Dietary aspects of migraine trigger factors

Fernanda C Rockett, Vanessa R de Oliveira, Kamila Castro, Márcia LF Chaves, Alexandre da S Perla, and Ingrid DS Perry

The significance of dietary factors as triggers for migraines is controversial, and the assessment of this topic is complex and inconclusive. In order to evaluate the published evidence on dietary triggers, a critical review of the literature was performed by conducting a search for food item descriptors linked to migraines in the PubMed and SciELO databases. Reviews and relevant references cited within the articles that resulted from the search were also included. Of the 45 studies reviewed, 16 were population studies that involved the association between migraines and eating habits or the prevalence of related dietary factors; 12 involved interventions or analyzed observational prospective cohorts; and 17 were retrospective studies. Approximately 30 dietary triggers were explored in total, although only seven of these were addressed experimentally. In the prospective studies, patients were instructed to keep a diary; two of these studies involved dietary interventions. Conclusions that are based on nonpharmacological prophylactic strategies with a scientific basis and that show an association between certain dietary factors and the triggering of migraines are limited by the lack of prospective studies with clear experimental designs. Nevertheless, the high frequency of possible specific dietary triggers validates efforts to elucidate the involvement of food-related factors in precipitating migraines.

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INTRODUCTION

Migraine, as one type of primary headache, is a clinical syndrome characterized by headaches with specific features and associated symptoms. Typical characteristics are recurrent headache disorder manifesting as an attack of moderate or severe intensity lasting 4–72 hours and having a unilateral location and pulsating quality; it is aggravated by routine physical activity and is associated with nausea and/or photophobia and phonophobia. It can be divided into two major subtypes: migraine without aura and migraine with aura (primarily characterized by the focal neurological symptoms that usually precede or sometimes accompany the headache). Migraines are considered a neurological disorder with a high frequency and significant personal and socioeconomic impact, and migraines affect more women than men in the adult population. Males show an earlier onset of migraine, which is more common in prepubescent boys than girls. Racial differences have also been described, with a higher prevalence among Caucasian Americans and a lower prevalence among Asian Americans.

Trigger factors of migraines (also referred to as triggering factors or precipitating factors) are defined as...
factors that, in isolation or in combination with other factors, induce a crisis in susceptible individuals\textsuperscript{8} and generally precede a crisis by less than 48 hours.\textsuperscript{7} Many of these factors have been reported, such as those related to food, hormones, and the environment, with stress being one of the most common.\textsuperscript{8,9} These factors are primarily based on retrospective reports from patients, though some researchers have used a prospective methodology with self-monitoring and recording of factors and occurrence of crises, and others have explored particular aspects experimentally.\textsuperscript{7,10,11} Despite this, there is little evidence to conclusively correlate the majority of these factors with the initiation of a crisis.\textsuperscript{12} The role of perceived dietary trigger factors is especially controversial and difficult to evaluate.\textsuperscript{10}

Given the importance of accurately recognizing dietary trigger factors in the prophylactic management of patients with migraines,\textsuperscript{13} this review seeks to evaluate evidence in the literature that substantiates the existence of such factors. For decades, the traditional management of migraines has consisted of the identification and elimination of triggering environmental factors.\textsuperscript{14,15} In addition, as proposed more recently, there has been a paradigm shift\textsuperscript{7} in management that advocates controlled exposure to and confrontation of the factor, except in cases where this would be inappropriate.

**SEARCH METHODOLOGY AND CATEGORIZATION OF THE LITERATURE**

Three general strategies were used to identify relevant studies for this review. First, PubMed and SciELO (Scientific Electronic Library Online) – the electronic library of Brazilian scientific journals – databases were searched from 1980 to 2010 for descriptors (dietary factors, food, food supplements, food additives, tyramine, biogenic amine, chocolate, nitrates, hot dogs, monosodium glutamate, Chinese restaurant syndrome, alcohol, wine, red wine, spirits, drinks, fatty acids, lipids, fasting, hunger, skipping of meals, dairy products, cheese, milk, ice cream, eggs, tropical fruits, citrus fruits, aspartame, artificial sweeteners, meat, water, hydration, dehydration, tea, coffee, caffeine, sea fruits, cola, Asian foods, triggers and precipitants) that are cross-listed with migraine, headache, and cephalalgia. Second, articles obtained from the two databases were searched for further references cited within. Third, 10 reviews on related search terms were screened for additional relevant articles.\textsuperscript{9,12,14,16–22} Reviewers (FR, VO, KC, and IP) independently screened all titles and abstracts in duplicate and then screened the full articles of all potentially relevant citations. Papers published in English, German, and Portuguese were reviewed.

Articles included in this analysis may have addressed other nondietary trigger factors but specified at least one factor relating diet to migraines. Studies in different age groups (children, adolescents, adults, and the elderly) were included. In the articles that also focused on other types of headaches, data not referring to migraines were removed from the results. Excluded articles consisted of 1) articles that may have addressed migraines but did not differentiate dietary trigger factors for migraines from dietary triggers for other types of headaches; 2) studies with limited accessibility, such as studies published prior to 1980; 3) case reports; and 4) studies that used elimination diets, i.e., those that sought to establish an association between migraines and food allergies (e.g., a therapeutic benefit was demonstrated with a decrease in the amplitude and frequency of migraine attacks after the introduction of a gluten-free diet).\textsuperscript{23,24}

The studies were categorized as follows: 1) population studies of the association of migraines with food habits or with the prevalence of dietary trigger factors; 2) studies involving dietary intervention or observational prospective cohorts; and 3) studies that, although considered transversal, were reported retrospectively in terms of trigger factors within migraine populations.

**RESULTS**

Forty-five articles were evaluated and included in this review. In the 16 population studies, the prevalence of migraines varied from 3.3\% to 19.0\%.\textsuperscript{25–32} Seven of these studies aimed to identify an association between specific eating habits and migraines,\textsuperscript{26–29,32–34} but dietary precipitating factors associated with migraines were actually identified in eight of these 16 studies\textsuperscript{30,31,35–40} (Table 1).

The majority of the studies on triggering or precipitating factors, however, consisted of retrospective transversal studies that generally looked at the occurrence of migraines triggered by dietary or other factors over a 1-year period. These studies were based on retrospective self-reporting, and they include the greatest number of dietary triggering factors; the frequency by factor or groups of factors is specified in the following section and in Table 2.

Of the nearly 30 dietary items addressed in the articles included in this review, only a handful had been tested experimentally: ice water, ice cream, ice; reduced lipid intake; chocolate; fasting; red wine; and water deprivation\textsuperscript{11,41–47} (Table 3).

In the few studies in which a prospective methodology was used, patients were instructed to keep diaries\textsuperscript{10,43,48,49} of these, two involved dietary intervention (Table 3).\textsuperscript{48,49}

Studies of European, North and South American, Asian, African, and Australian populations were per-
Table 1 Population studies that associate migraines with eating habits or the prevalence of dietary triggers.

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<tr>
<th>Reference</th>
<th>Population</th>
<th>Methods</th>
<th>Results</th>
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<tbody>
<tr>
<td>Milde-Busch et al. (2010)</td>
<td>$n = 1,260$ German adolescents from 11 public secondary schools 14–20 years of age $F = 669$ (53.1%); $M = 591$ (46.9%)</td>
<td>Diagnosis: IHS (2004) 1 PFs: questionnaire involving eating habits (eating meals [breakfast, brunch, lunch], ingestion of coffee, nonalcoholic and alcoholic beverages), among other aspects linked to lifestyle</td>
<td>Prevalence: migraines (10.2%); migraines + TH (19.8%) Associations: Prevalence of migraines increased among coffee drinkers ($P = 0.0013$) Prevalence of migraines + TH increased among consumers of cocktails ($P = 0.0013$) and coffee ($P = 0.0033$) Prevalence of migraines increased among those who drank at least one cup of coffee per day (OR = 3.4; 95% CI 1.6–7.0) Prevalence of migraines + TH increased among regular consumers of cocktails (OR = 3.4; 95% CI 1.9–6.0) and consumers of at least one cup of coffee (OR = 2.4; 95% CI 1.3–4.7) per day High consumption of cocktails and coffee was significantly associated with episodes of migraines + TH High consumption of coffee particularly associated with episodes of migraines NS: Occasionally omitting breakfast, regular consumption of wine and cocktails not associated with migraines Occasionaly omitting breakfast, regular consumption of beer not associated with migranes + TH Skipping meals or insufficient ingestion of liquids was not associated with any type of headache Prevalence: migraines (3.3%); 4% of F; 2.2% of M; MWA (67.5% of migraineurs) PFs: eating habits, the ingestion of alcohol, and other PFs PFs (among migraineurs): Eating habits: 2.7% Prevalence: migraines (12%) Associations: Heavy consumption of caffeine is associated with a greater prevalence of &quot;infrequent&quot; migraines Chronic headaches are lower among individuals with heavy caffeine consumption Consideration: individuals with chronic headaches should reduce their coffee consumption to avoid effects Prevalence: migraines (12%) Associations: Decreased prevalence of migraineurs with an increase in the units of alcohol consumed ($P = 0.0001$) Prevalence of migraineurs was slightly reduced among consumers of wine (0.8%; 95% CI 0.7–0.8) and liquor (0.8%; 95% CI 0.7–0.9) compared with those who abstain, i.e., those who never drink or did not drink during the previous 2 weeks Decreasing prevalence of migraines with increasing quantities of alcohol consumption versus alcohol withdrawal</td>
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<td>Houinato et al. (2010)</td>
<td>$n = 1,113$ residents of a rural community in Benin 15 years of age (36.8 ± 17.8 years) $F = 706$ (63.4%); $M = 407$ (36.6%)</td>
<td>Diagnosis: IHS (1988) 73 PFs: spontaneous reports and indications from a list of eating habits, the ingestion of alcohol, and other PFs</td>
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<tr>
<td>Hagen et al. (2009)</td>
<td>$n = 50,483$ Norwegians who participated in the Head-HUNT study (1995–1997)</td>
<td>Diagnosis: IHS (1988) 73 PFs: questionnaire with quantification of the number of cups of coffee or tea and the use of medication containing caffeine (ergotamine). Classification: heavy consumers (&gt;540 mg/day) and light consumers (0–240 mg/day).</td>
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### Table 1 Continued

