

Prevalence and Environmental Triggers of Migraine Headache Among Petroleum Industry Workers in Southern Iran: A Cross-Sectional Study

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Abstract

Background: Migraine is one of the most prevalent types of headache worldwide, imposing a considerable financial and health burden. This study aimed to assess the prevalence of migraine and its environmental risk factors among workers in industrial settings.

Methods: This cross-sectional study was conducted from March to May 2022 among male workers at the South Pars Gas Complex in Iran. Participants were randomly recruited to complete a questionnaire that included demographic data, a standardized migraine diagnostic tool (based on the ICHD-3), and predisposing factors. Environmental and medical factors previously identified as potential triggers of migraine were examined in detail.

Results: The overall prevalence of migraine was 14.9% (95% CI: 12.5–17.5; n=119/801), and probable migraine was 2.4% (95% CI: 1.4–3.7; n=19/801). Only a quarter of affected workers had been previously diagnosed or evaluated for migraine. Significant predictors of migraine included altitude difference between residence and workplace, poor sleep quality, and smoking. The most frequently reported triggers were weather (34.6% hot, 17.6% cold), sleep disturbances (27.5%), chemical odors (19.6%), stress (18.8%), and noise (7.2%). The most commonly used analgesic among participants was acetaminophen.

Conclusion: Migraine appears to be more prevalent among industrial workers compared to the general population, with multiple environmental factors contributing to its occurrence.

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Introduction

Migraine is the second most prevalent primary headache, notable for its severity and disabling nature.¹ According to previous reports, the global prevalence of migraine is 11.6%, meaning that approximately one in ten people worldwide suffer from this condition.² In Eastern Asia, the one-year prevalence of migraine has been reported to range from 6% to 14.3%.³ While in Iran, estimates range from 14% to 27.6%.^{4,5} Findings from the Global Burden of Disease study indicate that migraine is the

second-highest neurological contributor to disease burden, following stroke.⁶ Beyond the physical pain, migraine can significantly affect psychological health and well-being, as well as education, career performance, and financial stability.⁷

The incidence of headaches peaks between the ages of 25 and 45 in men, which corresponds to their most productive years.⁸ Studies show that the successful treatment of severely affected migraineurs can significantly reduce the overall financial burden.⁹ Despite available treatment options, clinical care

remains suboptimal due to misdiagnosis and undertreatment. Data indicate that only 2–14% of eligible individuals receive preventive medication for migraine,¹⁰ and Ineffective acute treatment is a well-established risk factor for chronification.¹¹

Environmental triggers are reported in more than 70% of patients.¹² One effective strategy to reduce the frequency of attacks is to avoid situations that provoke headaches. Patients with migraine often exhibit heightened sensitivity to environmental stimuli.¹³ Common triggers include stress, sleep disturbances, fasting, fatigue, changes in weather, air pollution, and alcohol consumption.

The petroleum industry represents one of the most complex work environments, characterized by exposure to air pollutants, constant noise, shift work, and sleep disturbances. Due to the critical nature of their tasks, workers experience daily occupational stress.¹⁴ Research indicates that headaches are among the most frequently reported complaints in employees of petroleum refinery plants.¹⁵ Certain chemicals, including sulfur dioxide, methane, and hydrogen sulfide, have the potential to induce headaches.¹⁴ To date, no study has specifically investigated the prevalence of headaches among this subgroup of workers in Iran.

This study aims to assess the prevalence of migraine among workers in the refinery and petrochemical industry in Asalouyeh, Bushehr Province, southern Iran, and to identify the primary environmental risk factors associated with this condition.

Methods

Study Design and Sample

This cross-sectional study was conducted from March to May 2022 among workers at the South Pars Gas Complex in Asalouyeh, Bushehr Province, southern Iran, one of the world's largest industrial sites. Male workers who had been employed in these units for at least one year were eligible to participate in the study. Workers with office-based or indoor jobs were excluded from the study.

Following a pilot study with 75 participants, a total sample of 800 workers was recruited through cluster random sampling from the employee roster, using Cochran's formula. Participants received both a brief verbal and a written explanation of the study objectives, as well as assurances regarding data confidentiality. The researcher's contact information was provided for follow-up questions, and participants were asked to provide their phone numbers only if they wished to receive additional guidance regarding their headaches.

Ethical Consideration

The study protocol was approved by the Ethics

Committee of Shiraz University of Medical Sciences (IR.SUMS.MED.REC.1401.231).

