	0.94 (0.58, 1.52)	0.53 (0.33, 0.87)	0.010
Model 2	1	1.04 (0.61, 1.78)	0.55 (0.32, 0.94)	0.030
Model 3	1	1.04 (0.61, 1.77)	0.55 (0.32, 0.94)	0.030

Model I: adjusted for energy intake.

Model II: additionally, adjusted for marital status, job status, income, lifestyle, education, smoking, drug use, underlying disease, physical activity level, family history of depression and menstrual status

Model III: additionally, adjusted for BMI.

healthy pattern were 45% less likely to have MDD compared with those in the bottom category (OR<sub>third vs first tertile</sub>: 0.55 (95% CI: 0.32-0.94);  $P = 0.030$ ). No significant association was detected between other patterns and odds of MDD.

## Discussion

In this study, 3 dominant food patterns were identified at the breakfast meal using principal components analysis. The first food pattern, defined by the high consumption of eggs and liquid vegetable oils, was named the "oil and egg" food pattern. The second, defined by high consumption of legumes and seasonings, was labeled as a "legumes and condiments" food pattern. The third food pattern, defined by high consumption of cheese, vegetables, fruits, and dairy products, was labeled as a "healthy" food pattern. According to our results, those who adhered to a healthy pattern at their breakfast meal were 45% less likely to have MDD. No significant association was found between other patterns and odds of MDD.

Our hypothesis in this study was that adherence to healthy dietary patterns at breakfast meals would be related to lower MDD odds in the study population. There has been little research on meal patterns. The "healthy" dietary pattern observed in the present study is nearly identical to the "cereal and dairy" dietary patterns in Chilean adults (35), the "bread, dairy, fruit, and sweets" pattern of Japanese adults (36), the "Mediterranean" pattern with high bread consumption, cheese, vegetables and seeds, and vegetable oils in European adolescents (37) and the pattern of "South-eastern Brazil" with high consumption of bread, tea, and cheese in Brazilian adults (38). The "oil and egg" dietary pattern of the present study is nearly identical to the "plant-based and egg" pattern with high consumption of eggs, vegetable oil, legumes, and vegetables in European adolescents (37) and the "Northern Brazil" pattern with high egg consumption. Potatoes, meat, corn, and juices were included in the breakfast meal (39). However, personal characteristics—such as sex, race, ethnicity, income level (40), marital

status (41), job status, working hours, shift work (42), quality and duration of sleep (43), and hours of sleep (43)—can influence the quality of food intake and the time of meals. Also, eating outside the house (44) and having a meal with the family and the number of meals consumed with the family (45) also affect the consumption of food groups; thus, eating breakfast in a restaurant reduces the chances of eating healthy foods compared with homemade foods (46).

When it comes to breakfast being the first meal of the day, the key is to either avoid eating it altogether or to eat it frequently. The kind of food eaten at breakfast has a significant impact on calorie intake as well as the choices made for subsequent meals and throughout the day.

Thus, having breakfast and receiving healthy food groups such as fruit and vegetables at breakfast is related to the reduction of daily calorie intake (47). Also, skipping breakfast leads to an increase in energy intake at lunch and more daily calories (48). To date, no study has investigated the relationship between breakfast food patterns and the odds of major depression. A cross-sectional study of Australian teenagers aged 13 to 15 revealed that, in a dose-response manner, mental health improved as the quality of the breakfast diet improved. This suggests that breakfast is important, even though the majority of breakfast studies have focused on issues like skipping breakfast (17, 49), eating breakfast regularly throughout the week, and the time and energy consumed during breakfast.

Also, in another study conducted on Welsh adults, an inverse relationship between breakfast cereal intake and depression score was reported (18). In addition, in a cross-sectional study on British teenagers, an inverse relationship was found between breakfast cereal intake and depression score (19). In this study, the researcher's hypothesis regarding the association between adherence the healthy dietary pattern at breakfast meal and MDD was accepted.