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<td>Takeshima et al. (2004)28</td>
<td>$n = 5,758$ Japanese residents of a rural community (entire adult population) $\geq 20$ years of age $F = 3,077$ (53.4%); $M = 2,681$ (46.6%) Of those eligible, 4,795 completed the questionnaire; of these, 1,628 presented headaches, of whom 1,264 responded</td>
<td>Diagnosis: IHS (1988)73 questionnaire applied to the entire adult population and another questionnaire specific to the characteristics of headaches PFs: structured questionnaire; associations; scale of eating habits and preferences</td>
<td>Prevalence: migraines (6%; 9.1% of F; 2.3% of M); MA (9.1% of migraines; 1% of F; 0.4% of M); MWA (62.3% of migraines; 8.1% of F; 1.9% of M) PFs among migraines: MA: Fasting, wine, chocolate, and ice cream: 0% MWA: Wine, chocolate: 0%; fasting: 0.9% ice cream: 1.4% Associations: Habitual consumption of alcohol greater among migraineurs (F and M) than among control subjects, but NS when adjusted for age Consumption of fatty/oily foods and coffee/tea greater among migraineurs than among control subjects ($P &lt; 0.0001$) Consumption of fish lower among migraineurs ($P = 0.04$) NS: consumption of vegetables, fruits, eggs, milk, soy, potatoes, algae, breakfast, and dinner</td>
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<tr>
<td>Zivadinov et al. (2003)29</td>
<td>$n = 3,794$ residents of Bakar (Croatia) (representative sample of the population) 15–65 years of age</td>
<td>Diagnosis: IHS (1988)73 PFs: structured interview at home containing eating habits, specific foods (chocolate, cheese, alcoholic drinks, fried/fatty foods, vegetables, and coffee), and other PFs</td>
<td>Prevalence: migraines (19%; 22.9% of F; 14.8% of M; NS between the sexes) PFs among migraineurs: Eating habits: 32.1%; various food items: 12.5% Associations: Food items: positive association with MA (OR 2.2; 95% CI 1.35–3.51; $P &lt; 0.0001$), especially red wine ($P &lt; 0.0001$)</td>
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<td>Fuh et al. (2003)35</td>
<td>$n = 8,359$ Taiwanese representing 1% of the population aged 13–15 years Respondents: 8,249</td>
<td>Diagnosis: IHS (1988)73 PFs: questionnaire filled out by respondents with the items &quot;ice cream&quot; and &quot;cola drinks,&quot; plus the question: &quot;Do you develop headaches when you ingest ice cream or other frozen desserts?&quot; in addition to other PFs</td>
<td>Prevalence: migraines (6.2%; F = 3.4%; M = 2.8%) PFs among migraineurs: Ice cream: 55.2%</td>
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<td>Henry et al. (2002)30</td>
<td>$n = 10,585$ French; representative sample of the population $\geq 15$ years of age 3,087 reported headaches 1,486 with headaches were interviewed</td>
<td>Diagnosis: IHS (1988)73 1st phase: population representative of the general national population. Triage: patients with headaches 2nd phase: personal interview PFs: list with 45 items (only PFs reported by more than 20% were considered)</td>
<td>Prevalence: migraines (17%); MWA and MA (7.9%; 11.2% of F; 3.4% of M) PFs among migraineurs: Alcoholic beverages: 23%</td>
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<tr>
<td>Ulrich et al. (2000)36</td>
<td>$n = 169$ pairs of Danish twins discordant for MA 51 MZ and 118 DZ 1 M: 1.4 F</td>
<td>Diagnosis: IHS (1988)73 semistructured interview by telephone with neurologist, included when at least one of the twins reported migraines or probable migraines PFs: semistructured interview via telephone included questions about alcohol and other PFs</td>
<td>Frequency: MA (7.1%; 1 M: 1.1 F); co-occurrence of MA and MWA (7%) PFs among migraineurs: Alcohol: 9% (7% of F; 12% of M) A reduced number of twins consumed more than 7 drinks/week, leaving the question open</td>
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<tr>
<td>Study</td>
<td>Sample Size</td>
<td>Sample Description</td>
<td>Diagnosis</td>
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<td>Bener et al. (2000)</td>
<td>1,159</td>
<td>United Arab Emirates students randomized, simple representative sample</td>
<td>IHS (1988)</td>
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<tr>
<td>Bánk &amp; Márton (2000)</td>
<td>2,000</td>
<td>Hungarian city residents; randomized sample of the general population</td>
<td>IHS (1988)</td>
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<tr>
<td>Ulrich et al. (1996)</td>
<td>4,000</td>
<td>Danish residents living in 11 cities, selected randomly from the Danish Central Person Registry</td>
<td>IHS (1988)</td>
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<tr>
<td>Russell et al. (1996)</td>
<td>4,000</td>
<td>Danish residents living in 11 cities, selected randomly from the Danish Central Person Registry</td>
<td>IHS (1988)</td>
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<tr>
<td>Turner et al. (1995)</td>
<td>825</td>
<td>Mexican Americans selected randomly by telephone number</td>
<td>IHS (1988)</td>
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<tr>
<td>Rasmussen (1993)</td>
<td>740</td>
<td>Danish citizens randomized in the National Person Registry</td>
<td>IHS (1988)</td>
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<tr>
<td>Rasmussen &amp; Olesen (1992)</td>
<td>740</td>
<td>Danish citizens randomized in the National Centre for Social Research</td>
<td>IHS (1988)</td>
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</table>

**Abbreviations:** CI, confidence interval; DZ, dizygotic; F, female; IHS, International Headache Society; M, male; MA, migraine with aura; MWA, migraine without aura; MZ, monozygotic; NS, not significant; NA, not available; PFs, precipitating factors; OR, odds ratio; TH, tension-type headache.
### Table 2  Retrospective studies with reports of precipitating dietary factors.

