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Research Article

Association of Adherence to the Adjusted Relative Mediterranean and MIND Diet With Chronic Migraine in Iranian Women

Samaneh Hajjarzadeh,[1,2,3] Farnush Bakhshimoghaddam,[1,2,4] Zeinab Nikniaz,[5] Reza Mahdavi,[6] Davood Shalilahmadi,[7] Majid Karandish,[2,4] and Maryam Behrooz[8]

[1]*Student Research Committee, Ahvaz Jundishapur University of Medical Sciences, Ahvaz, Iran*
[2]*Nutrition and Metabolic Diseases Research Center, Clinical Sciences Research Institute, Ahvaz Jundishapur University of Medical Sciences, Ahvaz, Iran*
[3]*Diabetes Research Center, Health Research Institute, Ahvaz Jundishapur University of Medical Sciences, Ahvaz, Iran*
[4]*Department of Nutrition, School of Allied Medical Sciences, Ahvaz Jundishapur University of Medical Sciences, Ahvaz, Iran*
[5]*Liver and Gastrointestinal Diseases Research Center, Tabriz University of Medical Sciences, Tabriz, Iran*
[6]*Nutrition Research Center, Tabriz University of Medical Sciences, Tabriz, Iran*
[7]*School of Medicine, Ahvaz Jundishapur University of Medical Sciences, Ahvaz, Iran*
[8]*Pediatric Health Research Center, Tabriz University of Medical Sciences, Tabriz, Iran*

Correspondence should be addressed to Majid Karandish; mkarandish@yahoo.com and Maryam Behrooz; mm.behroozp@gmail.com

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Objective: Migraine is a chronic neurological condition affected by multiple factors. There is increasing evidence that healthy diets may be related to migraine management. The present study investigated the association between adherence to the adjusted relative Mediterranean diet (arMED) and the Mediterranean–DASH Intervention for Neurodegenerative Delay (MIND) diet and the risk of chronic migraine (CM) in Iranian women.
Methods: In this study, 285 women with migraine participated. The women were categorized into the CM and episodic migraine (EM) based on their attack frequency per month. Adherence to the Mediterranean and MIND diets was assessed based on last year's dietary intakes collected using a semiquantitative food frequency questionnaire (FFQ). The odds ratio (OR) (95% confidence interval (CI) for CM across the arMED and MIND scores tertiles was assessed through logistic regression.
Results: About 40.7% of the studied sufferers experienced CM. Women with CM had significantly higher fat (p 0.004) and lower fiber (p 0.03) intakes than women with EM. There was a significant negative association between CM and the arMED score ((OR (95% CI)$_{crude}$: 0.91 (0.82–0.99); p value: 0.047)) and (OR (95% CI)$_{adjusted}$: 0.88 (0.80–0.98); p value: 0.018)) and MIND score ((OR (95% CI)$_{crude}$: 0.90 (0.85–0.97); p value: 0.007)) and ((OR (95% CI)$_{adjusted}$: 0.91 (0.85–0.98); p value: 0.03)).
Conclusion: Women who adhered more closely to the Mediterranean and MIND diets had lower chances of experiencing CM.

Keywords: diet; headache; Mediterranean; migraine; MIND; women

1. Introduction

Migraine is one of the most debilitating neurological disorders, characterized by recurrent attacks of moderate to severe headaches lasting 4–72 h [1, 2]. Approximately 12%–18% of adults worldwide suffer from migraine, with women three times more likely to have migraine than men [1]. Migraine can be categorized as episodic (less than 15 attacks

per month) or chronic (15 or more attacks per month), depending on how often they occur [3]. In terms of mechanisms, it is generally recognized that activation of the trigeminovascular system plays a role in migraine induction, which oxidative states and circulating proinflammatory substances may trigger [4].

In addition to medication, it is well known that the long-term control of migraine depends on lifestyle modification in terms of environmental factors and dietary behaviors that trigger headache attacks [5]. The role of nutrients and foods in preventing and treating migraine has been investigated in numerous studies [6, 7]. Recently, the focus of research has shifted to the study of dietary patterns, exploring the interactions and potential synergistic effects between different nutrients or foods [8]. These factors can exert their effect on migraine by regulating neuroreceptors and neuropeptides, modulating the brain's glucose metabolism and the sympathetic nervous system, and the downstream effects of inflammation, nitric oxide release, and, as a result, vasodilation [9].

