Association between mustard derivatives Consumption and Incidence of headache:A cross-sectional Study

Abstract

Background: Headache disorders are among the most common neurological disorders globally and, in susceptible individuals, they are commonly provoked by dietary factors. Mustard is a widely consumed condiment containing bioactive compounds, such as allyl isothiocyanate and glucosinolate derivatives, which may modulate vascular and neurochemical pathways. This study aimed to evaluate mustard (including mustard seeds, paste and sauces) as a dietary trigger for headache despite its common use in diet having been explored by few researchers.

Methods: This study aimed to 1) investigate the incidence of headache after consumption of mustard and 2) determine whether an association exists between frequency of mustard consumption and development of a headache among adults. A cross-sectional observational study was performed including 112 adults. The data were collected through a structured questionnaire that assessed demographic characteristics, frequency and type of mustard use, occurrence of headache after consuming mustard, latency between consumption and development of symptoms and other potential dietary triggers. The main outcome was self-reported headache after mustard. Descriptive statistics were obtained, and the relationship between mustard intake frequency and headache incidence was examined using the Chi-square test. Multivariate logistic regression was used to adjust for potential confounders, such as age, sex and other dietary triggers.

Results: Overall, participants were aged 35 ± 10 years with a total of 52% females and 48% males. The majority of participants were occasional mustard consumers (62%), 22% and 16% were frequent and rare mustard consumers, respectively. Forty-one (36.6%) subjects reported headache after using mustard. Frequent mustard consumers (62.5%) had a higher proportion of headaches than occasional (34.2%) and rare consumers (11.2%) ($p = 0.04$). However, multivariate logistic regression analysis revealed that this association lost statistical significance

($p > 0.05$) after adjustment for other dietelic triggers and demographic variables. Patients with headaches reported that the most common type of headache was migraine-like (51%), followed by sinus-type headaches (19%) and unspecified headaches (30%). The most typical time for headache onset was 2–4 hours after eating mustard.

Conclusion: It is based on an observational correlation between increased mustard consumption and higher reporting of headaches. However, this association was not maintained after adjustment for potential confounders and reflects that mustard is not likely a trigger for people with headaches at the population level. However, mustard can be a trigger for susceptible people. More prospective studies and controlled dietary challenge trials need to be conducted to gain more clarity of the potential role played by mustard and associated diet factors in headache etiology.

Keywords: Headache, Migraine, Mustard consumption, Dietary triggers, Cross-sectional study, Food-induced headache.

Introduction

Headache disorders are among the most common neurological disorders globally (Leonardi *et al.*, 2024). It may result in significant burden of disability and loss of quality of life (D'Amico *et al.*, 2020). The most prevalent of these are migraine and tension-type headache (Burch, 2019), which have an insidious impact affecting a considerable fraction of the adult population (D'Amico *et al.*, 2020). Dietary factors are commonly cited as precipitating factors for headache attacks, especially in people susceptible to migraine.

Histamine, tyramine and other biogenic amines have been implicated with triggering headaches(Durak-Dados, Michalski and Osek, 2020; Sanlier and Bektesoglu, 2021). These chemicals can affect blood vessels in the brain and neurotransmitter pathways, possibly triggering headache attacks in susceptible individuals(Frederiksen *et al.*, 2019). Foods known to be headache triggers are aged cheese, fermented products, chocolate and some condiments(Zaeem, Zhou and Dilli, 2016).

Mustard is a commonly used condiment made from mustard seeds and pervades sauces, dressings, and processed foods(Sharma *et al.*, 2024). A number of biologically active compounds can be found, including allyl isothiocyanate, glycosylates and trace elements such

as magnesium and selenium(Lietzow, 2021). These compounds can affect vascular regulation and inflammatory processes.

On the other hand, fermentation processes used in the preparation of some mustards can also result in the production of biogenic amines such as histamine and tyramine. For example, results belong to Yu and colleagues (Yu *et al.*, 2021) showed that L. plantarum and L. brevis can effectively reduce biogenic amines and nitrite in fermented mustard model studies.This may be associated with symptoms such as headaches and flushing.

