



## Prevalence of chronic headache in shift workers in an industry

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### Abstract

#### Introduction

Primary headaches and sleep disorders are closely related conditions. The global prevalence of chronic headache is estimated at 4.6%, while in Brazil it corresponds to 6.9%. Up to 50% of migraine patients report insomnia. This study evaluated the prevalence of chronic headache in workers and its association with fixed shift work, chronotype, and sleep.

#### Methods

This is a cross-sectional, observational, and analytical study involving 354 fixed-shift workers via an electronic form. The prevalence of chronic headache by work shift was calculated, and Pearson's Chi-square tests and binary logistic regression were applied to express the degree of association between independent variables and the presence of chronic headache.

#### Results

The prevalence of chronic headache was 12.43%. No statistical association was found between shifts and the disease ( $p > 0.05$ ), a finding consistent across subgroup analyses. Chronotype analysis revealed a strong dependence on shift ( $p < 0.0001$ ), evidencing a self-selection pattern (morning types in day shifts, evening/mixed types in night shifts). The most robust independent associated factors were analgesic overuse (OR: 13.7), irritability (OR: 3.5), and distractibility (OR: 2.4).

#### Discussion

The absence of negative impact from shifts suggests a neurobiological resilience promoted by chronobiological alignment (behavioral self-selection) in fixed schedules. Headache chronicity in this population is independent of work schedule, being predominantly associated with modifiable factors.

#### Conclusion

Chronic headache was characterized as independent of fixed shift work. Management, especially in refractory cases, should not be restricted to analgesia but incorporate active evaluation of diurnal symptoms and sleep disorders, aiming to mitigate comorbidities that perpetuate chronicity.



## Introduction

Headache is among the most prevalent and disabling diseases globally (1). According to the International Classification of Headache, third edition (ICHD-3), the more than 150 types of headache can be categorized as primary or secondary. Primary headaches are manifestations of cranial pain caused by the disease itself; this group includes tension-type headaches, migraine and trigeminal-autonomic headaches. Secondary headaches are those caused by other etiologies, such as infections, vascular diseases, tumors and those attributed to the use of substances. They are considered chronic when pain is present on 15 or more days of the month for 3 months (2).

Similarly, the International Classification of Sleep Disorders (ICSD) systematizes sleep disorders into several categories, such as insomnia, parasomnias, circadian rhythm disorders, which are closely related to primary headaches. This relationship is supported by shared pathophysiological mechanisms (3,4) and clinical evidence, with sleep-related headaches being a frequent complaint (5). Insomnia particularly stands out, identified in almost 50% of patients with migraine (6).

The circadian rhythm plays a central role in regulating biological functions, and its disruption can compromise health. However, the magnitude of this impact is not uniform, varying substantially according to individual chronotype (morning, evening or intermediate). Phenotypic differences in circadian preference should be considered, as misalignment between biological rhythm and environmental demands can exacerbate negative outcomes, making chronotype a key moderator of health (7,8).

The most recent data demonstrates that the worldwide prevalence of headache is 52.0% for episodic cases and 4.6% for chronic cases (9). In the Brazilian population, a higher prevalence is estimated for chronic headaches, corresponding to 6.9% (10). This prevalence, however, seems to be higher in workers who work alternate shifts (11). The recurrence of pain causes indirect economic losses related to absenteeism and reduced productivity, with significant social and economic losses annually (12–14). Considering the importance of circadian synchronization for brain homeostasis, this study aims to investigate the prevalence of chronic headache in workers in an industry, and its association with different work shifts, individual chronotype and self-reported sleep patterns.

## Methods

### *Study design and data analysis*

This is an analytical cross-sectional observational study, carried out using digital data collection (Google Forms® platform). The volunteers' participation was conditional on their

electronic acceptance of the Free and Informed Consent Form (FICF), presented at the initial stage of the instrument, which included the objectives of the research and the guarantee of data confidentiality. The inclusion criteria were: age  $\geq 18$  years, voluntarily agreeing to take part by electronically accepting the ICF and sending the fully completed electronic form. Exclusion criteria: age  $\geq 51$  years.