In this regard, several recent studies have reported the positive effects of healthy and high-quality diets rich in fruits, vegetables, nuts, whole grains, and legumes (such as DASH and Mediterranean diets) on migraine management [10–12]. Recently, the Mediterranean–DASH Intervention for Neurodegenerative Delay (MIND) diet was introduced by Morris et al. [13]. Although the MIND diet shares some of the same food groups as the Mediterranean diet and the DASH diet, it is specifically developed to be neuroprotective [13]. The MIND diet emphasizes natural plant foods with anti-inflammatory and antioxidant properties, which are known to help prevent neurotoxic damage. It also limits eating animal-based and saturated fat-rich foods [13]. Therefore, it can be expected that adhering to these three anti-inflammatory and antioxidant diets is related to migraine management. However, studies in this area are minimal and inconclusive.

In this regard, we aimed to assess the association between following the Mediterranean and MIND diets and the likelihood of developing chronic migraine (CM) in affected Iranian women. It is worth noting that we have previously reported the association between following the DASH diet and migraine in this population [14].

2. Materials and Methods

2.1. Study Design and Participants. The current study is a secondary analysis of data collected between July 2017 and March 2018 for our previous studies evaluating dietary patterns and diet quality in women with migraine [15, 16]. Patients aged 25–55 years who were neither pregnant nor breastfeeding were referred to the neurology clinics of Golestan Hospital in Ahvaz, Iran. All participants were evaluated by a neurologist using ICHD-III criteria [2]. While ICHD-3 criteria specify a 4–72-h duration for typical migraine attacks, we recorded actual patient-reported durations to capture real-world clinical variability. All diagnoses were confirmed by a neurologist, considering the presence of other migraine features (nausea, photophobia, etc.), typical headache characteristics (pulsating quality and unilateral location), and attack frequency patterns. We excluded patients meeting criteria for medication-overuse headache (MOH), those with other primary or secondary headache disorders, and individuals using analgesics > 10 days/month. Also, none of the women recruited had a history of epilepsy, thyroid disease, asthma, or hormonal disorders. All patients read and signed a written consent form, and the study was conducted following the principles outlined in the Declaration of Helsinki. The Ethics Committee of Ahvaz Jundishapur University of Medical Sciences (IR.AJUMS.REC.1402.260) reviewed and approved the study protocol.

2.2. Demographic Characteristics and Migraine Definition. Face-to-face interviews were used to collect participants' demographic and migraine characteristics. All participants were urban residents aged 25–55 years. While we attempted to collect family annual income data, reliable information could not be obtained due to participants' concerns about potential impacts on government subsidies in the Iranian socioeconomic context.

A Visual Analog Scale (VAS) was used as a criterion for the intensity of the pain. Participants reported the frequency of migraines as the number of attacks a month. Women who had 15 or more attacks per month were classified as having CM. If not, they were classified as having episodic migraine (EM) [2]. The International Classification of Headache Disorders, third edition (ICHD-III) criteria for migraine were used to diagnose migraine and aura status by a single neurologist [2] by a single neurologist.

2.3. Anthropometric and Dietary Intake Assessment. A single expert conducted all anthropometric measurements to minimize measurement errors. Weight (kg) was divided by height (m^2) to calculate body mass index (BMI) (kg/m^2). Physical activity was measured using the short form of the International Physical Activity Questionnaire (IPAQ), expressed in metabolic equivalents (MET) per minute per week [17]. The MET data were categorized into three levels of physical activity: low, moderate, and high.

A reliable and validated semiquantitative food frequency questionnaire (FFQ) was used to record participants' usual dietary intake over the past year [18, 19]. The participants reported the frequency of consumption of 147 questionnaire foods on a daily, weekly, monthly, and yearly scale. All the information was converted into values for daily food intake. Portion sizes consumed daily were estimated from household measurements [20]. Based on the grams of food items on the questionnaire, total daily energy, protein, carbohydrate, fiber, and fat intakes were calculated for each participant using Nutritionist IV software.

