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The relationship between dietary nutrients patterns and intensity and duration of migraine headaches

Niki Bahrampour[1], Atieh Mirzababaei[2], Habib Yarizadeh[2], Ahmad Mujtaba Barekzai[3], Faezeh Khorsha[2], Cain C. T. Clark[4] and Khadijeh Mirzaei[2]*

[1]*Department of Nutrition, Science and Research Branch, Islamic Azad University (SRBIAU), Tehran, Iran*
[2]*Department of Community Nutrition, School of Nutritional Sciences and Dietetics, Tehran University of Medical Sciences (TUMS), Tehran, Iran*
[3]*Department of Community Nutrition, Ghazanfar Institute of Health Science, Ministry of Public Health, Kabul, Afghanistan*
[4]*Centre for Intelligent Healthcare, Coventry University, Coventry, CV1 5FB, UK*

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Abstract

Migraine is a complicated brain disorder which affects approximately 12 % of the population, whilst the presence of migraine headaches is typically higher in women than men. Several nutrients are posited to improve headache severity. The aim of this study was to investigate the relationship between dietary nutrients patterns and intensity and duration of migraine headaches. This cross-sectional study was conducted with 266 women. Physical activity, general characteristics, anthropometric values and dietary intake were collected. Nutrient patterns were derived using principal component analysis with varimax rotation, and based on the correlation matrix, after completing the 147 item semi-quantitative FFQ, we discerned three nutrients patterns. The validated Migraine Disability Assessment (MIDAS) questionnaire and visual analogue scale (VAS) were used for assessing migraine intensity. Duration of headaches were defined as the hours the participants had headache in 1 d in last month. ANOVA, χ^2 and linear regression tests were used to interrogate the data. Linear regression showed there was a positive relationship between second pattern rich in vitamin B_1, carbohydrate, vitamin B_3, vitamin B_9, protein, and total fibre and VAS and pain duration. Furthermore, there was an inverse relationship between MIDAS and the first nutrient pattern characterised by dietary Ca, vitamin A, vitamin K, vitamin C, vitamin B_6, vitamin B_2, and Mg among women. Furthermore, there was a positive significant association between vitamin D and B_{12} (pattern 3) and headache duration. Dietary nutrients patterns should be monitored closely in individuals suffering with migraine.

Key words: Migraine: Dietary nutrients pattern: Migraine disability assessment questionnaire: Visual analogue scale: Headache

Migraine is a complicated brain disorder, defined as a moderate to severe headache[1] that can affect approximately 12 % of population, and is more prevalent in women (> 20 %) than men (> 10 %)[2,3]. Migraines can influence hypothalamus, cortical, diencephalic and brainstem nuclei of the brain[4], whilst nausea, vertigo, nasal congestion, photophobia, noises and smells, lack of appetite, and gastrointestinal disorders are other symptoms that patients with migraine headache also often report[2]. In some cases, headache will cease after sleeping[5], although lethargy may be present for a prolonged period after headache cessation[6]. There are numerous reasons for the pathology of migraine disease, for example, a disorder of endogenous pain modulating system, sensitivity to hemostasis alteration and vascular changes[7,8]. Although migraine may originate from hereditary causes, various other internal and external conditions, such as daily diet, certain foods, alcohol, hormonal fluctuations, stressful situations and lifestyle, may affect the intensity and duration of migraine[2–5]. The presence of migraine headaches is typically greater in women than men, where the hypothalamic–hypophyseal–ovarian axis, that regulates oestrogen secretion, could be impacting on cortical excitability or vascular dilation [9].

The role of diet on migraine headaches, although of contemporary interest, is not well understood. It has been shown that foods that containing tyramine should be eliminated, whilst some vitamins and minerals, such as Mg, B_2, and Q10, have been advocated for improving, and recovering from, headache duration and intensity[10]. Different types of diet, for example, a Western-based diet, may contribute to increased weight gain; consequently, this can affect migraine pathology (nitric oxide

Abbreviations: MIDAS, Migraine Disability Assessment; VAS, visual analogue scale.