### *Occupational exposure characterization*

Workers were randomly invited to answer the questionnaire. The sample included volunteers from different sectors of the factory, such as administrative staff, who work in an office environment; and production line employees, in direct contact with machinery. To better characterize the occupational exposure, it is noted that both environments maintain constant artificial lighting. Administrative tasks predominantly involve prolonged screen time and psychosocial demands related to routine social interactions. Conversely, production tasks require manual labor and the mandatory use of standard personal protective equipment (PPE), including hearing protection against occupational noise. All factory crew worked fixed shifts without routine rotation, with the administrative staff working 44 hours a week, from 9 a.m. to 6 p.m., while production employees worked fixed shifts from 5:30 a.m. to 1:35 p.m. (1st shift); 1:40 p.m. to 10 p.m. (2nd shift) or from 9:55 p.m. to 5:35 a.m. (3rd shift).

### *Data collection instrument and procedures*

The data collection instrument consisted of a self-administered structured questionnaire, made up of 17 multiple-choice questions that had to be completed, divided into three domains: (I) sociodemographic and work identification; (II) headache characterization; (III) sleep patterns and chronotype. The recruitment strategy was carried out in collaboration with the company, by putting up posters with QR Codes in communal areas and disseminating the access link via corporate instant messaging groups. In the evaluation of medication consumption, the questionnaire specifically inquired about the frequency of use of simple analgesics and non-steroidal anti-inflammatory drugs (NSAIDs), providing common examples to the participants (e.g., dipyron, paracetamol, and ibuprofen). The full questionnaire is provided as Supplementary Appendix 1.

### *Statistical analysis*

After collection, the data was presented in tables with absolute and percentage values. Microsoft Excel® and RStudio® software were used for statistical analysis. The prevalence of chronic headache was calculated by stratifying the sample by work shift. Pearson's chi-square test was used to compare proportions between categorical variables (such as shift versus chronotype or shift versus prevalence). A binary logistic

regression model was used to investigate the independent risk factors. In this analysis, the dependent variable was dichotomized into presence of chronic headache and absence. The magnitude of the associations was expressed by the Odds Ratio (OR) with their respective 95% Confidence Intervals (95%CI), adjusting for potential confounding factors. For all the statistical tests applied, a significance level of 5% ( $p < 0.05$ ) was considered. Finally, specifically in cases where the Chi-Square test showed a statistically significant association, a post-hoc analysis of adjusted standardized residuals was carried out to identify which specific cells or categories contributed to the observed difference.

*Ethical aspects*

The research project was approved by the Research Ethics Committee of the Health Sciences Sector of the Federal University of Paraná, approval number 6.234.316.

## Results

After excluding refusals to sign an informed consent form ( $n=3$ ) and individuals outside the age range ( $n=9$ ), the final sample consisted of 354 workers. There was a predominance of females and young people aged between 18 and 28. The detailed sociodemographic characterization, stratified by sector of work, is shown in Table 1.

Table 1. Sample characterization

	Production Sector		Others sectors		Total	
	n	%	n	%	n	%
<b>Age</b>						
18 to 28 years	88	48.09%	90	52.63%	178	50.28%
29 to 39 years	70	38.25%	62	36.26%	132	37.29%
40 to 50 years	25	13.66%	19	11.11%	44	12.43%
<b>Sex</b>						
Female	120	65.57%	116	67.84%	236	66.67%
Male	63	34.43%	55	32.16%	118	33.33%
<b>Work shift</b>						
First shift <sup>a</sup>	41	22.40%	29	16.96%	70	19.77%
Second shift <sup>b</sup>	72	39.34%	20	11.70%	92	25.99%
Third shift <sup>c</sup>	53	28.96%	37	21.64%	90	25.42%
Business hours <sup>d</sup>	17	9.29%	85	49.71%	102	28.81%

Legend: a = work shift from 5:30 am to 1:50 pm; b = work shift from 1:40 pm to 10:00 pm; c = work shift from 10:00 pm to 5:30 am; d = work shift from 8:00 am to 12:00 pm and from 2:00 pm to 6:00 pm; n = absolute values; % = relative values.

Regarding clinical aspects of headache and sleep, described in Table 2, 12.43% of the overall sample met the criteria for chronic headache ( $\geq 15$  days/month) and 52.82% for episodic headache (1 to 14 days/month), in a 3-month period. Excessive use of

analgesics was reported by 15.8% of participants. Regarding sleep, there was a high frequency of complaints: 59.3% of workers reported non-restorative sleep and 42.1% indicated increased sleep latency.