2.4. The Adjusted Relative Mediterranean Diet (arMED) and MIND Score. Adherence to the arMED and MIND diets was estimated based on participants' FFQs for the previous year. Wine was excluded from the current study due to religious restrictions and a lack of information in the FFQs. Both scores (arMED and MIND) components were assessed in

grams per 1000 kcal to adjust for the effect of daily energy intake.

Following the Mediterranean diet was estimated using an adjusted version of the rMED score, as described by Trichopoulou et al. [21] (arMED score) [22]. The arMED score consists of the eight main components of the Mediterranean diet including six food groups recommended to intake (whole grains, fruits (such as seeds and nuts), vegetables, olive oil, fish (excluding canned fish and products), and legumes) and two food groups recommended to limit (dairy products and meat). To determine the arMED score, the intake of eight food groups in grams per 1000 kcal was divided into tertiles. Women in the lowest tertile of recommended intake received a score of 0, those in the middle tertile received a score of 1 and those in the highest tertile received a score of 2. The exact opposite of this scoring protocol was used in the case of groups recommended for restriction. The scores for all eight dietary components were then added together to produce an overall arMED score, which theoretically ranges from 0 to 16 for each woman.

The MIND score includes 14 dietary components consisting of nine brain-healthy food groups (green leafy vegetables, other vegetables, beans, whole grains, berries, nuts, poultry, fish, and olive oil) and five unhealthy food groups (stick margarine, butter, cheese, red meat, fried/fast food pastries, and sweets) [13]. To determine the MIND score, intakes of 14 food groups were categorized into tertiles of the MIND score, expressed in grams per 1000 kcal. Women in the lowest tertile of brain-healthy food groups received a score of 0, those in the middle tertile received a score of 1 and those in the highest tertile received a score of 2. The exact opposite of this scoring protocol was used for the brain-unhealthy food groups. The scores for all 14 food components were then added together to produce an overall MIND score, which theoretically ranges from 0 to 28 for each subject.

2.5. Statistical Analysis. The association between dietary scores and odds of migraine was assessed using SPSS software (SPSS Inc., Chicago, IL, Version 24). Mean ± standard deviation and median (interquartile range) were used for quantitative variables with normal and non-normal distributions, respectively. Frequencies (percentages) were reported for the qualitative variables. To compare quantitative and qualitative variables between women with chronic and EM, the Mann–Whitney test and chi-square tests (Pearson chi-square and Fisher's exact test) were used. Logistic regression analysis in crude and adjusted models (adjusted for participants age, age of first onset, migraine type, pain duration, pain intensity, family history, marital status, educational level, occupational status, physical activity, and BMI) was used to determine the odds ratio (OR) (95% confidence interval (CI)) for CM between the arMED and MIND scores.

3. Result

We initially recruited 300 women with migraine through neurology clinics. During data cleaning, we excluded 15 participants (5% of the cohort) for incomplete FFQ responses (> 70 unanswered items), inconsistent dietary reporting (energy intake < 500 or > 5000 kcal/day). The final analytical sample consisted of 285 participants with complete and valid data.

Table 1 shows the demographic and migraine characteristics of the participants. The participants with CM were significantly younger than those with EM (34.61 ± 7.81 vs. 37.83 ± 9.30; p value = 0.005). These are shown separately for women with episodic (58.3%) and chronic (41.7%) migraine. Most of the studied women (90.7%) reported migraine without aura. About 32.6% of women with EM experienced headaches that lasted more than 24 h (against 17.6% of women with CM). In terms of occupation status, women with CM (more employed) were significantly different from women with EM. In terms of pain intensity, family history, education, and physical activity, there was no significant difference between the two groups.

The comparison of dietary intakes of women with CM and EM was outlined in Table 2. The EM group reported significantly higher fiber intake ($p = 0.03$) and lower fat intake ($p = 0.004$) than the CM group.

Table 3 compares the arMED score components of women with EM and CM. Only fruit intake ($p = 0.001$) differed significantly between the two groups. The MIND score components for women with EM and CM are compared in Table 4. Women with EM had significantly higher MIND scores than those with CM ($p = 0.02$). Women with EM consumed more green leafy vegetables ($p < 0.001$) and cheese ($p = 0.02$). The consumption of butter and stick groups was significantly higher in women with CM ($p = 0.047$). In women with EM, the total MIND score was significantly higher.