* **Corresponding author:** Khadijeh Mirzaei, email mirzaei_kh@tums.ac.ir

(NO), adiponectin and leptin), both directly and indirectly[11]. Lower consumption of B_9 and B_{12} is associated with methylene tetrahydrofolate reductase (MTHFR) gene mutation[12] and the occurrence of hyperhomocysteinemia, which may worsen the intensity of migraine[13]. In addition, vitamin D deficiency has been reported to increase the duration of migraine headaches[14]. Many studies have suggested that an inverse relationship exists between dietary Na and high glycemic carbohydrate and migraine[15,16]. Whilst, via prostaglandin reduction, vitamin E consumption has been reported to positively influence migraines[17]. Moreover, in Shu-Han Meng *et al.*, it was reported that higher intake of Ca and Mg may be inversely associated with migraine in women[18].

Nutrient patterns can provide a prospective view between total food intake and disease, where consideration is given to the impact of all dietary nutrients. In addition, studying dietary and nutrient patterns can also encompass both the food synergy and nutrients interactions[19]. However, many studies have paid attention to the role of specific foods on migraine, whilst few studies, to our knowledge, have explored the impact of dietary patterns on migraine. Therefore, the aim of present study is to investigate the relationship between dietary nutrients patterns and intensity and duration of migraine headaches.

Methods

Study population

This was a cross-sectional study, conducted on 266 women, in March 2016. The participants were diagnosed with migraine and referred to neurology clinics of Sina and Khatam Al-Anbia Hospitals and a professional headache clinic in Tehran, Iran. Inclusion criteria were as follows: 18–50 years of age, BMI between 18·5–30 kg/m^2, and visiting the headache clinic for the first time. Having any chronic diseases (CVD, cancer, diabetes, etc) and taking any medicines that can effect on serum lipoprotein concentrations, including atorvastatin and lovastatin, were excluded.

Demographic characteristics

General characteristics, including age, education status, job and marital status, were collected using a demographic questionnaire. The International Physical Activity Questionnaire (IPAQ) was used to assess physical activity and reported as metabolic equivalent (MET) hours per week (MET-h/week)[20].

Anthropometric measurements

Weight was measured, to the nearest 0·1 kg, with participants unshod and wearing light clothing, using a digital scale (SECA). Height was measured, to the nearest 0·5 cm, with participants unshod and wearing light clothing, using a wall-mounted stadiometer. BMI was calculated. The waist circumference (WC) was measured at the midpoint of the lowest rib and the hip bone. Also, hip circumference was measured using a flexible tape at the largest anterior protrusion. The ratio of waist-to-hip ratio (WHR) was calculated by dividing WC (cm)/height (cm).

Dietary assessment and nutrient dietary patterns

Dietary intake was evaluated using a 147-item semi-quantitative FFQ, considering the past year, via face-to-face interview. The reliability and validity of FFQ have previously been approved in Iran[21]. Data were analysed by Nutritionist-IV software, and portion sizes were converted to grams. Dietary macronutrients (protein, carbohydrate and fibre), vitamins (A,D,K,B_1,B_2,B_3,B_6, B_9,B_{12} andC) and minerals (Ca and Mg) were computed from total intake. Individuals with daily energy intakes lower than 500 kcal or more than 3500 kcal were excluded from the study[22].

Migraine diagnosis

Headaches/migraine were categorised according to the International Classification of Headache Disorders (ICHD–III) criteria[23] (beta version) (3–15 migraine days per month for at least 3 months). The validated Migraine Disability Assessment (MIDAS) questionnaire and visual analogue scale (VAS) were used for assessing migraine intensity [24–26]. MIDAS has five questions to evaluate the intensity of headaches over the last 3 months, where the questionnaire evaluates the drop in performance caused by migraine. As a result, the patients are divided into four groups: 0–5 (MIDAS Grade I, Little or no disability), 6–10 (MIDAS Grade II, Mild disability), 11–20 (MIDAS Grade III, Moderate disability) or 21+ (MIDAS Grade IV, Severe disability). In addition, the VAS was depicted as a 10-point scale, ranging from: mild pain [1–3], moderate pain (score 4–7) and severe pain (score 8–10). Also, the duration of the migraine headaches was discerned. Duration of headaches were defined as the hours the participants had headache in 1 d in the last month.