<table>
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<tr>
<th>Reference</th>
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<th>Methods</th>
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| Nazari et al. (2010)³¹ | \( n = 170 \) Iranian women, 85 selected randomly at a neurology clinic and a health center (migraine group) and 85 without migraines (control group) 18–50 years of age | Diagnosis: IHS (NA)  
PFs: questionnaire including diet and eating habits, among other PFs | PFs:  
With no regular dietary program*:  
Migraine group: 37.6%  
Control group: 17.6%  
Did not report skipping meals**:  
Migraine group: 37.6%  
Control group: 23.5%  
Eat less than 3 meals per day:  
Migraine group**: 29.4%  
Control group: 9.4%  
Significant difference between the two groups in diet and eating habits***  
*\( P = 0.0004 \) between the groups; **\( P = 0.046 \) between the groups; ***\( P = 0.001 \) |
| Theeler et al. (2010)³⁰ | \( n = 172,150 \) American soldiers and 22 civilian family members, receiving specialized service care  
F = 120 (70%); M = 51 (30%)  
Average age, 32 years | Diagnosis: NA  
PFs: structured questionnaire containing dietary PF (fasting, foods and beverages, dehydration, and caffeine deprivation) and other PFs | Dietary factors: reported more frequently by migraineurs than by other headache-sufferers (66% versus 37%; \( P < 0.001 \))  
Dietary factors: NS among soldiers and civilians PFs:  
Fasting or skipping meals: 46.3% (39% of F and 46% of M); foods (cheese, chocolate, citrus fruits, hot dogs, MSG, coffee, beer, and red wine): 0%*  
*Attributed to the fact that these foods are uncommon in northern India |
| Yadav et al. (2010)³² | \( n = 182 \) Indian outpatients with MA, seen at a university hospital  
F = 131; M = 51  
14–58 years of age (average age, 30.7 years) | Diagnosis: IHS (1988)³³  
PFs: questionnaire applied by researcher containing, among other PFs, specific foods and beverages, and fasting | *\( P = 0.0004 \) between the groups; **\( P = 0.046 \) between the groups; ***\( P = 0.001 \)  
Frequency: migraines (77%) PFs:  
Dietary factors:  
Fasting or skipping meals: 46.3% (39% of F and 46% of M); foods (cheese, chocolate, citrus fruits, hot dogs, MSG, coffee, beer, and red wine): 0%*  
*Attributed to the fact that these foods are uncommon in northern India |
| Fukui et al. (2008)³⁴ | \( n = 200 \) Brazilian migraineurs  
F = 162 (81%); 37.0 ± 11.14 years of age; M = 38 (19%); 40.7 ± 14.2 years of age (average age, 37.7 years) | Diagnosis: IHS (2004)³⁴  
PFs: questionnaire with predetermined list of dietary PFs (chocolate, sausage, salami, MSG, cheese, milk, aspartame, alcohol, red wine, white wine, coffee, sodas, citrus fruits, ice cream, and nuts) and other PFs | Fasting: 63.5%; dietary factors: 64%; chocolate: 20.5%; sausage: 6%  
salami: 4.5%; MSG: 2.5%; cheese: 8.5%; milk: 2.9%; aspartame: 8.5%; alcohol: 34%; red wine: 19.5%; white wine: 10.5%; coffee consumption: 14.5%; soda: 1.5%; citrus fruits: 4%; ice cream: 3%; nuts: 1.5%  
*\( P < 0.05 \) for F (22%) and M (7.8%)  
Minimum of 1 dietary PF: 64%; 2 dietary PFs: 39.5%; 3 dietary PFs: 23%; 4 dietary PFs: 8%; 5 or more dietary PFs: 4% |
Kelman (2007)\textsuperscript{a}

\( n = 1,750 \) US consecutive clinic patients with chronic, episodic, and probable migraines

36.67 ± 12 years of age

F = 1,475 (84.3%); M = 275 (15.7%)

Diagnosis: IHS (2004)\textsuperscript{1}

PFs: patients reported the frequency of headaches triggered by dietary PFs (foods, alcohol, and fasting) among other PFs, as well as the frequency of migraines on a scale of 0–3 (0, never; 1, occasionally, i.e., 1–33% of the time; 2, frequent, i.e., 34–66% of the time; 3, very frequent, i.e., 66–100% of the time)

Frequently: Foods: 26.9%; alcohol: 37.8%; fasting: 57.3%

Very frequently: Foods: 4.3%; alcohol: 9.5%; fasting: 12%

RFs: patients reported the frequency of headaches triggered by dietary PFs (foods, alcohol, and fasting) among other PFs, as well as the frequency of migraines on a scale of 0–3 (0, never; 1, occasionally, i.e., 1–33% of the time; 2, frequent, i.e., 34–66% of the time; 3, very frequent, i.e., 66–100% of the time)

Frequently: Foods: 26.9%; alcohol: 37.8%; fasting: 57.3%

Very frequently: Foods: 4.3%; alcohol: 9.5%; fasting: 12%

Wöber et al. (2006)\textsuperscript{b}

\( n = 120 \) Austrians

88 outpatients with headaches, either migraines (\( n = 66 \)) or TH (\( n = 22 \))

32 migraineurs not treated at the clinic, with migraines (\( n = 5 \)) or TH (\( n = 27 \))

18–65 years of age

Majority of patients were women

Diagnosis: IHS (2004)\textsuperscript{1}

PFs: questionnaire applied personally or by telephone with 25 potential PFs of migraines and TH (including dietary factors) in terms of personal experience (always, sometimes, never/don’t know) and on theoretical knowledge with respect to PFs (yes or no)

Food and alcohol triggers were greater among migraineurs than among patients with probable migraine (\( P = 0.017 \) and 0.010, respectively)

Episodic and chronic migraines: alcohol and food triggers were less frequent among chronic cases (\( P = 0.033 \) and 0.025, respectively)

MA and MWA: fasting and foods were more frequent among patients with MA than among patients with MWA (\( P = 0.027 \) and 0.010, respectively)

Men and women: the PF of fasting was more frequent among women (\( P = 0.000 \))

Personal experience was less among the individuals outside of the clinic than among the other two groups

Red wine: \( P < 0.05 \)

Theoretical knowledge was greater among the patients with migraines who were treated at the clinic:

Alcohol: \( P < 0.05 \); red wine: \( P < 0.01 \); chocolate: \( P < 0.001 \); cheese: \( P < 0.001 \)

Personal experience versus theoretical knowledge about PFs of migraines and TH (among all 120 subjects):

Hunger**: greater with personal experience

Alcohol*, red wine***, white wine*, chocolate***, caffeine***, nuts***, cheese***, additives***, spirits**, fruits/vegetables**: greater with knowledge

***\( P < 0.001 \); **\( P < 0.01 \); *\( P < 0.05 \)

Kelman (2006)\textsuperscript{c}

\( n = 1,009 \) American migraineurs frequenting a clinic

37.7 ± 11.7 years of age

F = 871 (86.3%); M = 138 (13.7%)

Blau (2005)\textsuperscript{d}

\( n = 95 \) British migraineurs were questioned on the insufficient ingestion of liquids and the triggering of migraines

Group A: 41 consecutive migraine-suffering patients and 9 colleagues known to have migraines (10–75 years of age, average age 44 year), of whom 15 had MA and 35 MWA

F = 31; M = 19

Group B: 45 members of the British Migraine Association

Diagnosis: established by a neurologist

PFs: list of dietary PFs (fasting, i.e., omission or irregular time of meals; specific foods, i.e., cheese, chocolate, alcohol [red or white wine, other alcoholic beverages], Chinese food, coffee, tea, or other drinks) and other PFs, and an open question “Do you develop migraines if you don’t drink enough liquids?”
<table>
<thead>
<tr>
<th>Reference</th>
<th>Population</th>
<th>Methods</th>
<th>Results</th>
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<tr>
<td>Karli et al. (2005)</td>
<td>n = 96 Turkish patients in a headache clinic, selected randomly</td>
<td>Diagnosis: IHS (2004)</td>
<td>PFs: Dietary factors*: MWA 25 (75.6%); 18 (78.3%) MA</td>
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<td>31 had episodic TH (35 ± 1.0 years of age; F = 24; M = 7)</td>
<td>PFs: questionnaire filled out by respondents, who were subsequently</td>
<td>Hunger*: MWA 24 (72.7%); 17 (73.9%) MA</td>
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<td>33 had MWA (36.7 ± 10 years of age; F = 29; M = 4)</td>
<td>interviewed by a headache specialist about dietary PFs (hunger, alcohol,</td>
<td>Alcohol: MWA 2 (6.1%); 0 (0%) MA</td>
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<td>23 had MA (40 ± 11.1 years of age; F = 21; M = 2)</td>
<td>and foods) among other PFs</td>
<td>Foods*: MWA 9 (27.3%); 10 (43.5%) MA</td>
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<td>9 had nonmigraine headaches with aura (34.7 ± 9.8 years; F = 9)</td>
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<td>*Significant difference between the types of headaches (P = 0.028; 0.013, and 0.01, respectively)</td>
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<td>Dietary factors were significant PFs among MA</td>
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<td>Jerusalimschy &amp; Moreira Filho (2002)</td>
<td>n = 100 Brazilian patients with MWA in outpatient care for headaches at a university hospital who reported 1 or more PFs for their migraines</td>
<td>Diagnosis: IHS (1988)</td>
<td>Hunger is significantly more common among MA, MWA, and nonmigraine</td>
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<td>10–64 years of age (average age, 33.6 years)</td>
<td>PFs: personal interview with specific protocol containing</td>
<td>headaches with aura when compared with episodic TH</td>
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<td>F = 84; M = 16</td>
<td>dietary and other PFs</td>
<td>PFs: Fasting: 48%; foods: 46%; alcoholic beverages: 28%; caffeine</td>
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<td>n = 55 US adults attending a clinic</td>
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<td>withdrawal: 22%</td>
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<td>Migraines: n = 38</td>
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<td>TH: n = 17</td>
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<tr>
<td>Scharff et al. (1995)</td>
<td>n = 172 consecutive Americans with MWA, TH, or migraine with TH</td>
<td>Diagnosis: IHS (1988)</td>
<td>PFs: Specific foods or drinks: 58%; alcohol: 42%; skipping meals: 82%</td>
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<td></td>
<td>F = 149 (85.6%); M = 23 (14.4%) 36.9 ± 12.3 years of age</td>
<td>PFs: specific questionnaire by telephone containing questions about</td>
<td>Aggravating factors: Specific foods or drinks: 55%; alcohol: 47%; skipping meals: 71%</td>
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<td>dietary PFs (specific foods, alcohol, and skipping meals)</td>
<td>PFs: Group 1 (remission): Foods: 0%</td>
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<td>Group 2 (without remission): Foods: 21.8%</td>
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<td>Frequency: MWA (40.1%); MWA + TH (30.8%)</td>
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<td>PFs among migraineurs: Alcohol: 35.3%; aspartame: 9.4%; cheese: 9.1%;</td>
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<td>chocolate: 22.1%; caffeine: 10.6%; MSG: 12.9%; skipping meals: 44.9%</td>
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<td></td>
<td>PFs of MWA + TH: Alcohol: 32.7%; aspartame: 7.8%; cheese: 0%; chocolate: 23.1%; caffeine: 47.2%; MSG: 11.3%; skipping meals: 47.2%</td>
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<td>NS among other types of headaches and PFs</td>
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<td>PFs: Skipping meals: 40% (43% of F and 31% of M)*</td>
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<td>Foods: 30% (31% of F and 28% of M)*</td>
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<td>*Significant difference between F and M (P &lt; 0.05)</td>
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Peatfield et al. (1995)\textsuperscript{a}