Questionnaire Design

A self-administered questionnaire was used, consisting of three sections:

1) Demographic Data: This section collected information on participants' date of birth, marital status, and anthropometric measures.

2) Migraine Diagnosis Tool: Migraine was assessed using a standardized tool based on the third edition of the International Classification of Headache Disorders (ICHD-3, beta version). This tool comprises 11 sections and has been previously validated for use in the Iranian population, demonstrating reliability and validity.¹⁶ To be diagnosed with migraine, participants' headache features had to fulfill all ICHD diagnostic criteria from A to E.¹⁷ Headaches that did not meet all criteria for migraine but did not fulfill criteria for another headache disorder were classified as probable migraine. Although the questionnaire did not focus specifically on tension-type headaches, participants with such headaches were identified based on additional diagnostic features included in the instrument.

Participants were asked about the frequency and characteristics of their headaches over the previous three months, including the number of headache days per month, duration of each episode, and severity, which was rated on a 10-point visual analog scale (1=mild, 10=severe). Due to potential inaccuracies in evaluating aura through a questionnaire, this aspect was not included. All responses were reviewed by a neurologist, who made the final diagnosis.

3) Environmental and Medical factors: This section of the questionnaire assessed environmental and medical factors identified in previous studies as potential migraine triggers. Participants were asked in detail about their medical history, including previous medical or surgical problems, as well as current medication and painkiller use (both overall and specifically for headache relief). To minimize recall bias, major medical conditions such as diabetes mellitus, hypertension, thyroid disease, and musculoskeletal disorders were recorded using a simple yes/no format.

The effect of weather on headaches was evaluated through two questions: "Do you think weather affects your headache?" and "Which weather conditions worsen your headache?" The latter allowed multiple-choice responses. Other relevant factors included sleep quality (categorized as poor or good), history of COVID-19 infection (including duration and severity of headaches during and after infection, as well as headache characteristics), smoking status, and shift

work schedule. All workers in these units worked 12-hour shifts, either on a fixed morning schedule or a rotating schedule.

Participants were also asked about their residential location during rest periods, as there were two groups: (a) workers who consistently reside in Asalouyeh, a coastal city within 10 kilometers of the industrial units with a hot and humid climate, and (b) workers who commute approximately 80 kilometers (about 2 hours) to a nearby city situated 641 meters above sea level with lower pollution levels. In both groups, the workers' families may or may not reside with them.

To capture additional potential migraine triggers, an open-ended question was included, allowing participants to report precipitating factors based on their personal experiences. Responses were subsequently categorized into six thematic groups derived from workers' reports: (1) stress and workplace tension, (2) sleep deprivation and fatigue, (3) olfactory triggers, (4) visual triggers, (5) auditory triggers, and (6) weather-related triggers.

Statistical Analysis

Questionnaires with five or more missing responses were excluded from the analysis. Statistical analyses were performed using SPSS for Windows version 26.0 (SPSS® Inc., Chicago, IL, USA). The prevalence of migraine was expressed as the number of cases per 100 individuals with 95% confidence intervals (CI). Continuous variables were analyzed using Student's t-test or ANOVA, while categorical variables were evaluated using Pearson's Chi-square or Fisher's exact tests, as appropriate. A p-value of <0.05 was considered statistically significant. Additionally, binary logistic regression was conducted to assess the predictive value of environmental and medical risk factors for migraine occurrence.

Results

A total of 900 questionnaires were distributed, and 829 were returned, resulting in a response rate of 89%. After excluding 28 questionnaires with more than five missing responses, 801 were included in the analysis (Figure 1). The mean age of participants was 36.2 ± 8.64 years, and the majority were non-native workers (73.5%, 95% CI: 70.2–76.5). The average work experience was 6.7 ± 6.4 years. Sociodemographic characteristics of the study population are summarized in Table 1.

