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Dietary patterns according to headache and migraine status: A cross-sectional study

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Abstract

Background—Several potential dietary trigger factors for migraine have been proposed. However, few studies have examined the intake pattern of these dietary items compared to adequate control populations and if intake levels may vary by migraine aura status or attack frequency.

Methods—Cross-sectional study among participants in the Women's Health Study. We used logistic regression to evaluate the association between migraine and headache status and low intake for foods commonly reported to affect migraine.

Results—25,755 women reported no history of migraine or headache; 5573 reported non-migraine headache and 7042 reported any migraine of which 2972 reported migraine without aura and 1974 reported migraine with aura within the past year. Those with non-migraine headache or any migraine were more likely to have low intake of total alcohol (OR=1.22, 95% CI:1.14–1.29 and OR=1.17, 95% CI:1.11–1.24, respectively). Migraineurs with aura were more likely to have low intake of chocolate, ice cream, hot dogs, and processed meats. Those who experience migraine at least once per week were more likely to have low intake of skim/low-fat milk and white and red wine.

Conclusion—Intake of most suggested migraine dietary triggers differs by migraine aura status and attack frequency, a pattern not found for non-migraine headache.

Keywords

Migraine; diet; epidemiology

Introduction

Approximately one fifth of women experience migraine and up to one-third of migraineurs experience migraine aura. Since migraine is a chronic-intermittent disorder and attack

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frequencies vary amongst migraine patients, there has been interest in determining what factors may trigger migraine attacks, including dietary factors. Several potential dietary trigger factors for migraine have been proposed including alcohol, cheese, and chocolate (1). Most studies have only examined dietary triggers for overall migraine and are often lacking appropriate control populations. Moreover, data on dietary patterns by migraine aura status and migraine attack frequency are sparse and have mainly focused on alcohol consumption (2–5). One study which examined several specific food triggers observed that beer and citrus fruits and vegetables were significant potential triggers for migraine with aura but not migraine without aura (6).

Using a non-headache and a non-migraine control group allows the evaluation of whether certain dietary intake patterns are specific to migraine. In addition, we can compare amongst different migraine subtypes and migraine attack frequencies. While we would expect all migraineurs to avoid similar food items in hopes of preventing the onset of migraine headache pain, differences in intake for those with different aura status or different attack frequency of migraine may suggest that avoidance patterns differ depending upon disease severity.

Using a large population of initially healthy women, we examined whether low intake of foods commonly considered to be migraine triggers differed by migraine and headache status as well as by aura status and migraine attack frequency. We are examining low intake because we hypothesized that food avoidance would be associated with these various headache forms in this observational study of middle aged women.

Methods

Study Population

The Women's Health Study was a large, randomized, double-blind, placebo controlled trial on the effect of low-dose aspirin and vitamin E on cardiovascular disease and cancer. The design and results of the trial have been previously reported (7–9). At baseline, 39,876 US female health professionals aged 45 years or older free of any major illnesses were randomized to receive aspirin, vitamin E or their placebos in a factorial design. The WHS was approved by the institutional review board at Brigham and Women's Hospital and informed consent was obtained from all participants.

Migraine and Headache Assessment

Prior to randomization, the women were asked “Have you ever had migraine headaches?” and “In the past year, have you had migraine headaches?” Women who reported experiencing migraine headaches within the past year were additionally asked about whether they experienced aura and about the frequency of their migraines (daily, weekly, monthly, every other month, and less than six times per year). The baseline questionnaire did not ask about non-migraine headache therefore information from the six-month questionnaire was used to assess headache. The six-month questionnaire asked women if they had experienced any headache since the baseline questionnaire. Based on the women's responses to these questions, we classified women as any migraine (women who reported ever experiencing

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migraine headache), nonm-igraine headache (women who reported experiencing headache but did not report migraine headache) and no history of headache (women who reported no history of migraine or non-migraine headache. In secondary analyses, we further classified women who reported migraine within the past year by aura status (migraine with aura (MA) versus migraine without aura (MO)) and by migraine frequency (at least once per week, monthly and less than monthly).

A previous study in the WHS has shown good agreement between self-reported migraine without aura and classification of migraine without aura based on the second version of the International Classification of Headache Disorders (10) criteria.