OR (95% CI) for CM across tertiles of arMED and MIND scores are shown in Table 5 and Figure 1. In both crude and adjusted models, there was a significant negative association between CM and the arMED score ($(OR\ (95\%\ CI)_{crude}$: 0.91 (0.82–0.99); p value: 0.047) and ($OR\ (95\%\ CI)_{adjusted}$: 0.88 (0.80–0.98); p value: 0.018)) and MIND score (($OR\ (95\%\ CI)_{crude}$: 0.90 (0.85–0.97); p value: 0.007) and ($OR\ (95\%\ CI)_{adjusted}$: 0.91 (0.85–0.98); p value: 0.03)). Women in the lowest tertile of the arMED and MIND scores were 12% and 9% more likely to have experienced CM, respectively, than women in the highest tertile of the arMED and MIND scores.

4. Discussion

The present study was designed to investigate the association between following Mediterranean and MIND dietary patterns and the odds of developing CM in Iranian women. Higher arMED and MIND scores were associated with lower odds of CM in the current study. The results of this study also showed that women with CM had a significantly higher intake of unhealthy food groups, including total fat, particularly butter and margarine, and a lower intake of healthy food groups, such as fiber, vegetables, and fruit. In other words, a low-quality diet was associated with a higher likelihood of having CM.

Table 1: Comparing demographic and migraine characteristics of participants with CM and EM.

Characteristics	Total $N = 285$	Episodic migraine: 169 (59.3%)	Chronic migraine: 116 (40.7%)	p value
Age (year)	36.52 ± 8.85	37.83 ± 9.30	34.61 ± 7.81	0.005*
Migraine type				
With aura	26 (9.1%)	17 (10.1%)	9 (7.8%)	0.54**
Without aura	259 (90.9%)	152 (89.9%)	107 (92.2%)	
Pain duration				
< 4 h	111 (38.9%)	63 (37.3%)	48 (41.4%)	**0.005****
4–24 h	98 (34.4%)	51 (30.2%)	47 (40.5%)	
25–48 h	32 (11.2%)	27 (16%)	5 (4.3%)	
> 48 h	44 (15.5%)	28 (16.6%)	16 (13.8%)	
Pain intensity (VAS)[&]				
1–3	1 (0.4)	0	1 (0.9%)	0.11***
4–7	126 (44.2%)	81 (47.9%)	45 (38.8%)	
8–10	158 (55.4%)	88 (52.1%)	70 (60.3%)	
Age of migraine onset				
< 10 years old	6 (2.1%)	5 (3%)	1 (0.9%)	0.76***
11–20 years old	36 (12.6%)	23 (13.6%)	13 (11.2%)	
21–30 years old	125 (43.9%)	72 (42.6%)	53 (45.7%)	
31–50 years old	116 (40.7%)	68 (40.2%)	48 (41.4%)	
> 50 years old	2 (0.7%)	1 (0.6%)	1 (0.9)	
Family history				
Yes	116 (30.7%)	64 (37.9%)	52 (44.8%)	0.89***
No	169 (59.3%)	105 (62.1%)	64 (55.2%)	
Marital status				
Not married	65 (22.8%)	65 (80.7%)	30 (25.9%)	0.52***
Married	220 (77.2%)	134 (79.3%)	86 (74.1%)	
Education level				
Lower than high school	156 (54.7%)	90 (53.3%)	66 (56.9%)	0.17**
High school graduated	62 (21.8%)	33 (19.5%)	29 (25%)	
Higher than high school	67 (23.5%)	46 (27.2%)	21 (18.1%)	
Occupation status				
Employed	59 (20.7%)	41 (24.9%)	17 (14.7%)	0.38**
Nonemployed	226 (79.3%0	127 (75.1%)	99 (85.3%)	
Physical activity[#] (Met)				
Low	197 (69.1%)	115 (68%)	82 (70.7%)	0.89*
Moderate	70 (24.6%)	43 (25.4%)	27 (23.3%)	
High	18 (6.3%)	11 (6.5%)	7 (6%)	

Note: Qualitative variables were reported as frequency (percentage). Statistically significant values (p value < 0.05) are highlighted in bold.
Abbreviations: CM; chronic migraine, EM; episodic migraine.
*p value based on the Mann–Whitney test.
**p value based on the Pearson Chi-square.
***p value based on the Fisher's Exact test.
[#]Physical activity based on MET (metabolic equivalent min/week).
[&]Pain intensity based on Visual Analog Scale.