Migraine Prevalence and Features

The overall prevalence of migraine among participants was 14.9% (95% CI: 12.5–17.5; $n=119/801$), while probable migraine was observed in 2.4% (95% CI: 1.4–3.7; $n=19/801$). Tension-type headache was reported in 25.8% of participants. Additionally, 24

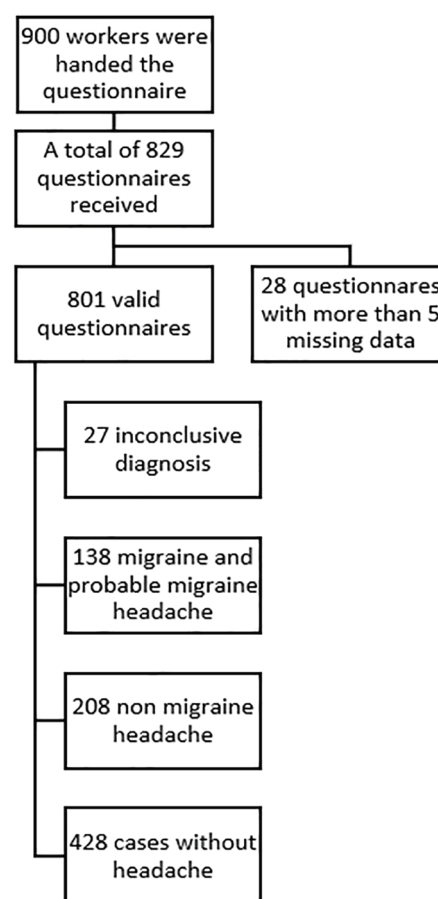


Figure 1: Flow Chart Depicting Subject Participation and Number of Cases Affected by Each Headache Disorder

individuals exhibited features of both migraine and tension-type headaches, making a definitive diagnosis inconclusive. There was also one participant with a previously diagnosed cluster headache, who was receiving treatment.

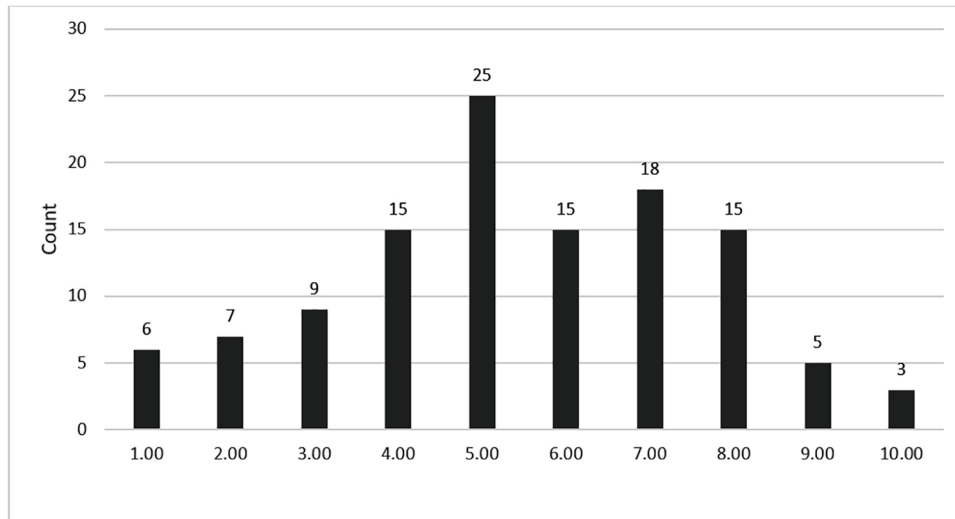
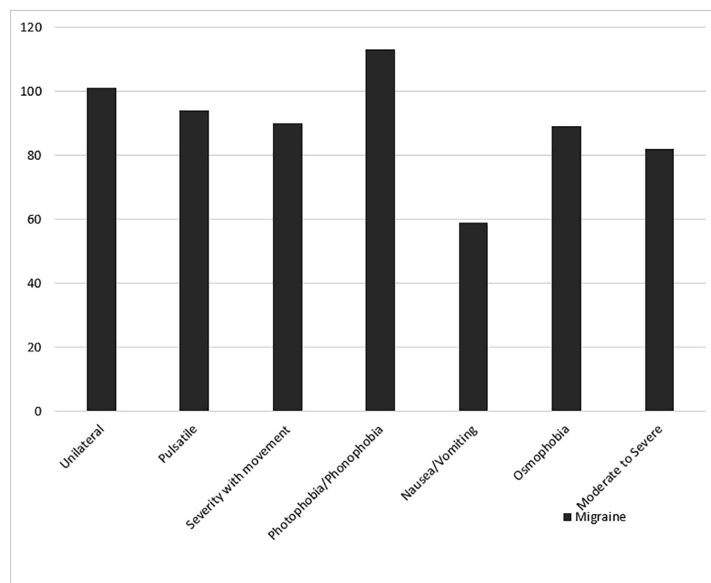
Migraineurs experienced an average of 12.98 (± 8.98) headache days over the past three months, which was significantly higher than the non-migraine headache group ($P < 0.001$). Among these patients, 59.9% reported their headache intensity as “moderate to severe.” Based on the Visual Analog Scale (VAS), the mean headache intensity was 5.43 (± 2.21) in patients with migraine, compared to 3.08 (± 1.67) in those with tension-type headache ($P < 0.001$). Figure 2 depicts the distribution of pain severity according to VAS scores among migraineurs. The most frequently reported characteristics in the migraine and probable migraine population were photophobia (81.9%), unilateral pain (73.2%), and pulsatile quality (68.1%). Figure 3 presents a comparison of these symptoms in patients with migraine.