Table 2. Data regarding headache and sleep

Questions	Categories	Production sector		Others sectors		Total	
		n	%	n	%	n	%
Frequency of headache in the last 3 months	< 1 time/month	65	35.52%	58	33.92%	123	34.75%
	1 to 14 times/month	94	51.37%	93	54.39%	187	52.82%
	≥ 15 times/month	24	13.11%	20	11.70%	44	12.43%
Frequency of analgesic use (for headache)	< 15 times/month	154	84.15%	144	84.21%	298	84.18%
	≥ 15 times/month	29	15.85%	27	15.79%	56	15.82%
Sleep duration	< 4 hours	14	7.65%	4	2.34%	18	5.08%
	4 to 8 hours	159	86.89%	160	93.57%	319	90.11%
	> 8 hours	10	5.46%	7	4.09%	17	4.80%
Sleep latency	< 30 minutes	98	53.55%	107	62.57%	205	57.91%
	≥ 30 minutes	85	46.45%	64	37.43%	149	42.09%
Sleep in a favorable environment	No	14	7.65%	13	7.60%	27	7.63%
	Yes	169	92.35%	158	92.40%	327	92.37%
Restorative sleep	No	111	60.66%	99	57.89%	210	59.32%
	Yes	72	39.34%	72	42.11%	144	40.68%
Daytime sleepiness	No	123	67.21%	129	75.44%	252	71.19%
	Yes	60	32.79%	42	24.56%	102	28.81%
Chronotype	Morning	78	42.62%	97	56.73%	175	49.44%
	Evening	48	26.23%	36	21.05%	84	23.73%
	Intermediate	57	31.15%	38	22.22%	95	26.84%
Distractibility	No	113	61.75%	127	74.27%	240	67.80%
	Yes	70	38.25%	44	25.73%	114	32.20%
Irritability	No	64	34.97%	82	47.95%	146	41.24%
	Yes	119	65.03%	89	52.05%	208	58.76%

Legend: n = absolute values; % = relative values

Analysis of the prevalence of chronic headaches (Table 3) showed no statistically significant association with work shifts. The lack of correlation was consistent both in the analysis restricted to the

production sector ( $p=0.9994$ ) and in the evaluation of the total sample ( $p=0.7398$ ), showing a homogeneous distribution of the disease between the different shifts.

Table 3. Prevalence of chronic headache according to work shift among workers

Work shift	Prevalence of chronic headache	p-value
<b>Production sector</b>		
General	13.11%	–
First shift <sup>a</sup>	17.07%	0.9994
Second shift <sup>b</sup>	12.50%	
Third shift <sup>c</sup>	9.43%	
Business hours <sup>d</sup>	17.65%	
<b>The total sample</b>		
General	12.43%	–
First shift <sup>a</sup>	15.71%	0.7398
Second shift <sup>b</sup>	13.04%	
Third shift <sup>c</sup>	10.00%	
Business hours <sup>d</sup>	11.76%	

Legend: a = work shift from 5:30 am to 1:50 pm; b = work shift from 1:40 pm to 10:00 pm; c = work shift from 10:00 pm to 5:30 am; d = work shift from 8:00 am to 12:00 pm and from 2:00 pm to 6:00 pm.

Investigation of factors associated with chronic headache by binary logistic regression (Table 4) identified excessive use of analgesics as the variable most strongly associated with the condition (OR=13.72; 95% CI 5.84-32.19;  $p<0.0001$ ). Behavioral variables also demonstrated strong statistical associations. Specifically, higher irritability was associated with a 3.52-fold

higher chance of chronic headache (OR=3.52;  $p=0.0144$ ), and reduced attention span (distractibility) was associated with a 2.37-fold increase (OR=2.37;  $p=0.0395$ ). Female gender was also identified as a factor significantly associated with the outcome (OR=3.24).