Statistical analyses

Data analyses were conducted using SPSS (version 20.0; SPSS Inc.). The normality of variables was assessed using Kolmogorov–Smirnov test. Nutrient patterns were derived using principal component analysis with varimax rotation and based on the correlation matrix. Fifteen nutrients were selected for factor analysis, including vitamin D, vitamin A, vitamin K, vitamin C, vitamin B_6, vitamin B_2, vitamin B_1, vitamin B_3, vitamin B_9, vitamin B_{12}, carbohydrate, protein, total fibre, Mg and Ca. Factor scores for all participants for each of the extracted factors were calculated by summing the frequency of consumption, multiplied by factor loadings across nutrients. Accordingly, three patterns were extracted. The first nutrient pattern consisted of Ca, vitamin A, vitamin K, vitamin C, vitamin B_6, vitamin B_2 and Mg. The second nutrient pattern included vitamin B_1, carbohydrate, vitamin B_3, vitamin B_9, protein and total fibre. The third tertile included vitamin D and vitamin B_{12} based on scree plot (eigenvalue > 1) evaluation. We categorised them into tertiles. The χ^2 test was used to assess the association between the tertiles

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of nutrient patterns and qualitative variables. In addition, one-way ANOVA was used to assess the association between the tertiles of nutrient patterns and quantitative variables. Linear regression was also applied, in crude and adjusted models (model 1: crude model; model 2: (adjusted for age); model 3: (adjusted for age, physical activity, BMI); model 4: (adjusted for model 3+ education, marital status, job)). $P < 0{\cdot}05$ was, *a priori*, considered to represent statistical significance. Moreover, positive beta values indicated that higher adherence of nutrient patterns increase the changes in the dependent variables and *vice versa*.

Results

Study population

The baseline characteristics of the participants among tertiles of nutrient patterns are shown in Table 1. Quantitative and qualitative variables across nutrient patterns tertiles did not show any significant differences.

Dietary nutrient pattern among food groups and nutrients intake

Food groups and nutrient intakes across tertiles of nutrient patterns are shown in Table 2. Vitamin A, K, C, B_6, B_2, B_9, total fibre, Mg and Ca intakes increased across tertiles of first nutrient pattern ($P < 0{\cdot}05$). Vitamin B_1, D, B_{12} and carbohydrate intakes decreased across tertiles of first nutrient pattern ($P < 0{\cdot}05$). Vitamin B_6, B_2, B_1, B_3, B_9, B_{12}, carbohydrate, protein, total fibre and Mg intakes increased across tertiles of second nutrient pattern ($P < 0{\cdot}05$). Vitamin D, B_3, B_{12}, carbohydrate and protein intakes increased across tertiles of last nutrient pattern ($P < 0{\cdot}05$). Vitamin K, C, B_9, total fibre and Ca intakes decreased across tertiles of last nutrient pattern ($P < 0{\cdot}05$). Three dominant patterns were ascertained (Table 3), which explained a large proportion of the variance. The first nutrient pattern consisted of Ca, vitamin A, vitamin K, vitamin C, vitamin B_6, vitamin B_2 and Mg. The second nutrient pattern included vitamin B_1, carbohydrate, vitamin B_3, vitamin B_9, protein and total fibre. The third tertile included vitamin D and vitamin B_{12}.

Nutrient patterns and intensity and duration of migraine headaches

The association between nutrient patterns and MIDAS and VAS among women is demonstrated in crude and adjusted models in Table 4, 5 and 6. There was a significant positive relationship between the second pattern and VAS in the crude model (β 0·27; 95 % CI 0·00, 0·53; *P*-value = 0·05), which remained significant in model 4, which was adjusted for all confounders (β 0·37; 95 % CI 0·13, 0·61; *P*-value =< 0·001). In addition, there was an inverse relationship between MIDAS and the first nutrient pattern (β –2·80; 95 % CI –5·20, –0·41; *P*-value = 0·02), which remained in model 4 (β –3·14; 95 % CI –5·47, –0·81; *P*-value = 0·01). Duration of headaches were positively related with second and third pattern. This remained after adjusting for confounders in all four models. The present study did not show any statistically significant association between other nutrient patterns and VAS and MIDAS and pain duration.