Demographic and Environmental Factors Related to Migraine

More than half of migraine cases occurred in participants aged 26 to 40 years (95% CI: 48.2–66.7).

Table 1: Demographic Characteristics of Participants

Demographics	Frequency (n)	Proportion (%)
Age	796	100
≤25	76	9.5
26-40	490	61.6
41_60	230	28.9
BMI	771	100
Underweight	14	1.8
Normal	390	50.6
Overweight	290	37.6
Obese	77	10
Marital status	801	100
Never married	214	26.7
Married	575	71.8
Divorced or widowed	12	1.5
Living with family	788	100
Yes	209	26.5
No	579	73.5
Residential area	783	100
Asalouyeh	540	69
Nearby cities	243	31

**Figure 2:** Bar chart depicting severity of pain among migraine patients as assessed by VAS score (number of cases)**Figure 3:** Bar chart depicting characteristics of headache among migraine patients (number of cases)

Additionally, the average body mass index (BMI) was significantly higher in migraineurs compared to non-migraine participants ($P=0.048$). Other demographic and environmental variables assessed in this study are summarized in Table 2.

Among migraine cases, 93.4% reported at least one trigger for their attacks. The most frequently reported triggers were weather conditions (34.6% hot, 17.6% cold), sleep disturbances (27.5%), and chemical odors (19.6%), followed by stress (18.8%) and noise (7.2%). Regarding headache severity, daily travel to work was the only factor significantly associated with increased pain intensity ($P=0.046$).

Significant associations were also observed between migraine and certain comorbid conditions, including thyroid disease (hyper- or hypothyroidism, $P<0.001$), musculoskeletal disorders (disc herniation, neck pain, $P=0.002$), and cardiovascular disease (history of heart disease or hypertension, $P=0.043$).

Binary logistic regression identified daily travel to work ($P=0.020$), poor sleep quality ($P=0.043$), and smoking ($P=0.027$) as significant predictors of migraine among workers. Detailed results of the regression analysis are presented in Table 3.

Headache Treatment and Medication Use

Only a quarter of migraineurs (26.53%) had previously been diagnosed or evaluated for migraine. Medication use was significantly higher among migraine sufferers compared to individuals with other headaches or those without headaches

($P<0.001$). The most commonly used painkillers were Acetaminophen and its derivatives (61.5%), followed by NSAIDs (45.3%). Only 10 participants reported using medications specifically for acute migraine attacks or prophylaxis, including Topiramate and ergots. One patient reported improvement after Botulinum toxin injection.

Migraine and COVID-19

Overall, 33.3% of the study sample had a confirmed history of COVID-19 infection, among whom 43.4% reported experiencing headache as a symptom. Most headaches resolved before the end of the disease course (average headache days in COVID-19 patients= 0.87 ± 4.59 days). Prolonged headache (lasting six or more days from disease onset) was reported in 4.4% of the general population and 5.8% of the migraine group, with a maximum duration of 60 days. Characteristics of prolonged headaches were not significantly different between migraine and non-migraine groups. No progression in migraine frequency or intensity was observed in any of the cases following COVID-19 infection.

Discussion

This study aimed to investigate the prevalence and characteristics of episodic migraine headaches among petrochemical and refinery workers, as well as environmental factors contributing to migraine attacks. All participants were men, and 14.9% of them met the criteria for migraine headaches. Key contributors to