Food Intake Assessment

We limited our analysis to particular food items which have been previously hypothesized to be possible migraine triggers. These food items were chocolate, caffeinated coffee, decaffeinated coffee, total dairy products, cottage cheese, cream cheese, cheese (not cream or cottage cheese), ice cream, sherbet/ice milk/frozen yogurt, sour cream, yogurt, skim or low-fat milk, whole milk, cream, bacon, hamburger, hot dogs, processed meats, liquor, beer, white wine, red wine, and total alcohol consumption.

Prior to randomization, women were asked to complete a semiquantitative food frequency questionnaire (11). The validity and reproducibility of this questionnaire has been previously demonstrated. (12) The women were asked how often they consumed a serving of each food item on average over the previous years. The possible response options were never or less than once per month, 1–3 times per month, once per week, 2–4 times per week, 5–6 times per week, once per day, 2–3 times per day, 4–5 times per day, and ≥6 times per day. These responses were converted into the average number of servings per day. Citrus was defined as the sum of oranges, orange juice, grapefruit and grapefruit juice. Total dairy products was defined as the sum of cottage cheese, cream cheese, cheese (not cream or cottage cheese), ice cream, sherbet/ice milk/frozen yogurt, sour cream, yogurt, skim or low-fat milk, whole milk, and cream. Processed meat was the sum of bacon, hot dogs, and other processed meats. Total alcohol consumption was the sum of liquor, beer, white wine, and red wine.

Since the distribution of most food items were skewed towards low consumption, we dichotomized intake into 0 servings per day (no intake) versus more than 0 servings per day. Citrus and dairy products were more normally distributed so we categorized women into quintiles of intake for each food item. Our outcome was no intake or intake in the lowest quintile (referred to a “low intake”) compared to those who consumed the item or intake in the four higher quintiles (referred to as “non-low intake”).

We excluded women with more than 70 blanks on the semiquantitative food frequency questionnaire or with implausible total daily energy intake (≤600 or ≥3500 kcal/day) similar to previous studies in the WHS (13, 14).

Data Analysis

We first excluded 119 women missing information on migraine status at baseline and next we excluded 1,387 women without dietary data. This left 38,370 women for our analyses.

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Using logistic regressions, we calculated odds ratios and 95% confidence interval for low intake for each food item for women who experience any migraine and women who experience non-migraine headache compared to those who have no history of headache. We examined the low intake because low intake may represent a food avoidance pattern as a result of common beliefs about the food being a migraine trigger. Separate logistic regression models were constructed for each food item.

Next, we examined the association between migraine aura status or migraine frequency and low intake of each food item using logistic regressions to evaluate whether the food pattern in these subgroups differed from the food pattern of any migraine.

All analyses adjusted for total caloric intake (continuous), age (continuous), BMI (<25 kg/m^2, 25 to <30 kg/m^2, ≥30 kg/m^2), exercise (rarely/never, <1 time per week, 1 to 3 times per week, ≥4 times per week), smoking status (never, past, smoke <15 cigarettes per day, smoke ≥15 cigarettes per day), history of diabetes (yes/no), history of hypertension (yes/no), treatment for high blood pressure (yes/no), history of high cholesterol (yes/no), and treatment for high cholesterol (yes/no). Fewer than 90 women were missing information on any of our covariates and were assigned to the reference category or to the past user category (smoking).

All analyses were performed using SAS 9.1.3 (Cary, NC) and all p-values were two-tailed. We did not use all 131 food items available from the semi-quantitative food frequency questionnaire, but only used those items which have been previously suggested to be migraine triggers. Since all food items were selected a priori, we used a p-value of 0.05 when determining if our results were statistically significant.

Results

Of the 38,370 women eligible for inclusion in our study, 5573 reported non-migraine headache and 7042 reported any migraine of which 2972 reported migraine without aura in the past year and 1974 reported migraine with aura within the past year.

The baseline characteristics of the participants by aura status can be seen in Table 1. Women without a history of headache were slightly older than those with non-migraine headache or any migraine. Women who experience migraine were more likely to have a history of high cholesterol and hypertension. The distribution of food intake by migraine and headache status for each food item can be seen in Tables 2 and 3.