- \textbf{Diagnosis}: IHS (NA)
- PFs: questioning in relation to dietary PFs (foods – cheese, chocolate, and citrus fruits; drinks – red wine and beer); patients who reported sensitivity to 2 or more foods were classified as migraine sufferers with episodes linked to foods

PFs:
- Migraines: Foods: 16.5% alcoholic beverages; red wine: 11.2%; beer: 28%
- Migraines + TH: Foods: 13%
- Migraines linked to foods (n = 71):
  - Red wine: 32%; alcoholic beverages: 26%
  - Migraines not linked to foods (n = 276):
    - Red wine: 7%; alcoholic beverages: 16%
  - Migraines + TH (n = 46):
    - Red wine: 9%; alcoholic beverages: 13%

Associations:
- Sensitivity to cheese/chocolate and red wine and also to beer
  \((P < 0.001)\)

Data show overlap in the sensitivity to beer, foods, and red wine, which suggests a metabolic connection between these sensitivities

Van den Bergh et al. (1987)\textsuperscript{b}

- \textbf{Diagnosis}: Ad Hoc Committee on Classification of Headaches (1962)\textsuperscript{a}
- PFs: open question

PFs:
- Specific foods: 44.7%; cheese and dairy products: 18.5%; eggs: 7.4%; chocolate: 22.5%; sweets (with sugar): 2.7%; fatty foods: 17%; cabbage: 4.6%; tropical fruits: 5%; meats: 3.6%; fish: 4.1%; ice cream: 4.6%; alcoholic beverages: 51.6%; beverages with caffeine: 6.4%; milk: 2.3%

Associations:
- Alcohol and specific foods: \(P < 0.0001\)

Peatfield et al. (1984)\textsuperscript{c}

- \textbf{Diagnosis}: Vahlquist (1955)\textsuperscript{c}
- PFs: open interview

PFs:
- Chocolate: 19.2%; cheese: 18.2%; citrus fruits: 11.1%; coffee: 7%; pork and dairy products: 3%; eggs: 2% alcoholic: 29%

Associations:
- Chocolate with cheese \((P < 0.001)\)
- Citrus fruits with chocolate and cheese \((P < 0.001)\)
- Alcohol with cheese, chocolate, and citrus fruits \((P < 0.001)\)
- Family history of migraine with chocolate \((P < 0.01)\) and alcohol \((P < 0.001)\)

\textbf{Abbreviations}: F, female; IHS, International Headache Society; M, male; MA, migraines with aura; MSG, monosodium glutamate; MWA, migraines without aura; NA, not available; NS, not significant; PFs, precipitating factors; TH, tension-type headache.
Table 3 *Studies using dietary interventions for migraines or prospective observational studies.*

<table>
<thead>
<tr>
<th>Reference</th>
<th>Population</th>
<th>Methods</th>
<th>Results</th>
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<tr>
<td>Chakravarty et al. (2009)</td>
<td>( n = 200 ) consecutive Indian outpatients suffering migraines</td>
<td><strong>Diagnosis:</strong> IHS (2004)¹</td>
<td><strong>PFs:</strong> Retrospective (frequency among migraineurs): Skipping meals: 31.5%; religious fasting: 13.4%; bitter chocolate: 1.5%; pizza: 1%; Chinese food: 3.5%; caffeinated beverages: 0%</td>
</tr>
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<td></td>
<td>MWA</td>
<td>PFs (retrospective): interview with a checklist of PFs (skipping meals, religious fasting, bitter chocolate, pizza, Chinese food, caffeinated beverages), among other PFs</td>
<td><strong>Prospective</strong> (number of migraines in 3 months ( = 1,563 ); data expressed as the frequency of migraine spells): Skipping meals: 13.4%; religious fasting: 0.2%; bitter chocolate: 0.1%; Chinese food: 0.3%; caffeinated beverages and pizza: 0%</td>
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<td></td>
<td>7–15 years of age</td>
<td>PFs (prospective): diaries maintained, with monitoring in the clinic for 3 months at 6-week intervals</td>
<td><strong>Associations:</strong> Fasting among females associated with severe migraines</td>
</tr>
<tr>
<td>Wöber et al. (2007)¹⁰</td>
<td>( n = 327 ) migraine-suffering Austrians recruited by newspaper advertisement ( \geq 18 ) years of age (41.9 ± 12.1 years)</td>
<td><strong>Diagnosis:</strong> IHS (2004)¹</td>
<td><strong>Consumption of beer before the beginning of a migraine episode reduced the risk of migraines</strong></td>
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<td></td>
<td>( F = 86.5%; M = 13.5% )</td>
<td>PFs: semistructured interview and diary for 90 days, with 52 items potentially related to migraines</td>
<td>The increase in daily fluid intake in the intervention group was approximately 1 L and reduced the total hours of headache in 2 weeks by 21 h (95% CI 46–5); headache intensity decreased by 13 mm (95% CI 32–5) on a visual analogue scale</td>
</tr>
<tr>
<td>Spigt et al. (2005)¹⁰</td>
<td>( n = 18 ) migraine-suffering Dutch subjects recruited by an advertisement in a local newspaper, allocated randomly</td>
<td><strong>Diagnosis:</strong> IHS (1988)²³</td>
<td><strong>PF among migraineurs:</strong> Ice test: positive in 56 of 76 migraineurs (F = 85.7% and M = 14.3%)</td>
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<td>Mean age, 44 years</td>
<td>PFs: patients were randomly allocated to placebo medication or advised to drink 1.5 L of water per day in addition to their normally consumed beverages for a period of 12 weeks. Effect measurements were recorded in a 2-week headache diary.</td>
<td><strong>Cheese and chocolate were consumed by the majority of the patients, every 2 days on average</strong></td>
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<td>( F = 14; M = 4 )</td>
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<td>Dehydration was related to 28.9% (mild/little intensity); 8.6% (moderate intensity); and 1.8% (severe intensity) of the days with migraine attacks by 91.4% of the patients</td>
</tr>
<tr>
<td>Selekler et al. (2004)¹¹</td>
<td>( n = 114 ) Turkish outpatients</td>
<td><strong>Diagnosis:</strong> IHS (1988)²³</td>
<td><strong>No dietary factor had a negative impact</strong></td>
</tr>
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<td>Migraines: 76</td>
<td>PF: &quot;Ice test&quot; (12 × 14-mm ice cubes placed in contact with the palate); report the presence/location of headache. Test considered negative when there was no pain within 90 s.</td>
<td>Consumption of alcohol was mostly by men, mostly wine, 11% of the days</td>
</tr>
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</table>
n = 669 Swedish women in a mammography screening program
40–74 years of age (average age, 54 years)
Diagnosis: self-reported for the ingestion of ice water and ice cream
PF: after the ingestion of 150 mL of water at 0–4°C, with an average of 21 s for ingestion by means of a straw (stimulation of the palate), report the presence of headaches (visual scale)
Active migraine considered when one or more migraine episodes occurred during the past year
Inactive migraine considered with previous experience of migraines, but not within the past year
Prevalence: active migraine (19.4%); inactive migraine (14.2%)

Chabriat et al. (1999) 60
n = 698 French adults in a randomized sample of 600 households
Migraineurs: 385
Controls (nonmigraineurs): 313
Diagnosis: IHS (1988) 73
PFs: 3-month record – (dietary and other PFs)
comparisons between control groups and migraineurs only when PFs were reported in at least 10% of the cases
Frequency: 12% of days in the migraine group; 2% of days with headache in the control group
PFs: expressed as a percentage of patients
Migraineurs:
Food and drinks: 36%
Controls:
Food and drinks: 24%
P < 0.05 frequency significantly different between the two groups