Table 4. Adjustment of the logistic regression model for the presence of chronic headache

Variable	OR [CI 95%]	p-value
<b>Age</b>		
18 to 28 years	1.7319 [0.4336 – 6.9179]	0.4370
29 to 39 years	0.9642 [0.2378 – 3.9101]	0.9593
40 to 50 years	–	–
<b>Sex</b>		
Male	–	–
Female	3.2490 [1.1145 – 9.4713]	0.0309
<b>Production sector</b>		
No	–	–
Yes	1.0895 [0.4426 – 2.6815]	0.8521
<b>Work shift</b>		
First shift	2.1711 [0.6914 – 6.8177]	0.1842
Second shift	–	–
Third shift	0.7263 [0.2149 – 2.4545]	0.6068
Business hours	1.3622 [0.3900 – 4.7574]	0.6281
<b>Frequency of analgesic use (for headache)</b>		
< 15 times/month	–	–
≥ 15 times/month	13.7211 [5.8484 – 32.1910]	<b>&lt; 0.0001</b>
<b>Sleep duration</b>		
< 4 hours	0.6808 [0.011 – 7.5818]	0.7545
4 hours to 8 hours	0.4565 [0.0750 – 2.7792]	0.3949
> 8 hours	–	–
<b>Sleep latency</b>		
< 30 minutes	0.4982 [0.2239 – 1.1087]	0.0878
≥ 30 minutes	–	–
<b>Sleep in a favorable environment</b>		
Yes	–	–
No	0.2791 [0.0406 – 1.9186]	0.1945
<b>Restorative sleep</b>		
Yes	–	–
No	1.5007 [0.6421 – 3.5073]	0.3487
<b>Daytime sleepiness</b>		
Yes	–	–
No	1.0509 [0.4439 – 2.4878]	0.9100
<b>Distractibility</b>		
No	–	–
Yes	2.3731 [1.0425 – 5.4020]	0.0395
<b>Irritability</b>		
No	–	–
Yes	3.5286 [1.2855 - 9.6805]	<b>0.0144</b>

Legend: OR – odds ratio; CI – confidence interval; values in bold are those with statistical significance.

Finally, the analysis of the distribution of chronotypes (Table 5) revealed a statistical dependence on the work shift ( $X^2 = 44.73$ ;  $p < 0.0001$ ). The analysis of standardized residuals showed a significant predominance of morning chronotypes in the first shift

and during business hours, while the third shift concentrated individuals with an afternoon or intermediate chronotype. The second shift showed no significant deviations from the expected distribution.

Table 5. Analysis of residual self-reported chronotype by work shift

Work shift	Morning	Evening	Intermediate
First shift	>	n.s.	<
Second shift	n.s.	n.s.	n.s.
Third shift	<	>	>
Business hours	>	<	<

Legend: Analysis of standardized residuals ( $p < 0.05$ ) indicates whether the observed frequency was significantly higher (>), lower (<), or not significant (n.s.) than expected.

Interaction analyses were performed to evaluate potential effect modification by sex and chronotype. No statistically significant interaction terms were observed in the multivariable

models, indicating that the absence of association between work shift and chronic headache was consistent across subgroups (Tables 6 and 7).

Table 6. Interaction analysis between work shift and sex

Interaction term	OR	95% CI	p-value
First shift × Female	0.4989	0.0415 – 6.0009	0.5837
Third shift × Female	13.706	0.0683 – 27.4353	0.8366
Business hours × Female	$2.2209 \times 10^6$	Not stable*	0.9899

Footnote: \*Estimate unstable due to sparse data in this interaction category (quasi-complete separation). Models adjusted for age, sector, analgesic use, sleep duration, sleep latency, sleep environment, restorative sleep, daytime sleepiness, distractibility, and irritability.

Table 7. Interaction between work shift and chronotype in the multivariable logistic regression model for chronic headache

Interaction term	OR	95% CI	p-value
First shift × Night chronotype	63.094	0.2065 – 192.9606	0.2911
Third shift × Night chronotype	0.4283	0.0115 – 15.8919	0.6456
Business hours × Night chronotype	13.907	0.0278 – 69.8742	0.8689
First shift × Day chronotype	0.2077	0.0125 – 3.4487	0.2730
Third shift × Day chronotype	0.3214	0.0151 – 6.8273	0.4665
Business hours × Day chronotype	32.047	0.2096 – 49.0073	0.4027

Footnote: Models adjusted for age, sector, analgesic use, sleep duration, sleep latency, sleep environment, restorative sleep, daytime sleepiness, distractibility, and irritability.