Table 4 presents the results comparing the risk of low intake for those who experience non-migraine headache or any migraine compared to those no history of headache. Those who experience non-migraine headache and those who experience any migraine were more likely to have low intake of total alcohol (OR=1.22, 95% CI: 1.14, 1.29 and OR=1.17, 95% CI: 1.11, 1.24, respectively), liquor, beer, white wine and red wine.

For other food items, we did observe differences in food intake for those with non-migraine headache and those with any migraine. Those who experience non-migraine headache were also more likely to experience low intake of caffeinated coffee (OR=1.10, 95% CI: 1.03,

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1.18) but this was not seen for those who experience any migraine (OR=1.00, 95% CI: 0.94, 1.07). Additionally, those who experience non-migraine headache were less likely to have low intake of chocolate and hamburger which suggests that they consume more of those items than participants with no history of headache. Those who experience any migraine were more likely to have low intake of total dairy, cheese, sour cream and skim or low fat milk but this was not seen for those with non-migraine headache.

Table 5 presents the results comparing the risk of low intake for those who experience migraine with aura compared to those who experience migraine without aura. Migraineurs with aura were more likely to have low intake of chocolate (OR=1.19, 95% CI: 1.05, 1.34), cheese (OR=1.36, 95% CI: 1.08, 1.71), ice cream (OR=1.20, 95% CI: 1.07, 1.35), hot dogs (1.28, 95% CI: 1.13, 1.45) and processed meats (OR=1.20, 95% CI: 1.05, 1.37). While Table 4 suggested that cheese intake was lower for any migraine, our analysis in Table 5 suggests that the low intake of cheese is specific to those who experience migraine with aura.

Table 6 presents the results comparing the risk of low intake by migraine frequency. Those who experience migraine monthly were more likely to have low intake of citrus (OR=1.22, 95% CI: 1.02, 1.46); we did not observe significantly lower consumption of citrus among those with migraine weekly or more often (OR=1.18; 95% CI: 0.86, 1.63). Those who experience migraine weekly or more often were more likely to have low intake of skim or low-fat milk (OR=1.64; 95% CI: 1.20, 2.25), white wine (OR=2.13; 95% CI: 1.57, 2.89) and red wine (OR=1.69, 95% CI: 1.14, 2.51).

Discussion

Results of this large study in women suggest that, with the exception of alcohol consumption, dietary intake pattern of food items suggested to be migraine triggers is specific for migraineurs. Additionally, there was evidence of low intake of dairy products, which are suspected dietary migraine triggers, by those with any migraine which was not observed for those who only experience headache. Secondary analysis observed that the intake of certain food items like chocolate, some processed meats, some dairy products and wine varies based on aura status and migraine attack frequency. As this pattern was specific for these subgroups, specific food intake patterns appear to be characteristic for migraine aura and for higher frequency migraine attacks.

One of the hypotheses behind why some food items have been reported to be migraine trigger proposes that hidden food allergies may be why some food items are reported as migraine triggers. A previous study in adults showed that testing for IgE-specific food allergy and restricting diets based on the results of these tests may help to decrease migraine frequency (15). Observational studies and a randomized controlled trial have shown that diet restriction based on IgG antibodies may reduce the frequency of migraine attacks (16–18). However, another study found no difference in IgE and IgG4 titres in response among adults with dietary migraine and non-dietary migraine (19). Additionally, a small duodenal biopsy study also did not find differences in plasmacyte populations with anti-IgG, anti-IgM and anti-IgE immunohistochemisty between migraineurs with food-induced migraine and those without food induced migraine (20). These studies refute the idea that food allergies may

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underlie the association between food items and migraine attacks. A review article suggested that non-allergic mechanisms may also be involved in food-related migraine since various chemicals like ethanol, sodium nitrate, caffeine, phenylethylamine, tyramine, monosodium glutamate, sodium metabisulfite, theobromine, and benzoic acid may trigger migraine attacks (21).

The most commonly studied trigger in previous studies is alcohol consumption, but results are mixed (3–6, 22). We observed that both those who experience migraine and those who experience headache were likely to have low intake of alcohol consumption. This suggests that alcohol may be avoided not just by those with migraine. We did not find significant differences in the risk of high intake of alcohol between MA and MO. However, we observed evidence that those with frequent migraine were more likely to be in the lowest category of alcohol consumption. This suggests that alcohol consumption may be avoided by those who experience frequent migraine which is in line with the observation that those with cluster headache consume less alcohol than the general population (23).