Table 2: Comparison of Independent Variables Based on Headache Diagnosis

Variable	Category	Migraine	Other headaches	No headache	P value
Age	Below 25	13 (9.5%)	20(8.6%)	43(10.1%)	0.270
	26_40	79 (57.7%)	157 (67.4%)	254 (59.6)	
	41 and above	45 (32.8%)	56 (24%)	129 (30.3)	
Marital status	Never married	33 (23.9%)	69 (29.4%)	112 (26.2%)	0.807
	Married	103 (74.6%)	162 (68.9%)	310 (72.4%)	
	Divorce and widowed	2 (1.4%)	4 (1.7%)	6 (1.4)	
Living with family	Yes	54 (39.4%)	49 (21.3%)	106 (25.2%)	<0.001
	No	83 (60.6%)	181(78.7%)	315 (74.8%)	
Shift schedule	Morning only	88(64.7%)	158 (67.5%)	275 (65%)	0.782
	Night and morning	48 (35.3%)	76 (32.5%)	148 (35%)	
Sleep quality	Good	104(78.2%)	201 (86.6%)	381 (89.4%)	0.004
	Poor	29 (21.8%)	31 (13.4%)	45 (10.6%)	
Worker residence	Asalouyeh	74 (54.8%)	167 (73.2%)	299 (71.2%)	<0.001
	Nearby cities (daily travel to work)	61 (45.2%)	61 (26.8%)	121 (28.8%)	
Smoking	No	89 (64.5%)	160 (68.4%)	319 (74.7%)	0.039
	Yes	49 (35.5%)	74 (31.6%)	108(25.3%)	

Table 3: Adjusted Odds Ratios (95% Confidence Intervals) for Risk Factors Associated with Migraine Among Petrochemical and Refinery Workers

Variables	B-Coefficient	P value	Odds ratio	95% CI
Daily travel to work (yes/no)	0.500	0.020	1.648	(1.082_2.513)
Poor sleep quality(yes/no)	0.524	0.043	1.688	(1.016_2.805)
Smoking(yes/no)	0.473	0.027	1.605	(1.057_2.438)

episodic migraine included age, obesity, smoking, poor sleep quality, and daily commuting to work, in addition to a medical history of thyroid, cardiovascular, and musculoskeletal disorders.

Although migraine is generally more prevalent in women, with male-specific prevalence reported between 6% and 10.1%,¹⁸ our study found a higher prevalence of 14.9%. This elevated rate may reflect environmental influences, as workers in industrial settings come from diverse regions and genetic backgrounds. Research indicates that the combination of multiple triggers can substantially increase the likelihood of migraine initiation,¹⁹ which may help explain the higher prevalence observed in industrial workplaces.²⁰ Age distribution also plays a role; migraine prevalence is typically highest before the age of 40, consistent with our findings.²¹ In this study, 61.6% of participants were between 25 and 40 years old, which may further account for the increased incidence of migraine among the sample.

Studies on the effect of climate on migraine have yielded inconsistent results. While patients frequently report weather as a trigger, objective meteorological data confirm this association only in a subset of individuals.²² In our study, 69.1% of participants believed that weather, particularly high temperatures, could exacerbate their headaches. A recent study by Tanik et al. compared migraine patients based on their sensitivity to hot and cold weather, finding that more than half of the patients were more sensitive to cold rather than hot temperatures.²³ This discrepancy may be due to interregional differences between study populations. Additionally, air pollution should be considered, as high temperatures can synergistically amplify the effects of pollutants such as nitrogen dioxide (NO₂), sulfur dioxide (SO₂), PM₁₀, and carbon monoxide (CO) on migraine occurrence.²⁴ These pollutants are commonly found at high concentrations in oil and gas industrial sites, where most workers perform outdoor tasks.^{25, 26}

A subgroup of workers in our study spent nearly two hours per day commuting to a nearby high-altitude city, which has a lower average temperature compared to Asalouyeh (14.3 °C vs. 26.5 °C during the study period). The prevalence of migraine in this group was nearly twice as high as among those who resided in Asalouyeh throughout the day (25.1% vs. 13.7%). Several factors may explain this phenomenon:

1) Several studies have demonstrated an association between living at higher altitudes and increased migraine prevalence. While some investigations emphasize the role of hypoxia in triggering headaches at altitudes above 2000 meters, others suggest that even minor but rapid changes in barometric pressure and meteorological variables can provoke migraine attacks.²⁷ A population-based study in Germany

reported a 20% rise in migraine attacks with every 5 °C change in temperature.²⁸ Similar findings have been reported in other studies, which also considered humidity and air pressure fluctuations. Although these associations do not apply universally, a subset of migraineurs appears to be weather-sensitive.²⁹ Several mechanisms have been hypothesized to explain this sensitivity. Animal studies, for example, indicate that shifts in barometric pressure can alter neuronal activity within the vestibular nuclei, which may modulate sympathetic tone and pain perception.³⁰ 2) Workers who commute long distances are exposed to additional physical strain. Prolonged daily transportation may increase exhaustion, and physical fatigue itself has been identified as an independent factor in migraine initiation.³¹