Despite widespread consumption of mustard, limited research has investigated its potential role as a dietary trigger for headache. Understanding whether mustard contributes to headache occurrence could help improve dietary recommendations for individuals prone to headaches. Therefore, this study aimed to evaluate the incidence of headache associated with mustard consumption and to assess the potential relationship between mustard intake and headache occurrence among adults.

Materials and methods

Study design

A cross-sectional observational study was conducted on 112 participantsto evaluate the association between mustard consumption and headache incidence.

Study population

Participants were recruited from outpatient clinics and community settings. Inclusion criteria included adults aged ≥ 18 years, individuals who consumed mustard-containing foods regularly and persons able to provide informed consent. The exclusion criteria were a diagnosed neurological disorder unrelated to headache, recent head trauma and inability to correctly recall habitual dietary intake.

Data collection

Data were collected by a structured questionnaire included demographic characteristics (age, sex, occupation), the frequency of eating mustard, type of mustard consumption (yellow, Dijon, brown and homemade), the presence of headache after preparations containing mustard use

and interval between eating preparation that contains mustard and occurrence headache history migraine or chronic headache and other dietary triggers. Participants were queried if headaches appeared within 0–6 h after mustard consumption.

Outcome measures

The main outcome was the occurrence of headache after mustard consumption, as reported by the subjects. Headache episode frequency, headache severity with VAS, association pattern between mustard intake frequency and headache occurrence was defined as the secondary outcomes.

Statistical analysis

Statistical software (GraphPad Prism 10.3) was used for data analysis. For descriptive statistics mean and standard deviation or frequency were calculated. The association between mustard consumption and headache occurrence was assessed using a Chi-square test. Three logistic regression analyses to identify independent predictors of headache occurrence. A p-value < 0.05 was considered statistically significant.

Results

Participant characteristics

The study finally included 112 subjects. Mean age was 35 ± 10 years with the study cohort consisting of 52% females and 48% males. Concerning the residency of a participant, 78% were live in urban and 22% were in rural areas as shown in the table1.

Table 1: Demographic characteristics of participants.

Characteristics	**Results**
Age (years, mean ± SD)	35 ± 10
Sex (female/male, %)	52/48
Residency (Urban/rural, %)	72/28

Mustard consumption patterns

Most participants reported consuming mustard occasionally (62%), a smaller proportion (22%) reported frequent consumption while the remaining 16% of participants reported rare consumption of mustard as shown in table 2.

Table 2: Mustard consumption patterns.

Frequency of mustard consumption	n	Participants (%)
Frequent	24	22
Occasional	70	62
Rare	18	16

Association between mustard intake and headache

To assess the association between mustard intake and headache, participants were divided into three groups according to their frequency of mustard consumption (rare consumers, occasional consumers and frequent consumers). The self-reported frequency of headaches in relation to mustard consumption was compared between groups by means of a chi-square test (table 3).

The results demonstrated that regular mustard consumption members were more prone to headache than non-mustard consumers or those with infrequent intake. In particular, the prevalence of participants who reported headaches following mustard intake increased linearly with increasing frequency of consumption. This first comparison indicated a moderate relationship between mustard intake and incidence of headache.However, given that headaches can be caused by several dietary and lifestyle factors they performed a multivariate logistic regression model to adjust for potential confounders. These ranged from the consumption of other common dietary triggers (including chocolate, aged cheese, caffeine-containing drinks and fermented foods) to demographic factors such as age and sex.

There were also markedly stronger associations between mustard consumption and headache incidence that attained statistical significance (p 0.05). This associative finding suggests that while and individuals may report mustard ingestion as a possible precipitant, this documented

association could be due in part to co-exposure of other dietary triggers or individual susceptibility to diet-induced headache. However, the descriptive trend seen through various mustard consumption levels suggests that some individuals may be intolerant and or have headache symptoms post mustard ingestion which needs further research with future prospective or controlled dietary studies.

Table 3: Association between mustard intake and headache.

