Original Article

Exploring the Relationship between Sleep Quality and Vitamin D Levels in Chronic Migraine Patients: A Cross-Sectional Study

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Abstract

Background and Aim: Chronic migraine imposes a considerable economic burden and is closely linked to other health conditions, Early detection of migraine-associated factors allows for timely interventions, impacting prevention, treatment, and prognosis.

Methodology: A descriptive cross-sectional study at King Fahad Hospital in Jeddah, Saudi Arabia, included 82 chronic migraine patients receiving botulinum toxin injections. This study explores the correlation between sleep quality and chronic migraine severity, investigates the relationship between vitamin D levels and migraines, and identifies predictors of poor sleep quality in the studied patient population.

Results: Our patient cohort, aged 21 to 63, is predominantly female (87.8%), with 50% having a university education. Surprisingly, less than 10% maintained adequate vitamin D levels. Nearly two-thirds, especially among the younger age group, those with chronic diseases, and smokers, faced moderate to severe disability due to migraines. Additionally, over half of the patients, particularly in the older age group, females, and those with lower education levels, experienced poor sleep quality, with a higher likelihood linked to lower vitamin D levels and more severe migraine scores.

Conclusions: These results underscore the significance of early detection in migraines, facilitating timely interventions for prevention, treatment, and prognosis. The complex interaction of sleep quality, migraine severity, and vitamin D levels highlights the necessity for holistic approaches to improve the well-being of individuals dealing with chronic migraines.

Keywords: Botulinum toxin; MIDAS; Migraine; PSQS; sleep quality; vitamin D.

Introduction

Migraine, a recurring neurovascular disorder with multifaceted pathophysiological mechanisms, manifests as a throbbing, moderate to severe unilateral headache accompanied by symptoms like nausea, vomiting, and heightened sensitivity to light and sound. With diverse subtypes, multiple comorbidities, and variable prognosis, the complete understanding of migraine's pathophysiology remains elusive. However, it is established that various triggers, encompassing lifestyle changes, sleep patterns, dietary factors, and hormonal imbalance can precipitate migraine attacks. The current consensus suggests that migraine arises from a reduced threshold in central mechanisms and intracranial hypersensitivity, influenced by an array of external and internal precipitating factors [1-2-3]. Migraine appears in two main forms: episodic and chronic. For individuals with episodic migraines, they typically encounter between 0 to 14 headache days each month, whereas those with chronic migraines endure more than 15 episodes over a span of at least three months. Chronic migraine not only exacts a significant economic toll worldwide but is also closely associated with comorbid conditions such as vascular diseases and psychiatric disorders like ischemic stroke, depression and others[4-5].

Sleep disturbance stands out as a frequently mentioned factor contributing to the occurrence of migraine headaches. The intricate connection between headaches and sleep revolves around a dual relationship where sleep disturbances can serve as triggers for headaches, while headaches, in turn, might lead to irregularities in sleep patterns among affected individuals. A study revealed that variations in sleep patterns significantly influenced headache occurrences, with 46% of tension-type and 60% of migraine patients experiencing such variations over time. Importantly, the presence of sleep disturbances in migraine patients cannot be solely attributed to chance or coexisting depression and anxiety; rather, it suggests the possibility of a shared biological foundation governing both the regulation of sleep and the pathogenesis of migraine. This intriguing insight points toward the potential existence of a common pathway influencing both sleep regulation and the onset of migraine headache [6-7]. Vitamin D deficiency is associated with chronic pain, depression, and neurological disorders due to its receptors in the brain. It's also linked to severe headaches, suggesting potential in migraine management. Vitamin D plays a role in migraine pathogenesis by affecting pain sensitization, inflammation, and immune function. Both vitamin D deficiency and migraines exhibit latitude-dependent risks, warranting further investigation into their impact on migraine frequency and severity[3-4-5].

This study has a twofold aim: first, to scrutinize the correlation between the quality of sleep and the severity of chronic migraine headaches; and second, to investigate the relationship between vitamin D levels and these migraines. In addition to these primary objectives, the study also endeavors to identify a spectrum of predictors contributing to poor sleep quality within the specific patient population under examination.