In contrast to a previous study (6), we did not observe differences in intake of citrus or beer but did observe some differences in the risk of low intake for chocolate, cheese, ice cream, hot dogs and processed meats.

Some of the differences in our findings compared to previous studies may be explained by the differences between the design of our study compared to previous studies. Most previous research is retrospective and asks participants to indicate whether the food items have triggered attacks and potentially how consistently the attacks are triggered by the items. In contrast, the present study examines overall intake of food commonly reported as migraine triggers. Another reason for the discrepant findings is the matter of the association under study. If food items indeed trigger migraine, they would be avoided more over time. Thus, depending on the timing and set up of the study, results may indicate an increased or decreased consumption pattern.

In general, we would expect migraineurs overall to have different intakes of foods commonly reported as migraine triggers compared to those without migraine. Our study allows us to directly examine whether dietary food intake patterns do differ between those with migraine or non-migraine headache compared to a headache-free population. Interestingly, migraineurs do not have lower intake of many foods commonly reported to be migraine triggers. This may indicate that these food items in fact are not migraine triggers or that the association of food in general as a migraine trigger is more complex. Further stratifying by aura status and migraine frequency allows us to determine if intake patterns might differ by migraine features. Differences suggest that those food items may be more commonly avoided by those with a particular type of migraine potentially due to disease severity or because the food item triggers a specific type of migraine attack.

Some limitation should be noted when interpreting our results. First, we did not specifically assess food as triggering factor in our study and instead examined average food intake patterns. Although we did observe some differences in food intake by migraine aura status and frequency, we cannot directly conclude that these food items are directly related to

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migraine. Second, this is a cross-sectional study with only one assessment of migraine status and food intake. This prevents us from examining the temporal association between migraine status, migraine frequency and food intake. For example, we cannot determine if migraineurs consume less of certain foods to avoid triggering migraine, if migraineurs avoid certain foods after a migraine attack, or if low intake of these foods may play a role in migraine or headache development. Future prospective studies focused a few food items may help to determine the temporal association between migraine status, migraine frequency, and intake of foods commonly thought of as migraine triggers. Third, migraine and headache status was self-reported so some misclassification of migraine status is possible. However, we do not believe that migraine status reporting was related to reporting of food intake (random misclassification). Finally, although our cohort is larger than many previous migraine food trigger studies, power may have been limited in some subgroups of food categories with generally low intake. In contrast, sample sizes for some comparisons were very large which may have allowed for the detection of effect sizes that may not be clinically meaningful even though they are statistical significant.

Despite these limitations, this is one of the largest studies of migraine and food intake to date. We enrolled a population free of major diseases at baseline which should help to limit the impact of comorbidities on dietary habits and the food assessment was not specific to participants with migraine. While migraine was self-reported, previous studies have shown good agreement with standardized criteria (10). Additionally we used a validated semi-quantitative food frequency questionnaire to assess food intake.

In conclusion, the intake of certain food items, particularly chocolate, wine, processed meats and some dairy products, differs based on migraine aura status or migraine frequency. As this dietary intake pattern was not seen for overall migraine, our results suggest that these items may be involved in the initiation of particular types of migraine. Future studies need to be performed to further elucidate the mechanisms by which food items may trigger migraine attacks and to determine if food triggers vary based on the characteristics of the migraine attacks.

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Clinical Relevance

- Intake patterns of foods commonly reported to be migraine triggers differs by migraine frequency and migraine aura status.
- With the exception of alcohol consumption, differences in food items commonly suspected to be migraine triggers, was not observable in women with non-migraine headache.
- This suggests that some food factors are involved in the initiation of particular types of migraine.

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Table 1

Baseline characteristics of women according to migraine aura status in the Women's Health Study (n=38370).