Frequency of mustard consumption	**Participants reporting headache**		**Participants without headache**		**p-value**
	n	**%**	**n**	**%**	
Frequent consumption	15	62.5%	9	37.5%	
Occasional consumption	24	34.2%	46	65.8%	
Rare consumption	2	11.2%	16	88.8%	
Total	**41**	**36.6%**	**71**	**74.4%**	**0.04***

Incidence of headache following mustard consumption

Headache onset typically occurred within 2–4 hours after consumption (figure 1).

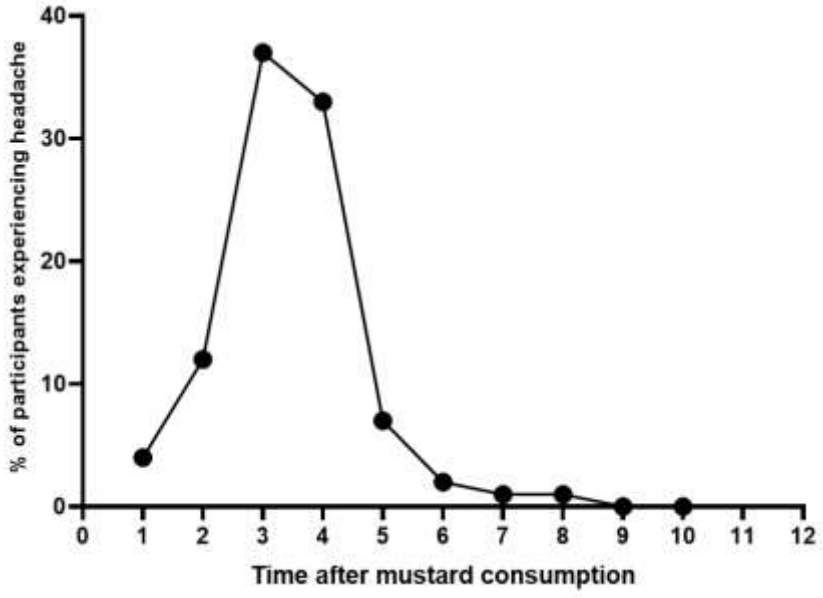

Figure 1: Time-dependent incidence of headache following mustard consumption

Types of headaches reported following mustard consumption

Respondents who had reported developing headaches after consuming mustard were asked to classify their headache symptoms according to common clinical characteristics. Headaches reported were classified into migraine-like headache, sinus-like headache, or unspecified headache. Most of the affected participate described clinical manifestations consistent with migraine-like headache, which included unilateral head pain associated with prominent symptoms like nausea or photophobia. Conversely, the smallest fraction developed sinus- type headache symptoms (given by frontal pressure and nasal congestion). However, 30% were unable to provide a clear classification of their symptoms and were classified as unspecified headache (table 4).

Table 4: Type of headache reported following mustard consumption.

Type of Headache	**Number of Participants (n)**	**Percentage (%)**
Migraine-like headache	21	51
Sinus-type headache	8	19
Unspecified headache	12	30
Total	**41**	**100**

The commonest pattern of headache attributed to photopheresis in this study was overall migraine-like headaches. Our results showing a similar distribution of headache types suggest that mustard do not lead to one single specific headache phenotype, but may act as an addition symptom trigger via several mechanisms which include vascular, inflammatory or neurochemical pathways.

Discussion

The present study aimed to evaluate the relationship between frequency of mustard consumption and headache among adults. While there is a descriptive trend of greater reporting of headache associated with increasing mustard consumption, this relationship is non-significant when adjusting for confounding dietary and demographic variables. Such findings are suggestive of the complexity that lies in trigger and contribute foods for headache

disorders, indicating a potential role for mustard as a trigger food while recognizing that such foods should not constitute universal risk factors in a dietary context.

The population being studied was fairly balanced by sex (about 50% female) and included subjects with mean ages of around 35 years(Fan *et al.*, 2023). These decades encompass the demographic peak for primary headache disorders (ie, migraine), affecting individuals aged 20 to 50 years on average (Fan *et al.*, 2023). The balanced size of participants and similarity in both sexes gives the study more internal validity with respect to previous epidemiological studies (Dong *et al.*, 2025) that have repeatedly shown a significantly higher prevalence of headache over-responsiveness among women compared to men for migraine and food related headaches. Hormonal effects - especially fluctuations in estrogen - might shape trigeminovascular pathways and increase the risk for dietary triggers.