Discussion

In the current cross-sectional study, there was a significant relationship between the second identified dietary pattern (vitamin B_1, carbohydrate, vitamin B_3, vitamin B_9, protein and total fibre) and VAS, which is used for pain intensity and headache duration. Furthermore, there was a negative relationship between MIDAS, which is used for migraine disability, and the first identified nutrient pattern (Ca, vitamin A, vitamin K, vitamin C, vitamin B_6, vitamin B_2 and Mg) among women. Furthermore, there we found a significant positive association between vitamin D and B_{12} (pattern 3) and headache duration.

Several factors may contribute to the incidence of migraine including family history[27], age[28], obesity[29], sex hormonal change[30], vascular changes[31], neurotransmitters[32], low socio-economic status[33], head injury[34], alcohol[35], stressful situations and dietary intakes[31,36]. Dietary nutrients intakes also have long-standing association with the risk of migraine in both sexes, but especially in women[37]. For instance, although of contemporary practical interest, a paucity of studies have evaluated the association between the dietary intake and migraine. Of the available literature, the findings are often contradictory; some cross-sectional studies have demonstrated that high intake of chocolate, caffeine, milk, cheese and alcoholic beverages can increase the risk of migraine[38–41]. But in our study, we found that Ca intake (rich in milk and cheese) was negatively related with migraine disability. Ca and Mg, together, can used for the development of many neurotransmitters and inflammatory mediators. These two minerals can be helpful for the nervous system function and reduce nerve tension[42]. Adding to the equivocal findings in the literature, the National Health and Nutrition Examination Surveys (NHANES) of America revealed that high dietary intake of Ca and Mg were inversely associated with migraine in women[42]. A cross-sectional study also revealed that the Dietary approaches to Stop Hypertension (DASH) adherence, which is rich in Mg and Ca, may be associated with lower headache severity and duration in migraine among female patients[43]. Furthermore, a systematic literature review revealed that high intake of nuts, citrus fruits, processed meats, monosodium glutamate, aspartame and fatty foods can contribute to migraine[44]. In line with the aforementioned study, higher consumption of protein (animal- and plant-based) and carbohydrate (simple and complex) may contribute to more headache intensity. A cross-sectional study revealed that high intakes of red meat increases the risk of migraine[45], whilst, in addition, several studies have reported that high carbohydrates intake causes the migraine among adult population due to insulin level changes and neuronal excitability[15,44,46,47]. Total fibre intake, which is high in fruits and vegetables (pattern 2), was positively associated with migraine. Similarly, Silva-Néto *et al.* found that many plant foods, which are high fibre, can be related with migraine headaches[48]. However, contrary with this study, contemporary research has highlighted that

Table 1. General characteristics of participants across tertiles of nutrient patterns scores