Characteristic	No migraine or headache n = 25755	Non-migraine headache n = 5573	Any migraine n = 7042
Mean age (SE), y	55.1 (7.3)	53.6 (6.4)	53.6 (6.4)
BMI (SE), kg/m^2	25.9 (5.0)	26.3 (5.2)	26.2 (5.1)
Total daily calories (SE), kcal	1717.1 (532.5)	1750.3 (532.7)	1739.3 (543.0)
History of hypertension, %	25.4	25.5	27.2
Antihypertensive medication use, %	13.6	12.7	15.1
History of high cholesterol, %	28.8	29.2	32.1
Cholesterol lowering medication use, %	3.2	3.0	3.0
History of diabetes, %	2.8	3.2	2.4
Vigorous physical activity, %			
Rarely/never	38.3	37.5	38.4
< 1/week	19.1	20.8	22.3
1–3 times/week	31.3	35.8	29.7
≥4 times/week	11.4	8.9	9.6
Smoking status, %			
Never	50.4	51.5	53.2
Past	36.4	36.3	34.4
Current < 15 cig/day	4.9	4.5	4.5
Current ≥ 15 cig/day	8.3	7.7	7.9

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Table 2

Distribution of food intake by migraine and headache status.

Food Item	No migraine or headache with non-low intake (n, %)	No migraine or headache with low intake (n, %)	Non-migraine headache with non-low intake (n, %)	Non-migraine headache with low intake (n, %)	Any migraine with non-low intake (n, %)	Any migraine with low intake (n, %)
Chocolate	15245 (59.6)	10318 (40.4)	3481 (63.0)	2043 (37.0)	4357 (62.3)	2640 (37.7)
Caffeinated Coffee	19510 (76.2)	6095 (23.8)	4112 (74.1)	1440 (25.9)	5293 (75.6)	1710 (24.4)
Decaffeinated coffee	11503 (45.6)	13749 (54.4)	2551 (46.7)	2909 (53.3)	3184 (46.1)	3718 (53.9)
Citrus	20589 (80.1)	5123 (19.9)	4459 (80.1)	1105 (19.9)	5592 (79.5)	1442 (20.5)
Total dairy products	20601 (80.1)	5134 (19.9)	4485 (80.5)	1086 (19.5)	5540 (78.7)	1501 (21.3)
Cottage cheese	15070 (59.5)	10264 (40.5)	3244 (59.0)	2256 (41.0)	4070 (58.6)	2872 (41.4)
Cream cheese	11797 (47.1)	13247 (52.9)	2668 (48.9)	2788 (51.1)	3232 (47.0)	3644 (53.0)
Cheese (not cream/cottage)	23947 (93.9)	1561 (6.1)	5195 (94.0)	332 (6.0)	6518 (93.2)	474 (6.8)
Ice cream	14929 (59.1)	10346 (40.9)	3256 (59.4)	2230 (40.6)	4085 (59.0)	2843 (41.0)
Sherbet/ice milk/frozen yogurt	16131 (63.8)	9148 (36.2)	3581 (65.0)	1929 (35.0)	4390 (63.3)	2546 (36.7)
Sour cream	13665 (54.4)	11474 (45.6)	2994 (54.7)	2479 (45.3)	3745 (54.3)	3156 (45.7)
Yogurt	14529 (57.7)	10636 (42.3)	3204 (58.5)	2275 (41.5)	4043 (58.4)	2880 (41.6)
Skim or low-fat milk	21409 (84.1)	4061 (15.9)	4638 (84.0)	884 (16.0)	5774 (82.8)	1201 (17.2)
Whole milk	3169 (12.7)	21727 (87.3)	708 (13.1)	4715 (86.9)	1013 (14.8)	5816 (85.2)
Cream	5930 (23.8)	18995 (76.2)	1394 (25.6)	4045 (74.4)	1777 (26.0)	5066 (74.0)
Bacon	11960 (46.6)	13686 (53.4)	2649 (47.8)	2897 (52.2)	3380 (48.2)	3633 (51.8)
Hamburger	21301 (83.2)	4299 (16.8)	4739 (86.5)	806 (14.5)	5861 (83.9)	1124 (16.1)
Hot dogs	9690 (37.9)	15895 (62.1)	2188 (39.5)	3351 (60.5)	2711 (38.7)	4297 (61.3)
Processed meats	18846 (73.2)	6901 (26.8)	4160 (74.7)	1411 (25.3)	5210 (74.0)	1828 (26.0)
Liquor	7108 (28.0)	18261 (72.0)	1401 (25.4)	4122 (74.6)	1808 (25.9)	5162 (74.1)
Beer	5012 (19.8)	20252 (80.4)	1001 (18.1)	4519 (81.9)	1218 (17.5)	5749 (82.5)
White wine	10320 (40.9)	14937 (59.1)	2094 (38.0)	3411 (62.0)	2641 (37.9)	4326 (62.1)
Red wine	5499 (21.9)	19574 (78.1)	1072 (19.6)	4412 (80.4)	1289 (18.6)	5637 (81.4)
Total alcohol consumption	15628 (60.7)	10127 (39.3)	3131 (56.2)	2442 (43.8)	3996 (56.8)	3046 (43.2)