Most of the participants lived in urban areas — which may be accounted for some differences in eating habits but also availability of processed food containing mustard or derivatives, they note. Urban populations typically experience much more exposure to condiment-laden dietary staples, fermented foods and processed diets which potentially play complex roles in modulating headache prevalence through intricate dietary cross talk (Kébé *et al.*, 2025). Most respondents claimed that they ate mustard only occasionally and almost none admitted to consuming it regularly (Grygier, 2023). This distribution is consistent with the role of mustard as a flavoring, rather than one of the major foods consumed, which is typical for dietary surveys in which information on consumption of mustard has been captured.

Mustard contains several bioactive compounds including allyl isothiocyanate, sinigrin, and other glucosinolate derivatives. These compounds are responsible for the pungent taste of mustard but may also have physiological effects. Allyl isothiocyanate has been shown to activate transient receptor potential ankyrin 1 (TRPA1) receptor in sensory neurons, which are known to play a role in nociception and trigeminal nerve activation. Activation of these receptors could theoretically contribute to headache symptoms in susceptible individuals(Lietzow, 2021).

The hydrophilic glucosinolates are chemically and thermically stable. However, they can be transformed into a wide variety of breakdown products by certain ß-thioglucosidases, termed myrosinases located not only in glucosinolate-forming plants but also in fungi and in bacteria

associated with the gut microflora (Bhat and Vyas, 2019; Nguyen *et al.*, 2020) as shown in figure 2.

In the unadjusted analysis, there was a statistically significant association between frequency of mustard consumption and incidence of headache. Frequent mustard consumers reported greater rates of headaches than rare or occasional. This one finding may indicate an axis of exposure dose (mustard use) that corresponds to headache incidence. However, when controlling for other dietary triggers (chocolate, aged cheese, caffeine-containing beverages and fermented foods), the association lost statistical significance. This finding suggests that the association of mustard consumption with headache may be confounded by co-consumption of other well-established dietary triggers.

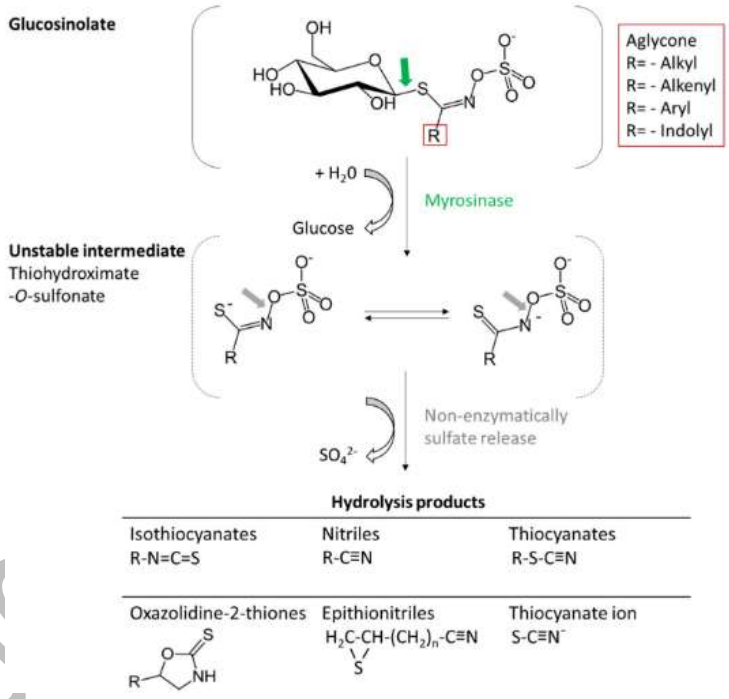

Figure 2: Enzymatic processing of glucosinolates by myrosinase into hydrolysis products in mustard.

Several different foods have been implicated in migraine triggers for susceptible subjects including tyramine-containing foods (aged cheeses) caffeine, alcohol, chocolate and fermented products. These foods can trigger headaches via a range of mechanisms, such as causing changes in cerebral vascular tone, modulating serotonin release, and stimulating trigeminal nociceptive pathways and inflammatory mediator release (Cavestro, 2025). As mustard is

typically eaten with other food types, including processed meats and sandwiches, or fast foods, it can be assumed that this association represents an overall diet rather than a direct causal relationship between the mustard and health.