Table 2: Comparing dietary intake of women with CM and EM.

Variables	Total $N = 285$	Episodic migraine: 169 (59.3%)	Chronic migraine: 116 (40.7%)	p value*
Body mass index	27.98 (6.14)	28 (5.70)	27.94 (6.72)	0.44
Energy (kcal/day)	2945.80 (1424.06)	2898.46 (1293.23)	3027.68 (16,329.84)	1
Protein (gr/1000 kcal)	34.03 ± 4.37	34.42 ± 4.22	33.46 ± 6.24	0.06[&]
Carbohydrate (gr/1000 kcal)	138.84 ± 4.07	140.47 ± 13.66	136.47 ± 14.39	0.02[&]
Fiber (gr/1000 kcal)	19.80 (11.07)	20.18 (11.28)	18.60 (8.86)	**0.03**
Total fat (gr/1000 kcal)	37.29 ± 7.77	35.88 (7.17)	38.50 (6.24)	**0.004**
Saturated fat (gr/1000 kcal)	10.57 (3.41)	10.63 (3.29)	10.62 ± 2.41	0.82
Unsaturated fat (gr/1000 kcal)	21.34 (6.23)	20.33 (5.37)	22.44 (7.23)	**< 0.001**

Note: Unnormal and normal distributed variables were reported based on the median (interquartile range) and mean ± standard deviation, respectively. Statistically significant values (p value < 0.05) are highlighted in bold.
Abbreviations: CM; chronic migraine, EM; episodic migraine.
*p values based on the Mann–Whitney test.
[&]p value based on the independent sample T-test.

Table 3: Comparing arMED score components of women with CM and EM.

arMED score components (gr/1000 kcal/day)	Total $N = 285$	Episodic migraine: 169 (59.3%)	Chronic migraine: 116 (40.7%)	p value*
Recommended to intake				
Whole grain	70.22 (124.51)	53.21 (125.66)	75.31 (123.47)	0.23
Fruits (including nuts and seeds)	125.4 (85.45)	132.12 (77.09)	112.42 (90.10)	**0.001**
Vegetables	99.10 (65.7)	100.65 (60.48)	96.86 (73.71)	0.21
Legumes	16.26 (11.93)	16.36 (13.19)	15.67 (11.69)	0.26
Fish	5.79 (9.51)	5.73 (10.36)	5.89 (8.37)	0.38
Olive oil	0 (0.27)	0 (0.21)	0.06 (0.30)	0.09
Recommended to limit				
Meats	19.47 (13.72)	19.80 (13.42)	19.44 (14.28)	0.92
Dairy products	104.42 (83.98)	110.28 (87.70)	102.84 (90.65)	0.31
arMED score (0–16)	8 (3)	7.37 ± 2.48	8 (3.50)	0.07

Note: Unnormal and normal distributed variables were reported based on the median (interquartile range) and mean ± standard deviation, respectively. Statistically significant values (p value < 0.05) are highlighted in bold.
*p values based on the Mann–Whitney test.

Table 4: Comparing MIND score components of women with CM and EM.