Variables		First nutrient pattern							Second nutrient pattern							Third nutrient pattern						
		T1		T2		T3		*P*	T1		T2		T3		*P*	T1		T2		T3		*P*
		Mean	SD	Mean	SD	Mean	SD		Mean	SD	Mean	SD	Mean	SD		Mean	SD	Mean	SD	Mean	SD	
Age (years)		33·63	8·29	34·53	7·35	34·79	7·97	0·58	34·19	8·24	34·66	7·69	34·09	7·72	0·88	35·23	7·56	33·85	7·66	33·88	8·35	0·41
Weight (kg)		68·44	14·11	68·29	13·16	81·96	99·00	0·20	80·80	99·89	69·32	12·67	68·70	13·37	0·30	69·50	12·91	80·71	99·33	68·48	13·12	0·30
BMI (kg/m^2)		26·15	5·37	25·91	4·93	27·45	4·27	0·07	26·92	4·94	26·42	4·43	26·17	5·34	0·59	26·59	5·16	26·72	4·92	26·20	4·67	0·77
WC (cm)		85·45	16·92	86·29	12·38	86·54	11·48	0·86	84·47	15·44	86·55	12·04	87·25	13·56	0·38	86·21	12·96	86·27	15·73	85·80	12·55	0·97
HC (cm)		104·68	15·61	104·25	11·69	101·21	15·48	0·22	100·96	15·55	103·84	10·74	105·32	16·07	0·13	102·32	15·38	103·67	13·04	104·15	14·80	0·69
WHR		0·88	0·70	0·83	0·07	0·93	0·75	0·53	0·90	0·70	0·83	0·07	0·90	0·75	0·70	0·90	0·70	0·83	0·11	0·90	0·75	0·70
PA (MET/min/week)		366·91	629·05	390·78	466·05	460·61	447·48	0·46	465·06	654·38	350·27	402·55	404·07	470·55	0·34	449·85	443·69	373·59	379·80	395·80	686·64	0·61
MIDAS score		27·74	25·85	21·74	16·37	21·53	15·36	0·06	20·89	16·05	25·56	21·59	24·48	21·37	0·26	22·70	16·35	21·99	17·03	26·26	24·99	0·31
VAS score		6·63	2·30	6·51	2·07	6·61	2·27	0·92	6·16	2·45	6·65	1·96	6·92	2·14	0·07	6·67	2·19	6·44	2·37	6·63	2·07	0·76
Pain duration		10·87	13·09	9·65	10·89	10·79	11·11	0·74	8·59	7·98	10·08	9·00	12·62	16·13	0·06	8·68	8·15	10·68	12·26	11·94	13·82	0·17
		n	%	*n*	%	*n*	%		*n*	%	*n*	%	*n*	%		*n*	%	*n*	%	*n*	%	
Education	Primary education	9	30	9	30	12	40	0·66	13	43·3	6	20	11	36·6	0·29	11	36·6	10	33·3	9	30	0·64
	Intermediate Education	6	40	5	33·3	4	26·6		3	20	8	53·3	4	26·6		6	40	4	26·6	5	33·3	
	Diploma	17	28·8	18	30.5	24	40·6		27	45·7	17	28·8	15	25·4		16	27·1	18	30·5	25	42·37	
	12 postgraduate education	10	43·4	5	21·7	8	34·7		8	36·3	6	27·2	8	36·3		8	36·3	10	45·4	4	18·1	
	Bachelor's degree	24	30·3	27	34·1	28	35·4		21	26·5	27	34·1	31	39·2		30	37·9	28	35·44	21	37·9	
	Student	8	33·3	9	37·5	7	29·1		8	32	11	44	6	24		7	29·1	8	33·3	9	37·5	
	MSc degree	13	39·3	15	45·4	5	15·5		9	27·2	13	39·3	11	33·3		9	27·2	9	27·2	15	45·4	
	PhD degree	2	66·7	0	0	1	33·3		0	0	1	33·3	2	66·6		2	50	2	50	0	0	
Job	Housekeeper	47	34·5	42	30·8	47	34·5	0·26	48	35·2	43	31·6	45	33	0·25	48	35·2	42	30·8	46	33·8	0·31
	Labour	1	100	0	0	0	0		1	1	0	0	0	0		1	100	0	0	0	0	
	Management employee	18	24	26	34·6	31	41·3		6	28·5	3	14·2	12	57·1		10	47·6	4	19	7	33·3	
	Non-managerial employee	8	38	9	42·8	4	19		23	30·2	27	35·5	25	32·8		20	26·6	30	40	25	33·3	
	No job	4	66·6	1	16·7	1	16·7		8	29·6	13	48·1	6	22·2		6	22.2	10	37	11	40·7	
	University student	10	37	11	40·7	6	22·2		2	33·3	3	50	1	16·6		3	50	3	50	0	0	
Marriage	Married	58	30·8	62	32·9	68	36·1	0·22	65	34·5	62	32·9	61	32·4	0·38	64	34	57	30·3	67	35·6	0·43
	Single	27	36·4	27	36·4	20	27		22	29·7	27	36·4	25	33·7		22	29·7	31	41·8	21	28·3	
	Divorce	3	75	0	0	1	25		1	25	0	0	3	75		2	50	1	25	1	25	

WC, waist circumference; HC, hip circumference; WHR, waist-to-hip ratio; PA, physical activity; MET, metabolic equivalents; MIDAS, Migraine Disability Assessment; VAS, visual analogue scale.
P-values were obtained from ANOVA test and χ^2 test. Qualitative variables were showed by number (percentage).
P-values resulted from one-way ANOVA analysis. Quantitative variables were showed by means ± SD. *P*-value < 0·05 was significant.