Bic et al. (1999) 46
n = 54 US migraineurs recruited by newspaper advertisements, medical clinics, hospitals, and community centers
24–71 years of age (average age, 41 years)
F = 42; M = 12
Diagnosis: IHS (1988) 73
PFs: baseline study for 12 weeks: 28 days; transition: diet restricted to 20 g/day of lipids without caloric restrictions, limitations in caffeine, with substitution with water (run-in of 28 days for adaptation); final: 28 days for evaluation of the intervention
Positive association with the decrease in the ingestion of lipids and a decrease in the frequency, intensity, and duration of migraines, along with a decrease in the use of medication (P < 0.0001)
Positive correlation between the baseline ingestion of lipids and the frequency of migraines (P = 0.02)

Marcus et al. (1997) 44
n = 63 women with chronic headaches recruited through an announcement in a US university
Migraines: 50%
TH: 37.5%
Migraines + TH: 12.5%
28.3 ± 10.7 years of age
Diagnosis: IHS (1988) 73
PFs: After 2 weeks of a diet with restrictions on vasoactive amines (chocolate or carob) and other potential PFs of headaches (tyramine, phenylethylamine, histamine, nitrates, caffeine, MSG, and aspartame), each individual underwent a double-blind study with samples of chocolate or carob presented randomly, with intervals of 3 days between the tests, and with a diary monitoring the diet and headaches (up to 12 h after the test)
Positive association with the decrease in the ingestion of lipids and a decrease in the frequency, intensity, and duration of migraines, along with a decrease in the use of medication (P < 0.0001)
Positive correlation between the baseline ingestion of lipids and the frequency of migraines (P = 0.02)

Mattsson (2001) 42
n = 669 Swedish women in a mammography screening program
40–74 years of age (average age, 54 years)
Diagnosis: self-reported for the ingestion of ice water and ice cream
PF: after the ingestion of 150 mL of water at 0–4°C, with an average of 21 s for ingestion by means of a straw (stimulation of the palate), report the presence of headaches (visual scale)
Active migraine considered when one or more migraine episodes occurred during the past year
Inactive migraine considered with previous experience of migraines, but not within the past year
Prevalence: active migraine (19.4%); inactive migraine (14.2%)

Ice water: 51/669 (7.6%) reported headache after drinking 150 mL of ice water
Women with active migraine were twice as likely to experience headaches with ice water than were women who did not have headaches
Ice water did not increase the risk in women with inactive migraine
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<th>Reference</th>
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| Martin & Seneviratne (1997) | *n* = 673 Australian students of psychology who reported hunger as a PF of migraines. The first 28 who fulfilled the criteria for migraines and the first 28 who fulfilled the criteria for TH were included. 18–30 years of age, F = 38, M = 18 | Diagnosis: IHS (1988)\(^7\) PFs: students were randomly placed in 1 of 4 experiments developed in a psychobiology laboratory: a. stress, foods; b. stress, food deprivation; c. no stress, with food d. no stress, without food | PFs: Hunger: triggered a migraine episode and increased its intensity (\(P < 0.01\))  
Food deprivation did not have a negative effect (stress) |
| Bird et al. (1992)\(^8\)     | *n* = 120 70 consecutive patients at an English clinic 15–73 years of age, F = 65; M = 550 English student volunteers, F = 30; M = 19 18–26 years of age | Diagnosis: IHS (1988)\(^7\) PF: ice cream Group 1: migraineurs Application of ice cream (5–10 mL) and 10 mL of ice cream swallowed in a bolus | Group 1: MA (14%); MWA (86%)  
Group 2: MWA (4%); nonmigraine headaches (58%); without headaches (38%)  
Previously reported PF: Migraineurs: 26% Others: 46%  
PF after test: Migraineurs: 17% Others: 46% |
| Littlewood et al. (1988)\(^9\) | *n* = 32 patients at an English clinic Group intervention: 19 migraineurs who attributed their migraine episodes to red wine  
Control group: 5 migraineurs who did not attribute their migraine episodes to red wine, and 8 healthy individuals | Diagnosis: Vahlquist (1955)\(^7\) PF: group intervention – 300 mL of red wine or 300 mL of a mixture of vodka/lime with an equal alcohol content; control – red wine only; observed for 3 h and contacted by telephone the following day, searching for symptoms | Intervention group: 9 of 11 developed symptoms after the consumption of red wine; 0 of 8 developed symptoms after the consumption of vodka (\(P < 0.001\))  
Migraine control group and healthy control group did not develop symptoms  
Alcohol is not a PF among patients sensitive to red wine alone |
| Salfield et al. (1987)\(^10\) | *n* = 39 Dutch children suffering migraines Group A: *n* = 20 (average age, 10.3 years)  
Group B: *n* = 19 (average age, 11.0 years)  
F = 8; M = 12  
F = 7; M = 12 | Diagnosis: established by a physician PFs: first 8 weeks – diary of symptoms; children with at least 1 migraine spell every 2 weeks were then randomly placed into group A or B, maintaining their respective diets and the diary of symptoms Group A: diet rich in fiber Group B: diet rich in fiber and poor in vasoactive amines | Reduction of migraine episodes:  
Group A (diet rich in fiber): from 13.35 ± 10.09 migraine spells to 6.93 ± 5.84 migraine spells (\(P < 0.001\))  
Group B (diet rich in fiber and poor in vasoactive amines): from 13.84 ± 9.25 headaches to 7.53 ± 9.41 headaches (\(P < 0.001\))  
Significant reduction of migraine spells in both groups (NS between the groups) |

Abbreviations: CI, confidence interval; F, female; IHS, International Headache Society; M, male; MA, migraine with aura; MSG, monosodium glutamate; MWA, migraine without aura; PFs, precipitating factors; NA, not available; NS, not significant; TH, tension-type headache.
formed. Only two studies conducted in rural environments were found. One of these was a community in Benin\textsuperscript{15} and the other a community in Japan\textsuperscript{28} (Table 1). Both studies reported a lower prevalence of migraines (3.3\% and 6.0\%, respectively) relative to the other population studies, which indicated a prevalence that varied from 12.0\% to 19.0\%.\textsuperscript{26,29–32} Similarly, nutritional items considered as precipitating factors of migraines were less common (Table 1).

**Frequency of dietary factors**

**Dietary factors.** Overall, in the literature reviewed, there are 15 studies that address dietary factors without specifying a particular food item. Of these 15, four are population studies\textsuperscript{29,31,32,40} (Table 1), 11 examined retrospective reports of perceived precipitating dietary factors\textsuperscript{8,50–59} (Table 2), and only one describes food as a trigger for migraines in a prospective study using a 3-month record in which patients recorded the frequency of consumption of food and drinks perceived as triggers for migraine\textsuperscript{60} (Table 3).

With precipitating factors variously expressed as “dietary factors,” specific foods, or simply “foods” in studies that did not specify the suspected precipitating factor, foods as triggering factors were reported with frequencies of 10.0\% to 46.0\%; these are presented in Table 1,\textsuperscript{28,30–32} Table 2,\textsuperscript{51–59} and Table 3.\textsuperscript{60} The lowest frequencies were found by Houinato et al.\textsuperscript{28} who performed a community in Benin (Table 1).

A recent study by Theeler et al.\textsuperscript{50} shows that dietary factors are reported at a significantly higher frequency by migraine sufferers than by patients with other types of headaches (Table 2).

Kelman\textsuperscript{51} found significantly higher frequencies of reports of foods as triggering factors of migraine crises in patients presenting migraines with aura than in patients with other migraine types (Table 2). Similarly, Zivadinov et al.\textsuperscript{29} showed a positive association between specific food items and migraines with aura (Table 1).

In addition, certain dietary habits were cited in four studies, three of which were population studies\textsuperscript{25,28,29} (Table 1) and one of which was retrospective\textsuperscript{61} (Table 3).

**Fasting or skipping meals.** The most frequently cited and most significant precipitating factor was fasting or skipping meals, reported in 18 studies. Of these studies, four were population studies\textsuperscript{38,31,33,37} (Table 1), 12 were retrospective reports of fasting or skipping meals as a trigger factor for migraine\textsuperscript{6,51−55,57,61−65} (Table 2), one was a retrospective/prospective study using food and migraine-spell diaries,\textsuperscript{48} and one was a randomized trial involving food deprivation as developed in a psychobiology laboratory.\textsuperscript{11}

With the exception of two studies by Takeshima et al.\textsuperscript{28} and Kelman,\textsuperscript{52} which show a frequency of just 0.9\% and 27.2\% of migraine sufferers reporting fasting as a precipitating factor, respectively, the frequency reported in other studies varied from 40.0\% to 82.0\% (Tables 1 and 2). In the study by Nazari et al.\textsuperscript{61} migraine-suffering patients reported skipping meals with a significantly higher frequency than did control individuals without migraines. The same study also showed a significant difference between migraine sufferers and control subjects with respect to eating at least three meals a day (Table 2).