MIND score components (gr/1000 kcal/day)	Total $N = 285$	Episodic migraine: 169 (59.3%)	Chronic migraine: 116 (40.7%)	p value*
Brain-healthy food groups				
Whole grain	60.63 (126.24)	42.22 (126.19)	68.65 (124.61)	0.24
Green leafy vegetables	10.44 (9.49)	11.74 (13.09)	8.87 (9.24)	**< 0.001**
Other vegetables	82.83 (57.33)	84.72 (53.24)	81.14 (61.26)	0.65
Nuts	3.69 (4.88)	3.77 (4.84)	3.49 (5.40)	0.91
Berries	4.42 (5.51)	4.47 (5.59)	4.33 (4.88)	0.24
Beans	16.26 (11.93)	16.36 (13.19)	15.67 (11.69)	0.26
Fish	6 (9.74)	6.01 (11.55)	6.14 (8.66)	0.28
Poultry	10.05 (9.36)	10.18 (8.92)	9.53 (9.78)	0.33
Olive oil	0 (0.27)	0.06 (0.3)	0 (0.21)	0.09
Brain-unhealthy food groups				
Red meats	6.24 (6.27)	6.26 (6.48)	6.06 (6.40)	0.55
Butter and stick margarine	2.79 (12.20)	2.38 (9.93)	5.64 (15.25)	**0.047**
Cheese	13.33 (17.22)	13.92 (16.76)	11.35 (17.80)	**0.02**
Pastries and sweets	10.98 (7.20)	11.37 (8.02)	10.69 (7.16)	0.96
Fried/fast food	6.89 (7.76)	6.74 (7.27)	7.32 (8.26)	0.25
MIND score (0–28)	14 (4)	15 (5)	13.56 ± 3.15	**0.02**

Note: Unnormal and normal distributed variables were reported based on the median (interquartile range) and mean ± standard deviation, respectively. MIND: Mediterranean–DASH Intervention for Neurodegenerative Delay. Statistically significant values (p value < 0.05) are highlighted in bold.
Abbreviations: CM; chronic migraine, EM; episodic migraine.
*p values based on the Mann–Whitney test.

Table 5: The odds ratio (95% confidence interval) for CM across the arMED and MIND scores.

Scores	Models	B	OR (95% CI)	p value
arMED score	Crude model	−0.09	0.91 (0.82–0.99)	**0.046**
	Adjusted model*	−0.12	0.89 (0.81–0.98)	**0.029**
MIND score	Crude model	−0.097	0.90 (0.85–0.97)	**0.007**
	Adjusted model*	−0.091	0.91 (0.84–0.98)	**0.026**

Note: ORs and p values based on logistic regression. Statistically significant values (p value < 0.05) are highlighted in bold.
*Adjusted for age, migraine type, pain duration, pain intensity, age of migraine onset, family history, marital status, education level, occupation status, physical activity, and body mass index.

The observed shorter migraine durations (< 4 h) in 37.3% of EM patients may be explained by several biologically and methodologically plausible factors. Early therapeutic intervention likely contributes to abbreviated attack durations in treated populations, while inherent population variability in migraine phenotypes may also play a role. Methodological considerations include our recording of typical rather than maximal attack duration and potential recall biases inherent in self-reported timing data. Cultural influences on symptom reporting may further affect duration estimates. Importantly, these patients met all the diagnostic criteria for migraine, suggesting that the ICHD-3 duration thresholds may need to be adapted for clinical populations where early treatment alters the natural history of attacks. This finding

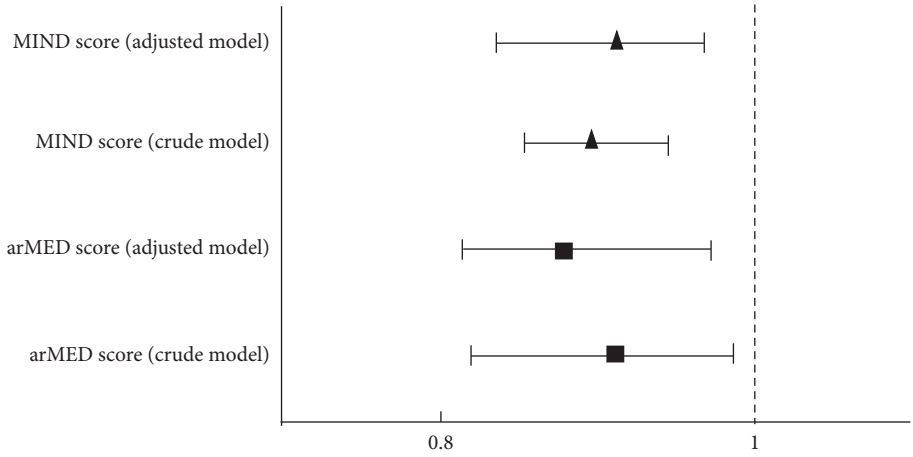

FIGURE 1: The figure presents odds ratios with 95% confidence intervals for the crude and adjusted models of both the MIND diet score and the adjusted relative Mediterranean diet (arMED) score. The reference line at odds ratio = 1 denotes no association.

highlights the importance of diagnostic approaches that consider treatment effects and population-specific manifestations while maintaining diagnostic rigor. The clinical reality of treatment-modified migraine presentations warrants consideration in both research criteria and clinical practice.