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Table 2. Total intakes across tertiles of nutrient patterns scores

Variables	First nutrient pattern							Second nutrient pattern							Third nutrient pattern						
	T1		T2		T3		P	T1		T2		T3		P	T1		T2		T3		P
	Mean	SD	Mean	SD	Mean	SD		Mean	SD	Mean	SD	Mean	SD		Mean	SD	Mean	SD	Mean	SD	
Vitamin D (μg/d)	1·90	1·15	2·25	1·08	1·71	0·77	< 0·001	1·81	1·11	2·01	1·02	2·01	1·01	0·17	0·92	0·54	2·06	0·59	2·87	0·81	< 0·001
Vitamin A (RAE)	508·19	138·57	628·16	134·09	1000·21	340·67	< 0·001	706·71	242·42	727·0	288·82	705·0	379·33	0·87	656·83	325·90	766·10	291·81	715·31	299·17	0·06
Vitamin K (μg/d)	144·49	110·79	307·01	165·51	908·60	435·32	< 0·001	503·0	356·91	493·5	505·3	367·6	403·59	0·06	537·89	436·06	548·79	457·97	277·83	332·33	< 0·001
Vitamin C (mg/d)	79·54	27·30	113·96	33·61	220·85	101·01	< 0·001	136·78	59·91	132·38	69·2	145·80	120·8	0·58	141·82	76·05	152·56	72·80	120·66	107·07	0·05
Vitamin B_6 (mg/d)	1·61	0·38	1·82	0·28	2·25	0·47	< 0·001	1·70	0·42	1·89	0·4	2·1	0·5	< 0·001	1·87	0·48	1·90	0·43	1·92	0·48	0·78
Vitamin B_2 (mg/d)	1·59	0·36	1·90	0·32	2·26	0·50	< 0·001	1·70	0·44	1·90	0·41	2·12	0·51	< 0·001	1·74	0·50	2·02	0·43	1·99	0·48	< 0·001
Vitamin B_1 (mg/d)	1·81	0·56	1·77	0·53	1·53	0·43	< 0·001	1·30	0·2	1·61	0·2	2·28	0·5	< 0·001	1·75	0·66	1·64	0·48	1·72	0·40	0·37
Vitamin B_3 (mg/d)	22·67	6·10	22·69	5·33	22·65	5·91	1·00	17·90	3·7	21·9	2·9	28·1	5·0	< 0·001	21·88	6·07	21·05	5·29	25·08	5·15	< 0·001
Vitamin B_9 (μg/d)	514·46	147·28	511·30	102·05	560·11	131·70	0·02	429·21	72·9	523·91	80·8	631·78	135·1	< 0·001	564·11	150·83	535·50	99·75	486·81	123·26	< 0·001
Vitamin B_{12} (μg/d)	3·61	1·45	3·91	1·42	3·21	1·28	< 0·001	3·20	1·26	3·66	1·35	3·84	1·53	< 0·001	2·20	0·57	3·38	0·71	5·11	0·89	< 0·001
Carbohydrate (g/d)	308·27	66·41	301·79	64·32	267·81	67·90	< 0·001	228·73	29·1	283·6	34·4	364·61	51·3	< 0·001	280·64	73·69	282·65	56·45	314·26	69·19	< 0·001
Protein (g/d)	77·58	15·12	80·09	15·02	80·20	17·68	0·47	66·43	9·9	78·0	8·0	93·32	15·4	< 0·001	73·32	15·41	76·11	14·14	88·39	14·30	< 0·001
Total fibre (g/d)	35·74	15·27	34·79	11·37	46·60	14·44	< 0·001	30·51	8·0	38·41	12·0	48·11	17·1	< 0·001	44·51	14·65	40·65	13·21	32·06	13·67	< 0·001
Mg (mg/d)	344·29	79·96	391·44	101·35	461·96	130·47	< 0·001	336·61	60·50	380·60	80·8	480·42	140·0	< 0·001	406·79	113·74	398·97	110·95	392·64	124·39	0·72
Ca (mg)	888·58	210·24	1165·45	209·04	1743·54	454·43	< 0·001	1230·60	426·01	1285·41	518·0	1285·39	476·91	0·68	1265·70	482·68	1412·66	481·46	1123·45	415·66	< 0·001

RAE, retinol activity equivalents.
P-values were obtained from ANOVA test. Data are presented as mean ± standard deviation.