## Discussion

### *Prevalence of chronic headache in shift workers*

This study found an overall prevalence of chronic headache of 12.43% in the sample studied, and 13.11% considering only the production sector (Table 3). This rate is higher than the Brazilian population estimate, which indicates a prevalence of 6.9% for chronic headache (10). The high frequency of this condition has significant repercussions on the quality of life and functional capacity of individuals. Economic impact studies show that indirect costs (resulting from absenteeism and reduced productivity) represent the largest share of the burden of the disease, surpassing direct medical costs (13,14).

Regarding the hypothesis that shift work acts as an aggravating factor, the statistical analysis showed no significant association. The lack of correlation was consistent both in the analysis restricted to the production sector ( $p=0.9994$ ) and in the evaluation of the total sample ( $p=0.7398$ ). Therefore, in this population, the work shift was not an isolated determinant of the presence of chronic headache.

However, it is important to note that a substantial portion of the total sample (59.32%) reported a perception of non-restorative sleep. The scientific literature establishes a bidirectional relationship between headache and sleep regulation (3,4). In accordance with this premise, there was a significant frequency of sleep complaints in the study population: 59.32% of the total sample reported non-restorative sleep and 42% indicated increased sleep latency. The coexistence of these altered parameters with the high prevalence of headache reinforces the understanding that sleep quality is compromised in this population, acting as a frequent and clinically relevant comorbidity.

This prevalence reinforces the need for intervention strategies. The clinical management of chronic headaches often remains sub-optimal, with a portion of the population not having access to adequate preventive treatment (15). The implementation of effective prophylactic therapies is essential not only for symptomatic relief, but also to mitigate the social, functional and economic impact associated with the chronification of pain (13).

### *Risk factors associated with chronic headache*

#### Female sex

There was a positive association between biological sex and chronic headache, more frequently among women, corroborating the literature (1,15,16).

#### Overuse of analgesics

Data analysis revealed an overuse of analgesics in 15.82% of the sample, a frequency higher than the prevalence of chronic headache found (12.43%). The overuse of analgesics demonstrated the strongest association with chronic headache in our study. These data suggest a scenario of inadequate management of episodic pain, which acts as a powerful catalyst for the clinical transformation of the disease.

The literature reports the overuse of symptomatic medication, particularly simple analgesics and NSAIDs, as one of the main modifiable risk factors for the progression of episodic migraine to the chronic form (16,17). In addition, this consumption pattern predisposes to the development of Medication Overuse Headache, a potentially disabling secondary condition with an estimated global prevalence of up to 2% (18). Clinical management in these cases requires interrupting the cycle of medication overuse and addressing comorbidities (18,19). Therefore, the magnitude of the association found reinforces the need for guidance on the rational use of analgesics and the implementation of appropriate preventive therapies.

#### Psychological symptoms

The interaction between headache and sleep disorders is characterized by a complex bidirectionality, supported by shared pathophysiological mechanisms involving hypothalamic pathways and neurotransmitter dysregulation (4,20,21). Although there was no statistical association between work shifts and headache prevalence ( $p>0.05$ ), the investigation of psychological symptoms revealed significant neurobehavioral markers. The data showed that irritability and distractibility were strongly associated with the presence of chronic headache in the sample.

Irritability demonstrated a robust statistical association with the presence of chronic headache in our sample. The inefficiency of restorative sleep processes compromises functional connectivity between the medial prefrontal cortex and the amygdala, resulting in a failure of top-down inhibitory control (22). The absence of this regulation predisposes the brain to limbic hyperreactivity to negative stimuli, which generates emotional instability and exacerbated responses (23). The sample studied showed a high prevalence of non-restorative sleep (59.32%), indicating a context of sleep inefficiency. This scenario promotes a state of physiological and inflammatory stress (24), in which irritability manifests as a reflection of neurobiological vulnerability, amplified in the presence of chronic pain.

Furthermore, a reduction in attentional capacity was consolidated as a relevant associated factor. Despite the direct cognitive impact of pain, current evidence indicates that

cognitive dysfunction in migraine (including attention deficits and executive function) manifests also during the interictal period and is aggravated by sleep disorders (25). The “wake state instability” theory can explain this phenomenon, in which residual homeostatic pressure causes involuntary psychomotor lapses (22). Thus, the complaint of inattention may reflect not only the impact of pain, but also the difficulty of maintaining cognitive stability in a scenario of high neurobiological demand. Additionally, stress and poor sleep quality are recognized in the literature as modifiable risk factors that determine the transformation of episodic migraine into chronic migraine (17). Thus, the irritability and inattention identified act not only as comorbidities, but possibly as perpetrators of a chronification cycle.