There is extensive literature on the contribution of nutrients and foods to migraine [7, 23]. However, the association between dietary patterns and migraine headaches has been studied only to a limited extent [15, 24]. Recently, Hajjarzadeh et al. [15] showed that migraine attack frequency was negatively associated with following a healthy diet high in fish, fruit, legumes, and vegetables and directly related to following a Western diet high in cola, salty foods, nuts, processed meat, and fast food.

The original Mediterranean diet is high in fruit, vegetables, legumes, nuts, whole grains, and olive oil, relatively high in fish and seafood, and moderate in wine [21]. Since alcoholic beverages have been suggested as a trigger for migraine headaches [25] and Iranian food culture is based on religious beliefs that drinking wine is forbidden [26], we calculated the arMED score proposed by Buckland et al. [22] to the assessment of an individual's adherence to the Mediterranean diet.

Our results showed that women who followed the Mediterranean diet were 12% less likely to have CM. In addition, we found that the consumption of fruits, including nuts and seeds, as arMED components was higher in women with EM than with CM. However, the arMED score was not significant between the two types of migraine headaches. In agreement with our results, Arab et al. [10] found that following the Mediterranean diet was associated with inverse clinical outcomes in migraine. Another study by Bakrhan et al. [11] showed that the Mediterranean diet was negatively associated with headache severity in patients with EM.

The MIND diet is a combination of key ingredients from the Mediterranean diet and the DASH diet, modified based on an extensive literature review of nutrition and the aging brain [13]. In a previous study, we found that higher adherence to the DASH diet, which is rich in whole grains, fruits, vegetables, nuts, and legumes, was associated with lower migraine index scores and a decrease in migraine attack frequency in the same study population [14]. Another study also showed that the DASH diet had a protective association with migraine duration in 266 women aged 18–45 [12]. However, the MIND diet has a greater prospective effect against mental disorders than DASH and Mediterranean diets alone, with a higher intake of natural plant foods, especially nuts, berries, green leafy vegetables, omega-3 fatty acids, and olive oil, and limited consumption of saturated fats and red meat [13]. In this study, greater adherence to the MIND diet was associated with a 10% reduction in the odds of experiencing CM. Consistent with our findings, Askarpour et al. [27] showed that a high score on the MIND diet was associated with lower odds of migraine characteristics related to headache intensity, frequency, and duration. The current study also demonstrated that the MIND score was significantly higher in women with EM compared to those with CM. Women with EM consumed significantly more green leafy vegetables and less butter and margarine. Interestingly, cheese consumption is significantly higher in women with EM than in women with CM. It could be attributed that cheese is a common migraine trigger and is believed to increase the intensity and duration of migraine headaches due to the presence of tyramine and histamine [25, 28]. Therefore, participants with CM who experience headaches more frequently may have avoided its consumption.

While FFQ captured 1-year dietary patterns preceding assessment, our study design cannot establish whether dietary changes preceded or resulted from migraine chronification. Notably, while most CM patients (78%) reported gradual increases in frequency, a subset (22%) experienced high-frequency attacks from the onset. Future prospective studies should employ repeated dietary assessments and track the frequency of attacks to clarify temporal relationships. The protective role of the Mediterranean and MIND diets can be attributed to their specific nutrient content and food groups although the underlying mechanisms are not yet fully understood. In conventional medicine, migraine is