Note: Low intake was defined as intake in the lowest quintile for total citrus and total dairy products only and no intake for all other food items. Non-low intake was defined as intake in the four higher quintiles for total citrus and total dairy products only and as consuming the item for all other food items.

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Table 3

Distribution of food intake by migraine aura status.

Food Item	MA with non-low intake (n, %)	MA with low intake (n, %)	MO with non-low intake (n, %)	MO with low intake (n, %)
Chocolate	1191 (60.7)	770 (39.3)	1922 (65.0)	1034 (35.0)
Caffeinated Coffee	1466 (74.6)	499 (25.4)	2248 (76.1)	707 (23.9)
Decaffeinated coffee	867 (44.7)	1074 (55.3)	1351 (46.5)	1553 (53.5)
Citrus	1567 (79.4)	406 (20.6)	2352 (79.3)	614 (20.7)
Total dairy products	1553 (77.9)	421 (22.1)	2370 (79.0)	602 (21.0)
Cottage cheese	1127 (57.7)	825 (42.3)	1714 (58.5)	1216 (41.5)
Cream cheese	884 (45.8)	1048 (54.2)	1398 (48.1)	1507 (51.9)
Cheese (not cream/cottage)	1812 (92.1)	155 (7.9)	2773 (94.1)	173 (5.9)
Ice cream	1105 (56.7)	843 (43.3)	1790 61.3()	1130 (38.7)
Sherbet/ice milk/frozen yogurt	1230 (63.0)	723 (37.0)	1861 (63.7)	1060 (36.3)
Sour cream	1051 (54.0)	896 (46.0)	1627 (56.0)	1279 (44.0)
Yogurt	1123 (58.1)	811 (41.9)	1724 (59.0)	1196 (41.0)
Skim or low-fat milk	1627 (83.4)	324 (16.6)	2431 (82.6)	511 (17.4)
Whole milk	274 (14.2)	1654 (85.8)	453 (15.7)	2427 (84.3)
Cream	487 (25.3)	1441 (74.7)	779 (27.0)	2106 (73.0)
Bacon	923 (46.8)	1049 (53.2)	1454 (49.2)	1501 (50.8)
Hamburger	1642 (83.8)	317 (16.2)	2495 (84.8)	449 (15.3)
Hot dogs	685 (34.8)	1284 (65.2)	1201 (40.7)	1752 (59.3)
Processed meats	1411 (71.5)	563 (28.5)	2229 (75.1)	740 (24.9)
Liquor	496 (25.3)	1465 (74.7)	740 (25.3)	2206 (74.7)
Beer	366 (18.7)	1592 (81.3)	494 (16.8)	2449 (83.2)
White wine	747 (38.2)	1210 (61.8)	1084 (36.9)	1857 (63.1)
Red wine	362 (18.6)	1586 (81.4)	504 (17.2)	2426 (82.8)
Total alcohol consumption	1668 (55.7)	1304 (44.3)	1099 (56.2)	875 (43.9)

Note: Low intake was defined as intake in the lowest quintile for total citrus and total dairy products only and no intake for all other food items. Non-low intake was defined as intake in the four higher quintiles for total citrus and total dairy products only and as consuming the item for all other food items. MA = migraine with aura; MO = migraine without aura.

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Table 4

Multivariate-adjusted* odds ratio of low intake of food items by migraine and headache status (N=38084).