Methods and Materials

Comprehensive cross-sectional study conducted at King Fahad Hospital in Jeddah, Saudi Arabia, a cohort of 82 patients diagnosed with chronic migraines and undergoing botulinum toxin injections was actively engaged. The primary objective was twofold: to scrutinize the intricate correlation between vitamin D levels and sleep quality and to explore an array of demographic and clinical factors shaping the context of chronic migraines. Rigorous patient data acquisition occurred through a meticulous process involving medical records and a thoughtfully crafted questionnaire. This survey instrument, meticulously developed by the authors through a thorough literature review and expert consultations, ensured a comprehensive capture of relevant information including Migraine Disability Assessment (MIDAS) score and Pittsburgh Sleep Quality Index (PSQI) [8,9]. All participants, prior to inclusion, provided informed consent, underscoring the ethical foundation of the study. The data collection spanned a diverse range of demographic and clinical aspects, encompassing variables such as age, gender, educational background, disease duration, medications utilized, and the frequency of migraines both before and after botulinum toxin injections. The evaluation of migraine severity relied on the well-established Migraine Disability Assessment (MIDAS) score, categorized into four distinct levels: No disability (Score: 0 to 5), Mild disability (Score: 6 to 10), Moderate disability (Score: 11 to 20), and Severe disability (Score: More than 20). Furthermore, the study categorized vitamin D levels into severities: severely deficient (less than 12 ng/mL), deficient (12-30 ng/mL), inadequate (30-50 ng/mL), and adequate (more than 50 ng/mL). To delve into the intricacies of sleep quality, the Pittsburgh Sleep Quality Index (PSQI) was employed, with scores categorized as indicative of good sleep (5 points or less) or poor sleep (more than 6 points) [8,9,10].

The collected data underwent rigorous statistical analysis using SPSS v21 with two-tailed tests at a significance level of 0.05. Descriptive analysis included presenting frequency distribution and percentages for study variables, encompassing participants' personal data and pertinent migraine-related information. Graphical representation was employed for Vitamin D levels and MIDAS scores, while cross-tabulation highlighted relationships between vitamin D levels and sleep quality. Significance was determined using Pearson chi-square tests and exact probability tests. Further investigation into the link between vitamin D levels and migraine severity involved Pearson correlation analysis and multiple hierarchical linear regression analysis, accounting for both crude and adjusted effects. The study adhered to ethical guidelines outlined in the Declaration of Helsinki and secured approval from the ethics and research committee of the King Fahad General Hospital, Ministry of Health, Jeddah, Saudi Arabia, ensuring ethical conduct and prioritizing participant well-being.

Results

The study enrolled 82 eligible cases diagnosed with migraine, ranging in age from 21 to 63 years, with a mean age of 46.3 ± 10.1 years. Hie majority, specifically 72 individuals (87.8%), were females, and 46 (56.1%) were married. In terms of education, almost half of the participants (48.8%) had attained a university level of education. Among the study population, 42 individuals (51.2%) identified as non-smokers. Medical history indicated that 12 participants (14.6%) had thyroid disorders, while 10 (12.2%) had bronchial asthma. Notably, approximately 42 individuals (51.2%) reported having no chronic health problems. Additionally, most of the patients had a family history of migraine among their first-degree relatives (Table 1).

Table 1. Demographic and clinical features, severity, frequency and treatment patterns of migraine patients receiving Botox at King Fahad General Hospital.

Socio-demographics	**No**	%
Age in years		
< 30	22	26.8%
30-39	22	26.8%
40+	38	46.3%
Mean ± SD	46.3 ± 10.1	
Gender		
Male	10	12.2%
Female	72	87.8%
Marital status		
Single	18	22.0%
Married	46	56.1%
Divorced	18	22.0%
Educational level		
Below secondary	26	31.7%
Secondary	10	12.2%
University	40	48.8%
Post-graduate	6	7.3%
Smoking		
Non-smoker	42	51.2%
Passive smoker	20	24.4%
Ex-smoker	6	7.3%
Current smoker	14	17.1%
Chronic diseases		
None	42	51.2%
Thyroid disease	12	14.6%
Bronchial Asthma	10	12.2%
HTN	9	11.0%
DM	6	7.3%
Multiple Sclerosis	2	2.4%
Others	9	11.0%
Family history of migraine		
Yes	46	56.1%
No	36	43.9%
Migraine severity		
No disability	8	9.8%

Regarding migraine data assessed by the MIDAS score, 42 individuals (51.2%) in the study faced severe migraines, indicating significant disability. Additionally, 24 participants (29.3%) exhibited moderate severity, while 8 (9.8%) reported mild severity, and another 8 (9.8%) experienced no disability due to migraines. MIDAS scores ranged from 0 to 70, with a mean score of 26.0 ± 18.4. Notably, 40 participants (48.8%) had been dealing with migraines for over a decade, while 24 individuals (29.3%) had a migraine history of less than 5 years.