believed to be the result of neurogenic inflammation, which excites sensory fibers in the brain even in response to normal stimuli. Several studies examining neuropeptides have confirmed that calcitonin gene-related peptides (CGRPs) are central to migraine as a neuroinflammatory disease [29]. CGRP may be involved in various physiological processes related to migraine, such as the release of inflammatory mediators and cerebral and dural vasodilation. Since anti-CGRP drugs for migraine are highly effective in relieving headaches, blocking the effects of CGRP appears to be a practical clinical approach [30]. Dietary antioxidants and anti-inflammatory substances found in fruits and vegetables, as components of both the Mediterranean and MIND diets, can reduce CGRP expression and decrease neurogenic inflammation implicated in migraine pathophysiology [31]. In addition, vegetable dietary components such as sulforaphane and indole-3-carbinol may inhibit the activation of the CGRP receptor signaling pathway [32]. On the MIND diet, vitamin E in green leafy vegetables, olive oil, nuts, and antioxidants in berries reduce migraines by preventing the brain from the effects of oxidative stress [33]. The Mediterranean diet, on the other hand, is rich in antioxidants and anti-inflammatory compounds, including monounsaturated fats, polyphenols, and omega-3 fatty acids, which have been shown to have beneficial effects on migraine symptoms [21].

Both of the dietary patterns evaluated in the present study have a low glycemic index, which is supposed to be associated with reduced migraine symptoms [34]. Also, it has been shown that migraine sufferers usually have low levels of magnesium in the brain during migraine attacks [35]. Magnesium may play an important role in migraine prevention by blocking N-methyl-D-aspartate (NMDA) receptors, reducing prostacyclin-dependent vasodilation, and preventing serotonin-dependent vasospasm [36]. Therefore, the components of the Mediterranean and MIND dietary patterns, including legumes, vegetables, whole grains, nuts, and seeds, which are rich in magnesium, can play a significant role in migraine headache management [13].

The strict exclusion of MOH cases strengthens our findings by eliminating a major confounding factor in CM studies. While MOH represents a vital transformation pathway from episodic to CM, our results specifically address dietary associations in primary CM unaffected by medication overuse. However, it is important to state some limitations of this study. The data were collected over five years ago (2017–2018); however, the study's conclusions remain relevant as dietary patterns and their associations with migraine are not time-sensitive. Measurement errors and recall bias are also possible due to the use of FFQs; however, we employed a validated version to mitigate these issues. In addition, we were unable to include family income data due to cultural sensitivities surrounding financial disclosure in Iran's subsidy system. While we included the age of migraine onset in our analysis, data on progression time from episodic to CM were not available in the current study. Future longitudinal studies tracking migraine progression would be valuable for understanding how dietary patterns may influence migraine progression over time. Also, the single-time-point assessment cannot determine whether dietary patterns influenced migraine progression or vice versa, highlighting the need for longitudinal designs with serial dietary and headache assessments. In addition, we acknowledge the tension between standardized diagnostic criteria and the complexities of real-world clinical presentations. The distribution of headache duration in our cohort highlights the importance of considering population characteristics when applying international criteria.

5. Conclusion

Our results showed that higher scores on the modified Mediterranean diet and the MIND diet were associated with a reduced likelihood of CM and may help relieve the clinical symptoms of migraine. Further prospective and comparative clinical studies need to confirm the association between these dietary scores and migraine.

Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Conflicts of Interest

The authors declare no conflicts of interest.

Author Contributions

Samaneh Hajjarzadeh, Farnush Bakhshimoghaddam, Davood Shalilahmadi, Reza Mahdavi, and Maryam Behrooz: conceptualization; Reza Mahdavi, Zeinab Nikniaz, and Davood Shalilahmadi: methodology; Samaneh Hajjarzadeh, Zeinab Nikniaz, and Maryam Behrooz: formal analysis; Samaneh Hajjarzadeh, Farnush Bakhshimoghaddam, and Zeinab Nikniaz: investigation; Samaneh Hajjarzadeh and Davood Shalilahmadi: data curation; Samaneh Hajjarzadeh and Farnush Bakhshimoghaddam: writing–original draft preparation; Farnush Bakhshimoghaddam, Majid Karandish, and Reza Mahdavi: writing–review and editing; Maryam Behrooz and Majid Karandish: supervision and project administration; Samaneh Hajjarzadeh: funding acquisition.

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