While the exact reasons for the positive effects of breakfast on depressive symptoms are not fully understood, there appears to be an inverse relationship between breakfast consumption and these symptoms. This connection may be

attributed to several likely mechanisms relevant to the pathology of depression. One primary factor could be the role of carbohydrate intake. Those who regularly eat breakfast tend to consume more carbohydrates compared with those who do so irregularly (50). After a night of fasting, blood glucose levels drop; this decrease triggers the release of cortisol, which in turn raises the levels of inflammatory cytokines (51). Lower serotonin levels resulting from this process can negatively impact neurotransmitter function, contributing to the onset of depression (52). On the other hand, eating a breakfast that contains carbohydrates can sufficiently reduce metabolic stress and cortisol (53). Also, carbohydrates consumed during breakfast can be transformed into glucose in the body, leading to alterations in the levels of acetylcholine, insulin, serotonin, glutamate, and cortisol (54, 55). Eating carbohydrates is particularly advantageous for the brain following an overnight fast, as it helps lower cortisol levels and mitigates stress signals. Moreover, carbohydrates are converted into glucose, which is essential for producing tryptophan—a protein precursor involved in the synthesis of serotonin. This neurotransmitter plays a key role in managing mood, depressive symptoms, and cognitive function (56, 57). In addition to carbohydrates, the consumption of vitamins and minerals also affects brain function. A variety of vitamins and minerals contribute to the optimal functioning of neurotransmitters, chemicals used to communicate between neurons in the nervous system. Neurotransmitters are directly responsible for aspects such as behavior, mood, and intellectual function. Dairy, one of the food groups that is frequently consumed in breakfast, provides calcium that plays a role in the release of neurotransmitters (58). Dairy products also contain tryptophan, a precursor of serotonin and a neurotransmitter involved in psychological processes. Enriched bread and breakfast cereals are good sources of B vitamins, thiamine, and pyridoxine. These vitamins help the processes of attention, synthesis of neurotransmitters, and carbohydrate metabolism (59, 60).

To our knowledge, this is the first study to investigate the association between meal-based dietary patterns and odds of MDD. Another is that the participants in the present study were classified in the case group based on the diagnosis of a confirmed psychiatrist and using DSM-V criteria. Additionally, more accurate results were obtained because dietary intake was evaluated by a qualified dietitian using an age-and-sex matching method and a 24-hour dietary recall. In the present study, we controlled for essential confounders that might have impacted psychological states. Finally, the current study used the 24-hour recall as a short-term diet evaluation method, which provides more accurate information about the types and amounts of food and the time of consumption compared with long-term evaluation methods. However, it is important to take into account a few limitations. Even though we controlled for numerous factors, it is important to consider the potential influence of residual confounding from unspecified or unmeasured variables, such as socioeconomic status. We also encountered difficulties during factor analysis in identifying main dietary patterns, including challenges in grouping foods, determining the number of factors, and assigning names to the

patterns. Certain food groups may not align with any of the identified patterns; thus, it is advisable to interpret the results with caution.

## Conclusion

We found an inverse association between healthy dietary patterns at breakfast meals and odds of MDD. However, no significant relationship was detected between the “oil and egg pattern” and “legumes and condiments pattern” and the odds of MDD. To present more useful dietary guidelines, it would be useful to recommend healthy dietary patterns at breakfast meals. It is recommended to carry out additional research with a larger sample size and prospective design to confirm these findings.

## Authors' Contributions

H.S.H. and S.S.-b. were involved in the conception and design of the research. H.S.H., M.E., and R.A. contributed to the acquisition, analysis, or interpretation of the data. H.S.H. wrote the initial draft of the manuscript, while S.J. and S.S.-b. provided critical revisions. S.J. has agreed to take full responsibility for the integrity and accuracy of the work. All authors reviewed and approved the final version of the manuscript.

## Ethical Considerations

This research was carried out in accordance with the Declaration of Helsinki guidelines. After a detailed presentation of the project, all participants provided their informed consent by signing the necessary documents. The Ethics Committee of Iran University of Medical Sciences approved the study protocol (IR.IUMS.REC.1401.334).

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## Conflict of Interests

The authors declare that they have no competing interests.

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