When experimentally induced, hunger was capable of triggering and intensifying migraine crises.\textsuperscript{11} A prospective study showed an association between fasting and severe migraines among girls, and fasting was associated with migraine spells in 13.4\% of children and adolescents in a study by Chakravarty et al.\textsuperscript{48} (Table 3). On the other hand, Milde-Busch et al.,\textsuperscript{31} in a broad population study, did not find a significant association between skipping meals and migraines (Table 1).

In addition, Turner et al.\textsuperscript{31} showed an association between skipping meals and menstrual migraines (Table 1).

**Alcoholic beverages.** In all, 26 studies in the present review analyzed alcoholic beverages as potential triggers: 11 were population studies\textsuperscript{37−39,32,33,36−40} (Table 1), 13 reported these triggers retrospectively\textsuperscript{6,51−55,58,59,62−66} (Table 2), one was a prospective study,\textsuperscript{10} and one was an intervention study\textsuperscript{46} (Table 3).

In the population study performed by Aamodt et al.\textsuperscript{27} the prevalence of migraine sufferers was slightly reduced among wine drinkers compared with those who abstained from wine. However, Zivadinov et al.\textsuperscript{29} found a positive association between migraines with aura and red wine consumption (Table 1).

Although studies did not report red wine as a precipitating factor among migraine sufferers in a rural environment or among outpatients in India\textsuperscript{28,62} (Tables 1 and 2), other studies reported frequencies between 11.2\% and 19.5\% for red wine and 10.5\% for white wine.\textsuperscript{8,58} An association was also found between a sensitivity to cheese or chocolate and red wine\textsuperscript{58} (Table 2).

Wöber et al.\textsuperscript{10} analyzed a 90-day consumption diary of 40 potential precipitating factors and found that none of the dietary factors involved in the study had a negative impact, including alcoholic beverages consumed 7.0–10.0\% of the time by 60.0–80.0\% of the patients, with wine being the most commonly ingested (Table 3).

In contrast, in an experimental study by Littlewood et al.,\textsuperscript{46} migraine sufferers developed symptoms with greater frequency after the consumption of red wine than after the consumption of vodka (Table 3).
Other studies show that the heavy consumption of alcoholic beverages is significantly associated with migraines and tension-type headache and that habitual consumption of alcohol is greater among migraine sufferers than among control subjects. However, Rasmussen did not find an association between the consumption of alcohol and migraines (Table 1), and Aamodt et al. actually found that those who consumed alcohol tended to experience a lower prevalence of migraines compared with those who abstained from alcohol. An association with migraines was found only with excessive intake of alcohol (Table 1).

Among migraine sufferers, the reports of alcohol as a precipitating factor of crisis varied from 17.0% to 76.0%, with the majority of the studies placing the frequency at above 30.0% (Tables 1 and 2). Peatfield et al. identified alcohol as a precipitating factor when it was combined with cheese, chocolate, or citrus fruits (Table 2). In contrast, Wöber et al. found that the consumption of beer before the onset of a migraine reduced the risk of occurrence (Table 3).

**Chocolate.** Of the 14 studies in this review that address chocolate as a trigger, four were population studies (Table 1), seven reported the trigger retrospectively (Table 2), one was retrospective and also prospective, and one was prospective but found no impact of the trigger on migraine episodes, and one was a randomized trial (Table 3).

While studies by Fukui et al., Scharff et al., Van den Bergh et al., and Peatfield et al. show frequencies of 19.2% to 22.5% among migraine sufferers who report chocolate as a precipitating factor (Table 2), other studies report much lower frequencies, from 0.0% to 6.0%, as shown in Tables 1, 2, and 3. found that, on average, chocolate was consumed every 2 days by the majority of migraine-suffering patients during a 90-day period. In a separate randomized, provocative double-blind study, subjects consumed samples of chocolate or carob (placebo). Tests were performed at 3-day intervals to monitor the diet as well as the migraine crisis (migraines occurring up to 12 hours after the test). In contrast to carob, chocolate did not trigger a crisis among migraine-suffering patients in the study (Table 3).

**Caffeine.** Twelve studies in this review identified caffeine consumption or caffeine withdrawal as a migraine crisis trigger: four population studies (Table 1), seven retrospective reports of migraine precipitants, and one prospective study (Table 3).

Population studies show a greater prevalence of migraineurs among adolescents and adults who consume coffee; this was also true for adults who consume coffee or tea. However, Rasmussen did not observe this association (Table 1).

Among migraineurs, the frequency of coffee as a triggering factor varied from 6.4% to 14.5%. On the other hand, Yadav et al. and Chakravarty et al. did not identify this precipitating factor among migraineurs who were analyzed retrospectively (Tables 2 and 3). Moreover, the same factor was also analyzed prospectively by Chakravarty et al. (Table 3).

Headaches caused by caffeine withdrawal, on the other hand, are widely described in the literature and were found in 37 of the 48 (77.0%) experimental studies included in a broad review by Juliano and Griffiths. According to the authors, headaches are considered a valid symptom of caffeine withdrawal. This review includes the study by Ierusalimschy and Moreira Filho, in which caffeine withdrawal was reported by 22.0% of patients who suffer from migraines without aura (Table 2).

**Citrus fruits and vegetables.** Seven studies in the present review considered citrus fruits and vegetables as possible precipitants, two of which were population studies (Table 1) and five of which were retrospective reports of the precipitant (Table 2).

While Takeshima et al. did not find an association between the consumption of fruits and vegetables and the occurrence of migraines in a rural adult population (Table 1), Bener et al. described citrus fruits as significant risk predictors for migraines among students (Table 1).

In addition, Yadav et al. found no evidence of citrus fruits as precipitating factors of migraines, Fukui et al. found a frequency of 4.0%, and Van den Bergh et al. found a frequency of 5.0%. In the study by Van den Bergh et al., tropical fruits are cited specifically, in addition to cabbage, which had a frequency of 4.6% (Table 2).

Similarly, Peatfield et al. found an association between citrus fruits and chocolate and cheese, as well as between alcohol and cheese, chocolate, and citrus fruits (Table 2).

**Lipids.** Three studies included in the review identified an association between fatty foods and migraines: one population study (Table 1), one retrospective report (Table 2), and one interventional study (Table 3).

The population study showed greater consumption of fatty and oily foods by migraineurs than by control individuals (Table 1). Van den Bergh et al. describe a frequency of 17.0% among migraineurs who report fatty foods as precipitating factors (Table 2).

In another 12-week study, Bic et al. found a positive association between a decrease in the ingestion of lipids and a decrease in the frequency, intensity, and duration of migraines, along with a decrease in the use of medications. There was also a positive association between the baseline intake of lipids and the frequency of migraines (Table 3).
Fluid deprivation or low consumption of fluids. Of the four studies included that examined the association between fluid deprivation or low consumption of fluids and the occurrence of migraines, one showed no association between insufficient ingestion of liquids and migraine crisis in a population study\(^8\) (Table 1), one was a retrospective report\(^64\) (Table 2), one was a prospective report of the possible precipitant,\(^10\) and one was a randomized trial\(^6\) (Table 3).

Blau\(^64\) found reported frequencies of 54.0% and 31.0% of insufficient ingestion of water as a precipitating factor among different groups of migraineurs. Elsewhere, Wöber et al.\(^10\) described an elevated frequency (91.4%) (Table 3). In a prior experimental study, Blau et al.\(^67\) observed the resolution of headaches after the relatively early ingestion of fluids (during the first 30 min and between 1 and 3 hours after ingestion) in 22 of 34 and 11 of 34 patients, respectively. Additionally, in a randomized study, an increase of water intake reduced total hours and intensity of the crisis\(^67\) (Table 3).

Ice cream or ice water. The consumption of ice cream or ice water as a possible trigger was addressed by seven studies, including three population studies\(^8,28,35\) (Table 1), one retrospective report\(^59\) (Table 2), and three experimental studies\(^41,42,45\) (Table 3).

An early study\(^68\) is in conflict with a more recent study\(^45\) concerning whether headaches caused by ice cream are more common among migraineurs. The authors found a positive response to this question, with headaches occurring in 93.0% of migraineurs but in just 31.0% of control subjects. The study by Bird et al.\(^45\) showed a higher occurrence of cold-temperature-induced headaches among non-migraine-suffering individuals (Table 3). Interestingly, this precipitating factor was reported by 1.4% to 4.6% of adult migraineurs\(^8,28,59\) (Tables 1 and 2), but 55.4% of adolescent migraineurs\(^35\) (Table 1).

When ice cubes were brought into contact with subject palates experimentally, 74.0% of migraineurs reported the occurrence of headaches.\(^41\) Mattsson\(^42\) found that when ice water was applied to their palates, women who had suffered at least one crisis during the past year were twice as susceptible to headaches as women who had not experienced a headache crisis in the past year (Table 3).