#### Neurobiological adaptation hypothesis and the role of chronobiological alignment

Although the association between chronic headache and sleep disorders has been well established in the literature (3,4), the data from this study did not show a higher prevalence of headache in night workers or across different fixed work shifts ( $p=0.9994$ ). This finding suggests that specific work patterns and individual adaptation profiles may strongly modulate this relationship.

Recent literature highlights that acute and irregular circadian disruptions act as significant headache triggers. For instance, Harmsen et al. (26) demonstrated that acute circadian misalignment in rotating shift workers led to a 31% higher prevalence of headaches on night shifts compared to day shifts within the same individuals. Similarly, Navarro-Pérez et al. (27) observed that starting 24-hour on-call shifts significantly increased migraine-related disability (MIDAS scores), anxiety, and sleep disturbances among medical residents.

In contrast to the acute misalignment and intermittent severe deprivation observed in those studies, our sample consisted exclusively of workers on fixed, stable shifts. Robust cohort studies offer a critical perspective that aligns with our findings. Appel and colleagues (11) observed that the increased risk of headache and migraine is concentrated in workers on variable shifts, with no significant difference between fixed day and night shifts. Furthermore, a meta-analysis involving more than 420,000 participants (28) showed that while shift work in general increases the risk of migraine, night work specifically was associated with a lower incidence of the disease. This epidemiological data is consistent with our results, reinforcing that night work, when fixed and stable, may not necessarily act as a risk factor for chronic headaches.

A determining factor for this absence of a negative impact may reside in a self-selection based on chronotype. The analysis revealed a strong statistical dependence between work shift and self-reported chronotype, as detailed in Table 5. There

was a significant predominance of morning chronotypes in the First shift and in Business Hours, while the Third shift was mostly composed of individuals with an evening or intermediate chronotype. Park and colleagues (8) demonstrated that the alignment between individual chronotype and working hours promotes greater physiological and psychological resilience.

Therefore, the neurobiological adaptation hypothesis represents a successful behavioral adjustment. Unlike the acute chronobiological stress seen in rotating or 24-hour schedules, the tendency of workers in fixed shifts to seek out or stay at times that are more consistent with their endogenous circadian rhythm acts as a protective factor, possibly mitigating the chronobiological stress that could favor the chronification of pain.

#### Study limitations

This study has limitations inherent to its cross-sectional design, reduced time for data collection, in addition to the impossibility of follow-up. Furthermore, the use of a non-validated, self-administered questionnaire may limit direct comparability with studies utilizing standardized clinical scales (e.g., MIDAS). Additionally, our sample consisted exclusively of employees on fixed work schedules, precluding comparisons with rotating shift workers, and the duration of employment in the current shift was not assessed. However, this is a low-cost and easily replicable study. The higher prevalence of chronic headache than the population average may suggest a self-selection bias to some degree, where symptomatic individuals may have been more likely to participate in the survey. Thus, further studies are needed to investigate the evolution of these parameters and corroborate the hypothesis of resilience through chronobiological alignment.

## **Conclusion**

The results of this study revealed a prevalence of chronic headache substantially higher than the Brazilian population average, characterizing it as a high-impact morbidity in this industry. However, no statistical association was observed between the disease and different work shifts, indicating that the work schedule, by itself, did not act as a determining factor for chronicity in this sample. The analysis of chronotypes suggests a mechanism of behavioral self-selection: the tendency of workers to settle on schedules congruent with their biological preference seems to promote greater neurobiological resilience. An important modifiable risk factor was identified: the excessive use of analgesics, which favors the chronification of headache. The strong association with irritability and reduced attentional capacity, with a high prevalence of non-restorative sleep, denotes a state of neuropsychological vulnerability and probable consequent maladjustment in pain control mechanisms. Therefore, the management of headache in this population,

especially in refractory cases, should not be limited to analgesia. The study highlights the need to incorporate the active assessment of daytime symptoms and the treatment of sleep disorders into clinical practice, aiming to mitigate comorbidities that perpetuate chronicity and hinder pain control.

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