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Table 3. Principal factor loading of nutrients intake

Nutrients	Pattern 1	Pattern 2	Pattern 3
Ca (mg)	0·91		
Vitamin A (RAE)	0·90		
Vitamin K (μg/d)	0·90		
Vitamin C (mg/d)	0·85		
Vitamin B_6 (mg/d)	0·78		
Vitamin B_2 (mg/d)	0·77		
Mg (mg/d)	0·65		
Vitamin B_1 (mg/d)		0·96	
Carbohydrate (g/d)		0·88	
Vitamin B_3 (mg/d)		0·85	
Vitamin B_9 (μg/d)		0·80	
Protein (g/d)		0·79	
Total fibre (g/d)		0·65	
Vitamin B_{12} (μg/d)			0·91
Vitamin D (μg/d)			0·86
Percent of variance explained	49·88	22·06	12·72

RAE, retinol activity equivalents.
Factor loadings of < 0·5 have been removed to simplify the table. Extraction method: principal component analysis. Rotation method: Varimax with Kaiser Normalization. a. Rotation converged in four iterations.

Table 4. Association of nutrient pattern and VAS among subjects with migraine

		VAS*		
		β	95 % CI	*P*
Pattern 1	*M1*	-0·14	-0·40, 0·13	0·32
	M2	-0·16	-0·43, 0·10	0·22
	M3	-0·17	-0·40, 0·06	0·15
	M4	-0·19	-0·43, 0·05	0·11
Pattern 2	*M1*	0·27	0·00, 0·53	0·05
	M2	0·29	0·03, 0·55	0·03
	M3	0·34	0·11, 0·57	< 0·001
	M4	0·37	0·13, 0·61	< 0·001
Pattern 3	*M1*	0·04	-0·23, 0·30	0·78
	M2	0·05	-0·21, 0·31	0·70
	M3	0·03	-0·20, 0·26	0·81
	M4	0·04	-0·20, 0·28	0·73

PA, physical activity.
* Linear regression; VAS, visual analogue scale; M1, (crud); M2, (adjusted for age); M3, (adjusted for age, PA, BMI); M4, (adjusted for M3+ education, marital status, job).

Table 5. Association of nutrient pattern and MIDAS among subjects with migraine

		MIDAS*		
		β	95 % CI	*P*
Pattern 1	*M1*	-2·808	-5·20, −0·41	0·02
	M2	-2·837	-5·24, −0·43	0·02
	M3	-2·86	-5·15, −0·57	0·01
	M4	-3·14	-5·47, −0·81	0·01
Pattern 2	*M1*	-0·04	-2·46, 2·39	0·98
	M2	-0·02	-2·45, 2·41	0·99
	M3	0·24	-2·08, 2·57	0·84
	M4	0·44	-1·93, 2·82	0·71
Pattern 3	*M1*	1·54	-0·87, 3·95	0·21
	M2	1·55	-0·86, 3·97	0·21
	M3	1·40	-0·91, 3·70	0·23
	M4	1·77	-0·61, 4·14	0·14

PA, physical activity.
* Linear regression; MIDAS, Migraine Disability Assessment; M1, (crud); M2, (adjusted for age); M3, (adjusted for age, PA and BMI); M4, (adjusted for M3+ education, marital status and job).