Milk, cheese, and other dairy products. In a population study by Takeshima et al.,\(^28\) there was no association between the consumption of milk and the onset of migraines (Table 1). In Table 2, the study by Yadav et al.\(^62\) did not find cheese to be a precipitating factor of migraine crises, while the other studies found frequencies of 8.5% to 18.2%\(^59,65,66\), when milk is analyzed separately, the frequency is around 2.0%.

In all, 12 studies were included: four involved population studies\(^28,37–39\) (Table 1), seven included retrospective reports of milk or dairy products as possible precipitants\(^4,59,62,63,65,66\) (Table 2), and one prospective study asked patients to keep a diary of migraine crises and possible precipitants, which showed no negative dietary impact.\(^10\)

Meat and eggs. Three studies in this review considered meat and eggs as potential migraine triggers: one population study\(^28\) and two studies in which the trigger was reported retrospectively.\(^59,66\)

While the population study found a lower consumption of fish among migraineurs (Table 1), Van den Bergh et al.\(^59\) found fish consumption was reported as a precipitating factor by 4.1% of migraineurs. The consumption of pork in association with dairy products was a triggering factor for 3.0% of migraineurs,\(^66\) while meat was a precipitating factor for 3.6%\(^59\) (Tables 1 and 2).

Although no association between egg consumption and migraines was found in population studies,\(^28\) 2.0% to 7.4% of migraineurs reported eggs as triggers in retrospective studies.\(^59,66\) (Table 2).

Other dietary factors. Under this broad subject area, eight studies were included, six retrospective reports of triggers\(^8,28,59,62,63,65\) (Table 2), one prospective study, and one interventional study.\(^48,49\) (Table 3).

In a study by Chakravarty et al.,\(^48\) pizza and Chinese food were indicated retrospectively as precipitating factors among only 1.0% and 3.5% of migraineurs, respectively. When these foods were consumed by the same population in a prospective study, no increase in migraine spells was observed (Table 3). Similarly, in the study by Fukui et al.,\(^8\) sausage, salami, and monosodium glutamate were reported as precipitating factors by 6.0%, 4.5%, and 2.5% of the participants, respectively. These findings are in contrast with those of Scharff et al.,\(^65\) who found monosodium glutamate to be a triggering factor reported by 12.9% of migraineurs (Table 2).

Aspartame triggered migraines in around 9.0% of migraineurs,\(^8,65\) while sodas and walnuts were reported by 1.5%\(^8\) and sugary foods by 2.7%\(^65\) (Table 2).

In contrast, Salfield et al.\(^49\) found a reduction of migraines among control groups with diets rich in fiber as well as among a group with a diet rich in fiber and poor in vasoactive amines; interestingly, the amines provided no added benefit (Table 3).

Combined dietary precipitating factors

The study of Fukui et al.\(^8\) is one of the few identified in this review in which migraineurs report (and explore) a combination of dietary factors as having triggering
potential (Table 2). Similarly, Zivadinov et al.\textsuperscript{29} found that 12.5% of migraineurs in their study present multiple food items as precipitating factors (Table 1).

Peatfield\textsuperscript{66} found a significant association between sensitivity to cheese or chocolate and red wine as well as to beer. Van den Bergh et al.\textsuperscript{66} showed associations between alcohol and specific foods, and Peatfield et al.\textsuperscript{66} found associations between various dietary factors, such as between chocolate and cheese, citrus fruits with chocolate and cheese, alcohol with cheese, and chocolate and citrus fruits. In addition, they identified an association between a family history of migraines and chocolate and alcohol as trigger factors (Table 2).

**Dietary triggering factors related to gender**

With the exception of a study that did not specify the gender of the participants\textsuperscript{49} (Table 2) and three studies by Mattsson,\textsuperscript{32} Marcus et al.\textsuperscript{44} (Table 3), and Nazari et al.\textsuperscript{61} (Table 2), which evaluated only women, the vast majority of the studies examined for this review included both genders. In the aforementioned studies, the women with migraines were twice as susceptible to headaches when exposed to ice water compared with women who did not suffer from headaches.\textsuperscript{42} Carob was more likely than chocolate to provoke headaches among female migraineurs\textsuperscript{44} (Table 3). Female migraineurs ate fewer meals per day when compared with control females\textsuperscript{61} (Table 2).

In relation to the difference between genders, Robbins\textsuperscript{57} found a significant difference between men and women in the omission of meals as a precipitating factor of migraines, with a higher frequency among women. Similarly, Kelman\textsuperscript{51} observed that triggering by fasting was more frequent among women, and Fukui et al.\textsuperscript{8} found a higher frequency of triggering by red wine among women (Table 2). Even at younger ages, among migraine-suffering children, fasting was associated with severe migraines only in girls\textsuperscript{48} (Table 3).

On the other hand, Russell et al.\textsuperscript{39} found no difference between men and women in the frequency of migraines without aura triggered by beer/spirits, red wine/ripened cheese, and chocolate. Similarly, Zivadinov et al.\textsuperscript{29} found no difference between men and women in the frequency of eating habits and various food items as triggering factors (Table 1).

**Precipitating factors and age**

One of the few studies that stratified dietary factors by age (16–29; 30–49; ≥50 years) shows an association between an increase in age and alcohol as a precipitating factor, while specific foods and skipping meals did not show statistical differences as precipitating factors across age groups\textsuperscript{52} (Table 2).

**Dietary triggering factors among children and adolescents.** A recently published study on nutrition in a population of adolescents demonstrated an association between migraines and coffee or cocktails.\textsuperscript{33} Another population study showed an elevated prevalence of migraines among adolescents who consumed ice cream.\textsuperscript{35} Bener et al.\textsuperscript{34} found that consumption of citrus fruits is a significant risk predictor for migraines among students.

On the other hand, in an experimental study, Salfield et al.\textsuperscript{49} showed that a fiber-rich diet reduced migraine frequency among migraine-suffering children, with or without the addition of vasoactive amines to the diet (Table 2).

A study with both retrospective and prospective characteristics, also conducted in migraine-suffering children and adolescents, found an association between fasting and severe migraines in girls but a reduced sensitivity to other dietary triggers.\textsuperscript{48}

**DISCUSSION**

The majority of studies on precipitating factors are based on retrospective self-reports. The possibility of selective memory among patients, as well as the need of patients for plausible causal explanations, may result in biased information\textsuperscript{10} and may partially explain some of the discrepancies among studies.

The wide variability of the frequency of reported triggers in different studies may be due to the wording of questions in the questionnaires and interviews. In the study by Fukui et al.,\textsuperscript{8} in which the reported frequencies are generally higher than those in other literature reports, foods are the first items in the list of trigger factors, which may have influenced the responses. In his recent review, Martin commentsthat75.9% of migraineurs in the study by Kelman\textsuperscript{51} responded positively when asked whether they could identify precipitating factors for their migraines, yet this percentage increased to 94.6% when the individuals were asked about specific triggering factors. It is possible that the variability of frequencies is also due to the variety of eating habits among the populations studied. This is the case in the population studies in this review, in which the authors suggest that the foods commonly described as precipitating factors are consumed less and are therefore less likely to precipitate migraines\textsuperscript{35}; the results from the two rural populations bear this out.\textsuperscript{23,28} Rural populations, when compared with other populations, report a significantly lower prevalence of migraines in general, which may also reflect racial and geographical differences,\textsuperscript{3} as in studies involving African
and Asian individuals. In addition, the knowledge of existing evidence that associates specific dietary triggers with migraines may reduce the frequency with which these triggers are chosen for consumption, as reported by Wöber et al. In an earlier study by the same investigators, the theoretical knowledge of wine, chocolate, caffeine, cheese, food additives, and nuts (P < 0.001) as well as spirits, fruits, and vegetables (P < 0.01) as precipitating factors had a greater influence on perceived dietary triggers than did the personal experience of migraineurs and/or tension-type headache sufferers. Theoretical knowledge has the potential to impact self-observation, thereby leading to reduction or elimination of exposure to precipitating factors, but these aspects were not evaluated. Hunger as a triggering factor was an exception because, in this case, personal experience had a greater impact than did theoretical knowledge (P < 0.01).

Another factor to be considered is the nature of the population studied. Migraine-suffering patients who were recruited from clinics had deliberately sought care for their migraines, and it is likely that these individuals experience migraines that are more severe, causing them to be more attentive to precipitating factors. Differences in the selection of subjects, as indicated by Hulihan, may also help to explain inconsistencies between the findings of Bird et al., who found migraineurs reported fewer headaches induced by cold-temperature palate stimulation compared with student controls, and those of other studies, such as that by Raskin and Knittle, who found that migraineurs in a hospital population were more sensitive to cold.