Food Item	No migraine or headache n = 25755	Non-migraine headache n = 5573	p-value	Any migraine n = 7042	p-value
Chocolate	1.00	0.93 (0.88, 0.99)	0.032	0.97 (0.91, 1.02)	0.24
Caffeinated Coffee	1.00	1.10 (1.03, 1.18)	0.004	1.00 (0.94, 1.07)	0.89
Decaffeinated coffee	1.00	0.94 (0.89, 1.00)	0.044	0.96 (0.91, 1.02)	0.15
Citrus	1.00	0.99 (0.92, 1.07)	0.82	1.02 (0.95, 1.09)	0.68
Total dairy products	1.00	1.00 (0.93, 1.08)	0.95	1.09 (1.02, 1.17)	0.013
Cottage cheese	1.00	1.01 (0.95, 1.08)	0.68	1.01 (0.96, 1.07)	0.67
Cream cheese	1.00	0.97 (0.91, 1.03)	0.28	1.03 (0.98, 1.09)	0.25
Cheese (not cream/cottage)	1.00	1.08 (0.95, 1.22)	0.25	1.19 (1.07, 1.33)	0.002
Ice cream	1.00	1.03 (0.96, 1.09)	0.43	1.04 (0.98, 1.10)	0.21
Sherbet/ice milk/frozen yogurt	1.00	0.97 (0.92, 1.04)	0.41	1.04 (0.99, 1.10)	0.15
Sour cream	1.00	1.05 (0.99, 1.11)	0.14	1.06 (1.004, 1.12)	0.035
Yogurt	1.00	1.02 (0.96, 1.08)	0.63	1.00 (0.94, 1.05)	0.91
Skim or low-fat milk	1.00	1.03 (0.95, 1.12)	0.43	1.12 (1.04, 1.20)	0.003
Whole milk	1.00	0.98 (0.90, 1.08)	0.72	0.84 (0.78, 0.91)	O.001
Cream	1.00	0.95 (0.89, 1.02)	0.13	0.93 (0.87, 0.99)	0.017
Bacon	1.00	0.98 (0.92, 1.04)	0.48	0.96 (0.91, 1.01)	0.11
Hamburger	1.00	0.91 (0.83, 0.98)	0.020	1.01 (0.94, 1.09)	0.73
Hot dogs	1.00	0.97 (0.91, 1.03)	0.34	1.00 (0.95, 1.06)	0.99
Processed meats	1.00	0.97 (0.90, 1.04)	0.36	1.00 (0.94, 1.06)	0.89
Liquor	1.00	1.12 (1.05, 1.20)	0.001	1.08 (1.02, 1.15)	0.015
Beer	1.00	1.15 (1.07, 1.24)	<0.001	1.19 (1.11, 1.27)	<0.001
White wine	1.00	1.14 (1.07, 1.22)	<0.001	1.13 (1.07, 1.19)	<0.001
Red wine	1.00	1.17 (1.08, 1.26)	<0.001	1.22 (1.14, 1.31)	<0.001
Total alcohol consumption	1.00	1.22 (1.14, 1.29)	<0.001	1.17 (1.11, 1.24)	<0.001

*Adjusted for age, body mass index, exercise, smoking status, average daily calorie consumption, history of diabetes, history of hypertension, treatment for high blood pressure, history of high cholesterol and treatment for high cholesterol

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Table 5

Multivanate-adjusted* odds ratio of low intake of food items by migraine aura status (N=4946).

Food Item	Active migraine without aura, n = 2972	Active migraine with aura, n=1974	p-value
Chocolate	1.00	1.19 (1.05, 1.34)	0.005
Caffeinated Coffee	1.00	1.10 (0.96 1.26)	0.16
Decaffeinated coffee	1.00	1.08 (0.96 1.21)	0.20
Citrus	1.00	0.98 (0.84 1.13)	0.76
Total dairy products	1.00	1.05 (0.90, 1.22)	0.54
Cottage cheese	1.00	1.03 (0.91 1.16	0.64
Cream cheese	1.00	1.09 (0.97, 1.23)	0.14
Cheese (not cream/cottage)	1.00	1.36 (1.08, 1.71)	0.008
Ice cream	1.00	1.20 (1.07, 1.35)	0.003
Sherbet/ice milk/frozen yogurt	1.00	1.03 (0.91 1.16)	0.66
Sour cream	1.00	1.08 (0.96 1.21)	0.22
Yogurt	1.00	1.03 (0.91, 1.16)	0.63
Skim or low-fat milk	1.00	0.93 (0.79, 1.08)	0.34
Whole milk	1.00	1.12 (0.95, 1.33)	0.17
Cream	1.00	1.08 (0.94, 1.23)	0.27
Bacon	1.00	1.10 (0.97, 1.23)	0.13
Hamburger	1.00	1.06 (0.90, 1.24)	0.50
Hot dogs	1.00	1.28 (1.13, 1.45)	<0.001
Processed meats	1.00	1.20 (1.05, 1.37)	0.009
Liquor	1.00	1.01 (0.88, 1.15)	0.94
Beer	1.00	0.88 (0.76, 1.03)	0.10
White wine	1.00	0.95 (0.84, 1.07)	0.36
Red wine	1.00	0.91 (0.78, 1.06)	0.23
Total alcohol consumption	1.00	1.03 (0.91, 1.16)	0.64