Table 6. Association of nutrient patterns and headache duration among subjects with migraine

		Pain duration*		
		β	95 % CI	*P*
Pattern 1	*M1*	-0·25	-1·68, 1·17	0·72
	M2	-0·29	-1·17, 1·14	0·69
	M3	-0·25	-1·66, 1·16	0·72
	M4	-0·24	-1·67, 1·18	0·73
Pattern 2	*M1*	1·53	0·12, 2·95	0·03
	M2	1·57	0·15, 2·99	0·03
	M3	1·62	0·22, 3·02	0·02
	M4	1·61	0·19, 3·04	0·02
Pattern 3	*M1*	1·93	0·52, 3·33	0·007
	M2	1·95	0·54, 3·35	0·007
	M3	1·87	0·48, 3·26	0·008
	M4	1·89	0·49, 3·29	0·008

PA, physical activity.
* Linear regression; M1, (crud); M2, (adjusted for age); M3, (adjusted for age, PA and BMI); M4, (adjusted for M3+ education, marital status, job).

Mediterranean-based diet (rich in vitamin K and C and Mg) adherence was not associated with the risk of migraine[49,50]. Indeed, our study reinforces the idea that vitamin K may be related with arterial stiffness[51] and vitamin C may act as a prophylactic agent[17].

In the current study, there was a positive association between higher consumption of vitamin B_{12}, B_9, and D and duration of migraine headaches. However, total intake of vitamin D was less than the recommended reference intake (RDA), which is 10–20 mcg among participants[52]. Rich sources of vitamin D are meat, fish and egg yolk. Red meat may aggregate migraine headaches via tyramine content[41]. Further, vitamin D deficiency has been reported to increase the duration of migraine headaches[14], whilst a cross-sectional study demonstrated that lower consumption of B_9 and B_{12} are associated with increasing the risk of migraine through MTHFR gene mutation[17,53]. The main source of vitamin B_{12} in this population is animal-based proteins, which have been reported to have a positive relationship with migraine headaches. Moreover, a case–control study demonstrated that lower dietary intake of folate was not associated with the risk of migraine[54]. Several studies have reported that supplementation with pyridoxine and folate, not only, reduces the homocysteine levels but also improves the migraine symptoms[55,56]. Concordant with our study, many studies revealed that lower intake of vitamin B_6 and B_2 is associated with the risk of migraine[57]. Indeed, we found that consumption of foods high in Ca, Mg, vitamin B_2, C, B_6 and A may reduce the headaches in migraine patients.

To the best of our knowledge, this is the first study to have investigated the relationship between dietary nutrients patterns and intensity and duration of migraine headaches among women in Iran, and very few studies have been conducted pertaining to dietary patterns and migraine[58]. The present study outcomes confirm the importance of identification of triggers for the management of patients with migraine disorder and emphasises the consumption or avoidance of specific dietary

British Journal of Nutrition

nutrient patterns. This study can help to guide and inform insight into the relationship between nutrients and migraine. However, despite the novel addition to the literature, there were some limitations that warrant consideration. Although the cross-sectional design of the study can show us the relationships between outcome and exposure, the present study design precludes causal inferences being drawn between dietary nutrients patterns and intensity and duration of migraine headaches. In addition, factor analysis (varimax method) was used to identify patterns, and limitations of this method may be responsible for bias in our study. The number of derived factors is optional, and it depends on the decisions of the researchers. Clearly, further prospective longitudinal studies are needed to more firmly establish the impact of, and association between, dietary nutrient patterns and migraine occurrence, severity and duration, respectively.

Conclusion

Our study found a significant relationship between the second identified dietary pattern, which included vitamin B_1, carbohydrate, vitamin B_3, vitamin B_9, protein, and total fibre and VAS and pain duration. Furthermore, we found a relationship between MIDAS and the first nutrient pattern, characterised by Ca, vitamin A, vitamin K, vitamin C, vitamin B_6, vitamin B_2 and Mg, among women. Additionally, there was a significant association between the third nutrient pattern (vitamin D and B_{12}) and pain duration. Overall, this research demonstrates that dietary nutrients patterns should be monitored closely in individuals suffering with migraine.

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K.M. and N.B. conceptualised the study. F.K. gathered the data of study. N.B. wrote the first draft of the manuscript and revised the manuscript. H.Y. did the statistical analyses. A.M.B. wrote the first draft of discussion section. A.M. and K.M. were checked the manuscript. C.C.T.C. and N.B. reviewed and edited the paper. All authors read and approved the final version of the manuscript.

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