A significant aspect of major industries, including oil and gas, is the prevalence of rotating shift schedules and resulting sleep deprivation. Sleep disturbances, such as reduced duration or poor quality of sleep, are more frequently observed in individuals with chronic, episodic, or probable migraine.³² Interestingly, a nationwide study in South Korea found that although migraine sufferers do not necessarily sleep fewer hours, they perceive greater sleep insufficiency and require more restorative rest compared with the general population.³³ Conversely, daytime naps have been shown to alleviate migraine attacks, and cognitive behavioral therapy for insomnia (CBTi) has been associated with reversion of chronic migraine to its episodic form.³⁴ Despite these findings, the biological mechanisms underlying the sleep–migraine relationship remain poorly understood, as confounding factors such as psychological comorbidities, caffeine or sedative overuse, and obesity contribute to a vicious cycle between migraine and sleep disturbances.³⁵

In our sample, 21.8% of patients reported poor sleep quality. Since sleep quality is a potentially modifiable risk factor, efforts to encourage diagnosis and treatment of sleep disorders are justified. Contrary to earlier research on shift work in the same region, we did not observe a significant association between night shifts and either migraine prevalence or severity.³⁶ This discrepancy may be partly attributable to seasonal factors during the study period: day workers were exposed to intense heat and prolonged sunlight, whereas night workers were less affected by these conditions.

Most migraine sufferers perceive at least one environmental trigger for their attacks, typically defined as a factor that induces headache upon either exposure or withdrawal.³⁷ Nearly all patients report a trigger when presented with a standardized list of precipitants.³⁸ In our study, 93.4% of workers identified at least one trigger for their headaches. Among these, stress was the most frequently mentioned factor.

Prior studies investigating migraine triggers in men similarly report stress as the most common provoker, followed by exposure to bright light and sleep deprivation.³⁹ Evidence from the French occupational cohort study (GAZEL) demonstrated that statutory retirement was associated with a substantial reduction in headache prevalence, even after adjustment for potential confounders.⁴⁰ Although psychological stress is an unavoidable element of refinery workplaces, interventions aimed at improving overall well-being may help reduce the burden of chronic pain conditions such as migraine.⁴¹

Migraineurs generally have a lower threshold for sensory stimuli. Noise is among the most common exposures in industrial environments. In our study, auditory stimuli were frequently reported by participants as triggers for migraine, underscoring the need for further research in this area. Workers engaged in tasks within noisy environments appear to be at greater risk for both migraine and tension-type headaches.⁴² Moreover, the combination of noise and headache may impair problem-solving ability, ultimately reducing workplace efficiency.

Despite routine medical evaluations in this occupational setting, migraine remains substantially underdiagnosed. Only a quarter of workers who fulfilled the diagnostic criteria for migraine had previously been suspected or evaluated for the condition. The high prevalence of self-medication, particularly narcotic use, suggests that many workers underestimate the clinical significance of recurrent headaches and fail to seek professional assessment. Given these findings, incorporating standardized migraine evaluation tools into annual staff health assessments, alongside educational programs, may improve awareness, facilitate earlier diagnosis, and reduce the risk of medication overuse.⁴³

Conclusion

Our findings support the view that environmental factors significantly influence the prevalence of migraine headaches. Workers in the oil and gas industry are exposed to a wide range of potential triggers, resulting in a higher prevalence of migraine and probable migraine in this population compared to the general public. Preventive strategies such as smoking cessation, weight management, behavioral therapy for sleep disorders, and stress reduction may help control the burden of migraine among workers.

Future research should focus on quantifying the impact of migraine in this occupational group, including productivity loss, and on developing tailored educational and preventive programs. To minimize recall bias, diary-based data collection methods are recommended for use. Additionally, environmental

monitoring can help identify specific workplace precipitants, and studies evaluating the duration and severity of attacks may provide further insight into the occupational health impact of migraine.

Authors' Contribution

MS: Record searching, Data extraction, Quality assessment, Resources, writing original draft, Writing review & editing. MP: Quality assessment, Project administration, Resources, supervision, Review & editing. AS: Conceptualization, Data analysis, Supervision, Quality assessment, Review & editing.

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Conflict of Interest

None declared.

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