Of the studies using a prospective methodology, some were based on patient diaries. While this methodology provides a high degree of reliability, it is still not exempt from possible biases because, as Wöber et al. argue, some migraineurs will avoid the precipitating factors. Because retrospective studies are dependent on memory, it is likely that the frequencies reported will be different from those reported in prospective studies. A study of children by Chakravarty et al. reported frequency retrospectively and the number of migraine spells triggered by a given factor; results differed depending on the method used. In addition, the authors observed differences between the reports of parents and their children: while some parents denied any type of precipitating factor in the retrospective study, 100% of the children’s diaries identified at least one factor, and frequently more than one factor, demonstrating the subjectivity of retrospective studies and perceptions of specific events that had occurred during the 3-month period of the prospective study.

Another aspect to consider is that suspected trigger factors may be induced by the onset of a migraine; specifically, the prodromal phase of a migraine may actually stimulate cravings to consume certain foods. In other words, even though a specific food may be classified as a precipitating factor, the possibility exists that its consumption results from a migraine rather than causes it. Chocolate is the most widely cited example, as it has been observed that some patients exhibit cravings for sweet substances (chocolate among them) in the prodromal phase. In such cases, chocolate consumption is a premonitory symptom of migraines and not a precipitating factor – a perspective that was not addressed in this study. In addition, the role of chocolate as a potential precipitating factor is still unclear. On one hand, there are numerous reports that support its role as a dietary trigger, either at elevated frequencies or lower frequencies, between 0.0% and 6.0%. On the other hand, it has also been shown in a prospective analysis of eating habits that the majority of migraine-suffering patients consumed chocolate without any negative effects; furthermore, a randomized experimental study found that chocolate did not trigger migraines.

The study by Fukui et al. shows that a significant portion of migraineurs present more than one dietary factor as potential precipitating factors, exposing the likely interaction of multiple factors – another topic that was not frequently addressed in the studies evaluated in this review. Peatfield, who found a significant association between sensitivity to cheese or chocolate and red wine and also to beer, suggests there is an overlap in sensitivity to these items, which may indicate a physiological connection between these factors. Indeed, as pointed out by Martin, triggers may not operate independently: the occurrence of one may increase the likelihood of exposure to one or more other triggers (simultaneous occurrence may result in an aggregative effect). Additionally, some potential factors may not be capable of eliciting migraines without the presence of another trigger. For the most part, in the studies reviewed, it is not clear whether the triggers were consumed together. This does not allow for more specific conclusions about whether the effects result from isolated or combined food items.

Studies also diverge in the differences in frequencies of dietary precipitating factors between men and women. For example Russell et al. analyzed dietary trigger factors in groups (red wine/ripe cheese), while Fukui et al. examined red wine in isolation for differences between genders. The latter authors found a striking difference between genders; namely, that red wine was a much more common precipitating factor among women; the authors offered explanations related to possible habits or to genetic or hormonal susceptibility. It is interesting to observe, in studies by both Robbins and Kelman, that skipping meals and fasting were reported with greater frequency as precipitating factors among women;
Chakravarty et al.\textsuperscript{48} obtained similar results among girls. However, analysis of these results is complicated by the preponderance of female subjects involved in many of these studies; a larger sample size is required to enable modeling of possible differences between genders.

Analysis of differences related to life stages is limited by a lack of studies focusing on this aspect and by the narrow age-group ranges that have been evaluated up until now. For example, although adolescents have been included, most of whom are at least 15 years old, the wider-reaching studies analyzing precipitating factors have not used stratified age groups.\textsuperscript{25,29–31,37,45,62}

In their review, Millichap and Yee\textsuperscript{9} argue that maintaining a balanced diet, avoiding fasting or meal skipping, and recognizing and avoiding specific precipitating factors are all important to consider before commencing long-term administration of prophylactic medication in children. Unfortunately, these authors fail to include possible sensitivities to food items.

There were no medium- or long-term studies that restricted exposure to previously identified precipitating factors and monitored the subsequent effects. However, Bic et al.,\textsuperscript{43} in an experimental study, showed a positive correlation between the baseline ingestion of lipids and the frequency of migraines in a population of migraineurs; they observed that decreased ingestion of lipids was associated with a decrease in the frequency, intensity, and duration of migraines and a decrease in the use of medication. Although they believe that a reduction in dietary lipids improves outcome for migraine patients, they acknowledged that other factors such as weight reduction and changes in nutrient intake also may play a role. As such, the authors could not conclude with certainty that the improved outcome experienced by migraineurs was directly due to dietary lipid reduction, and they recognized the importance of validating their findings with further randomized studies. The greater prevalence of migraines among obese individuals, demonstrated in a large study by Peterlin et al.,\textsuperscript{70} suggests that weight reduction could have played a positive role in the Bic et al.\textsuperscript{43} study. Although Ray and Kumar\textsuperscript{71} debate whether migraines constitute a cause or effect of obesity, Kinik et al.\textsuperscript{72} observed in a pediatric population that obese patients present more frequent migraine spells than do overweight or normal-weight patients ($P = 0.018$). Together, these findings underscore the need to evaluate anthropometric parameters during dietary interventions in order to avoid biases.

Similarly, the reduction of migraine spells among children subjected to a control diet (rich in fiber) and a diet rich in fiber but with reduced vasoactive amines, as described by Salfield et al.,\textsuperscript{49} could, according to the authors, be attributed to the simple modification of the diet that may have previously been irregular and rich in sugars. The modified diets introduced in the study may have counterbalanced possible hypoglycemia. As a further aside, the increase in dietary fiber may have inhibited the absorption of vasoactive amines, explaining the similarities in results between the two high-fiber groups.

The association between migraines and the consumption of alcohol is consistently substantiated in population studies.\textsuperscript{28} However, there are conflicting results related to alcohol consumption.\textsuperscript{10,27–29,32,33,46} Nevertheless, the vast majority of studies showing alcohol to be a precipitating factor point to individual susceptibility, genetic or otherwise. To determine the influence of this precipitating factor, more randomized controlled trials are necessary. With respect to caffeine, the frequencies expressed for this precipitating factor among migraineurs are well below those reported for alcohol. The triggering effects of caffeine, however, have been demonstrated consistently in various studies looking at caffeine alone\textsuperscript{8,35,59,66} and in association with other factors,\textsuperscript{26,28,33} establishing caffeine as a probable, though less severe, precipitating factor.

As regards red wine, the design of the studies in this review varied from retrospective studies and population studies exploring associations between migraines and putative dietary triggers to prospective studies and experimental approaches. Further work is needed to reconcile the contradictory data that report a curiously lower prevalence of migraine in wine drinkers,\textsuperscript{27} a high frequency of wine as a precipitating factor,\textsuperscript{8,52} a positive association between migraine with aura and red wine,\textsuperscript{29} and no impact of alcohol on migraine spells among migraineurs.\textsuperscript{10}

The most frequently cited and most significant precipitating factor in the studies reviewed was fasting or skipping meals.\textsuperscript{8,31,37,48,51–53,57,62,66} Fasting as a trigger was demonstrated experimentally\textsuperscript{11} and by association with severe migraines.\textsuperscript{48} Although there is a strong case for a potential link between fasting and migraines, a recent study could not demonstrate this association.\textsuperscript{33}

A limited number of articles address the question of dehydration, liquid deprivation, or low consumption of liquid as a precipitating factor of migraines. These factors were reported with high frequency in one study\textsuperscript{49}; another study found similar results when addressing headaches generally, without differentiating migraines.\textsuperscript{87} None of the prospective or experimental studies in this review analyzed these factors, thereby limiting conclusions about this topic.

Furthermore, among the traditional dietary factors, cheese, though not significant among the association or prospective studies in this review, is reported with a relatively high frequency as a precipitating factor of migraine spells.\textsuperscript{8,59,65,66} In the only study in which the frequency was zero, the authors argue that the population likely does not
consume cheese or other possible migraine trigger foods in significant amounts.62

CONCLUSION

This review, although not systematic, covers the breadth of literature largely restricted to reports of dietary factors perceived as possible precipitating factors of migraine headaches. This study objectively shows the high frequency with which some of these factors may precipitate migraines in migraineurs. The data accumulated here highlight the importance of recognizing these factors in the management of migraineurs. Management strategies may vary. At present, the traditional approach seeks to identify and eliminate precipitating factors. The increased evaluation of dietary triggers in patients, an approach that is still practically nonexistent is clearly validated by the findings of this literature search. In addition, a paradigm shift has been proposed recently, which advocates controlled exposure and the development of strategies to confront precipitating factors, except in cases in which this would be inappropriate. Regardless of the strategy, the first and most important step is recognition of the precipitating dietary factor or factors. This is difficult in clinical practice, given the lack of evidence from controlled studies.

It is important to educate patients on the basis of scientific evidence and focus on the factors that can be changed. Despite the vast literature, there are relatively few data on potential precipitating factors. While descriptions in the literature of dietary triggers date back many decades, analyses involving population studies, prospective studies with and without interventions, and research investigating the interactions between various factors have only recently been emerging and will help elucidate the role of these factors in the promotion or alleviation of migraine headaches.

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