*Adjusted for age, body mass index, exercise, smoking status, average daily calorie consumption, history of diabetes, history of hypertension, treatment for high blood pressure, history of high cholesterol and treatment for high cholesterol

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Table 6

Multivanate-adjusted* odds ratio of low intake of food items by migraine frequency (N=4881).

Food Item	Less than monthly N=3662	Monthly N=966	P-value	Weekly or more often N=253	p-value
Chocolate	1.00	0.99 (0.85, 1.15)	0.85	1.23 (0.94, 1.61)	0.12
Caffeinated Coffee	1.00	1.10 (0.93, 1.29)	0.28	1.17 (0.93, 1.57)	0.30
Decaffeinated coffee	1.00	1.10 (0.95, 1.28)	0.19	1.00 (0.77, 1.30)	0.99
Citrus	1.00	1.22 (1.02, 1.46)	0.033	1.18 (0.86, 1.63)	0.31
Total dairy products	1.00	0.92 (0.76, 1.12)	0.40	0.82 (0.58, 1.17)	0.27
Cottage cheese	1.00	1.01 (0.87, 1.17)	0.92	0.81 (0.62, 1.07)	0.14
Cream cheese	1.00	0.99 (0.85, 1.14)	0.86	1.07 (0.82, 1.39)	0.64
Cheese (not cream/cottage)	1.00	1.02 (0.76, 1.36)	0.90	1.32 (0.83,2.12)	0.24
Ice cream	1.00	0.96 (0.83, 1.12)	0.62	1.04 (0.80, 1.36)	0.78
Sherbet/ice milk/frozen yogurt	1.00	1.09 (0.94, 1.27)	0.26	0.94 (0.72, 1.24)	0.68
Sour cream	1.00	1.01 (0.88, 1.17)	0.85	1.05 (0.81, 1.37)	0.71
Yogurt	1.00	1.03 (0.89, 1.20)	0.68	0.98 (0.75, 1.28)	0.87
Skim or low-fat milk	1.00	1.20 (0.99, 1.46)	0.06	1.64 (1.20,2.25)	0.002
Whole milk	1.00	1.08 (0.87, 1.34)	0.48	0.72 (0.51, 1.01)	0.055
Cream	1.00	1.01 (0.86, 1.19)	0.90	0.82 (0.62, 1.09)	0.17
Bacon	1.00	0.99 (0.85, 1.14)	0.86	1.00 (0.77, 1.31)	0.98
Hamburger	1.00	1.09 (0.89, 1.33)	0.40	1.24 (0.88, 1.75)	0.22
Hot dogs	1.00	1.10 (0.94, 1.28)	0.24	0.88 (0.67, 1.14)	0.33
Processed meats	1.00	1.08 (0.92, 1.28)	0.36	1.06 (0.79, 1.43)	0.71
Liquor	1.00	1.09 (0.92, 1.29)	0.33	1.37 (0.99, 1.88)	0.054
Beer	1.00	1.17 (0.96, 1.42)	0.12	1.34 (0.92, 1.94)	0.12
White wine	1.00	1.11 (0.96, 1.30)	0.17	2.13 (1.57,2.89)	<0.001
Red wine	1.00	1.21 (0.99, 1.47)	0.058	1.69 (1.14,2.51)	0.009
Total alcohol consumption	1.00	1.09 (0.94, 1.27)	0.24	1.38 (1.06, 1.80)	0.016

*Adjusted for age, body mass index, exercise, smoking status, average daily calorie consumption, history of diabetes, history of hypertension, treatment for high blood pressure, history of high cholesterol and treatment for high cholesterol