The multivariate analysis performed in the current study suggests that mustard consumption alone should not be considered as an important independent headache trigger, at a population level. However, individual sensitivities to specific foods can range widely from person to person, and mustard may still activate a response in people with increased trigeminal sensitivity. Most of those patients who developed headaches reported symptoms occurring two to four hours after ingesting the mustard. This timing is in line with previously described latency periods for food-induced headaches.

Dietary triggers commonly elicit symptoms within hours as they are capable of impacting the neurovascular unit via fast metabolic or neurochemical routes. Such as cerebral blood vessel tone which can be affected by vasoactive amines, trigeminal nociceptors which may be triggered food additives and inflammatory mediators that modify neuronal excitability. This temporal pattern observed therefore supports biological plausibility of a dietary trigger mechanism, however it does not determine causality. The most commonly described phenotype among participants with mustard-associated headaches was one of migraine-like headache. Over half of those affected reported symptoms consistent with migraine including unilateral pain and typical features like nausea or photophobia.

This insight correlates the well-documented phenomenon that food triggers are major initiators of migraine attacks but not headache types. Migraine is closely associated with environmental and dietary triggers, with food precipitating attacks in 20–30% of those affected.

The lower percentage of sinus-headaches-type in this study may indicate referred facial pain or misdiagnosis of migraine symptoms, which can sometimes resemble sinus pressure or nasal drainage. A significant proportion of participants also described unspecified types of headaches, suggesting that classification of headache symptoms in survey studies without formal diagnosis is challenging.

Although these findings do not provide evidence for a strong independent association between headache and mustard consumption, multiple mechanisms have been postulated to help

explain how mustard could provoke attack in susceptible individuals. First, mustard is composed of the pungent compound allyl isothiocyanate that can stimulate trigeminologous nerve endings in the nasal and oral mucosa (Shusterman, 2023), Activation of trigeminal sensory pathways can trigger neuropeptide release, with calcitonin gene-related peptide (CGRP) at the nexus of migraine pathophysiology. Second, mustard components modulate vascular response by inducing short-term vasodilation or vasoconstriction (Rahman *et al.*, 2024). Migraine attacks are closely associated with dysregulation of the vascular tone of brain dysregulated by certain dietary components. Third, mustard may be a synergistic factor along with other dietary triggers. The foods consumed together at a meal can collectively affect inflammatory mediators, serotonin metabolism, and neuronal excitability to reduce the threshold for headache activation.

The study results suggest that mustard should not be considered a blanket dietary trigger for headaches. But clinicians should at least be aware that individual patients may have certain food sensitivities. Individualized dietary assessment remains a cornerstone of headache management. Patients with recurrent migraines may benefit from dietary trigger diaries to identify the foods they consistently consume before a headache event. Mustard is a potent headache producing agent, so also high dosage of mustard can lead to the headache and if any body has recurrent headache pattern involving mustard than temporary omission should be considered ultimately leading to planned reintroduction will new diagnosis.

Conclusion

The present study revealed a descriptive association of increased headache reporting among participants who consumed mustard more often. But the association weakened when researchers controlled for other dietary triggers and demographic factors, suggesting that mustard is probably not an independent headache trigger in the general population. However, in many individuals, mustard is likely to be a trigger given the timing of onset and prevalence of migraine type headaches. Additional prospective and mechanistic studies are required to clarify the role of mustard and related dietary factors as pathophysiological triggers in food-related headache.

Future studies on serving sizes of mustard to investigate the potential role for its components in headache pathophysiology should therefore use either prospective cohort designs or controlled dietary challenge study designs. Larger sample sizes and clinical diagnosis of headache would add a greater degree of reliability to findings. Biochemical studies to explore the effects of mustard components on trigeminal nerves activation and CGRP release would be helpful for establishing more mechanistic pathways between mustard consumption and headache symptoms.

Conflict of interest

Authors declare no conflict of interest amongst each other or any other parties.

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