Concerning preventive medications, over half experimented with more than one, including 18.3% using Topiramate, 15.9% on Amitriptyline, and 7.3% on Beta-blockers. For abortive medications during migraines, about one-third exclusively used paracetamol, another third used medications from the triptan group, and 15% opted for combination therapy, as detailed in Table 1. Surprisingly, less than 10% of our patients exhibited sufficient vitamin D levels **(Figure 1),** and half of our patient have poor sleep quality **(Figure 2).**

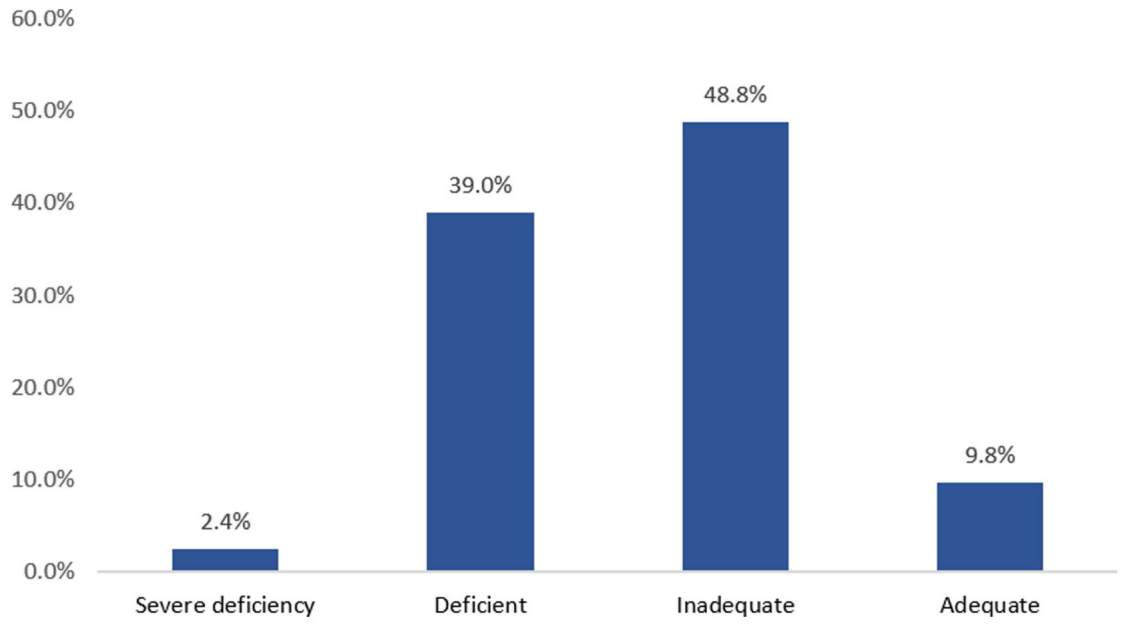


Figure 1. Vitamin D level (severity) among migraine patients who received Botox, King Fahad General Hospital

Table 2. Factors associated with sleep quality among migraine patients who received Botox

Factors	Sleep quality				p-value
	Poor sleep		Good sleep		
	No	%	No	%	
Age in years					
<30	10	45.5%	12	54.5%	.ûû7*
30-39	6	27.3%	16	72.7%	
40+	26	68.4%	12	31.6%	
Gender					
Male	6	60.0%	4	40.0%	,553A
Female	36	50.0%	36	50.0%	
Marital status					
Single	8	44.4%	10	55.6%	.373
Married	22	47.8%	24	52.2%	
Divorced	12	66.7%	6	33.3%	
Educational level					
Below secondary	20	76.9%	6	23.1%	
Secondary	4	40.0%	6	60.0%	.0i7*A
University	16	40.0%	24	60.0%	
Post-graduate	2	33.3%	4	66.7%	
Chronic diseases					
Yes	21	52.5%	19	47.5%	.821
No	21	50.0%	21	50.0%	
Smoking					
Non-smoker	20	47.6%	22	52.4%	
Passive smoker	14	70.0%	6	30.0%	,090A
Ex-smoker	4	66.7%	2	33.3%	
Current smoker	4	28.6%	10	71.4%	
Duration of migraine					
Less than 5 years	12	50.0%	12	50.0%	.qnO
5-10 years	12	66.7%	6	33.3%	
More than 10 years	18	45.0%	22	55.0%	
Migraine severity					
No disability	0	0.0%	8	100.0%	
Mild disability	2	25.0%	6	75.0%	.001*A
Moderate disability	18	75.0%	6	25.0%	
Severe disability	22	52.4%	20	47.6%	

P: Pearson X^2 test *N Exact probability test*

* P < *0.05 (significant)*

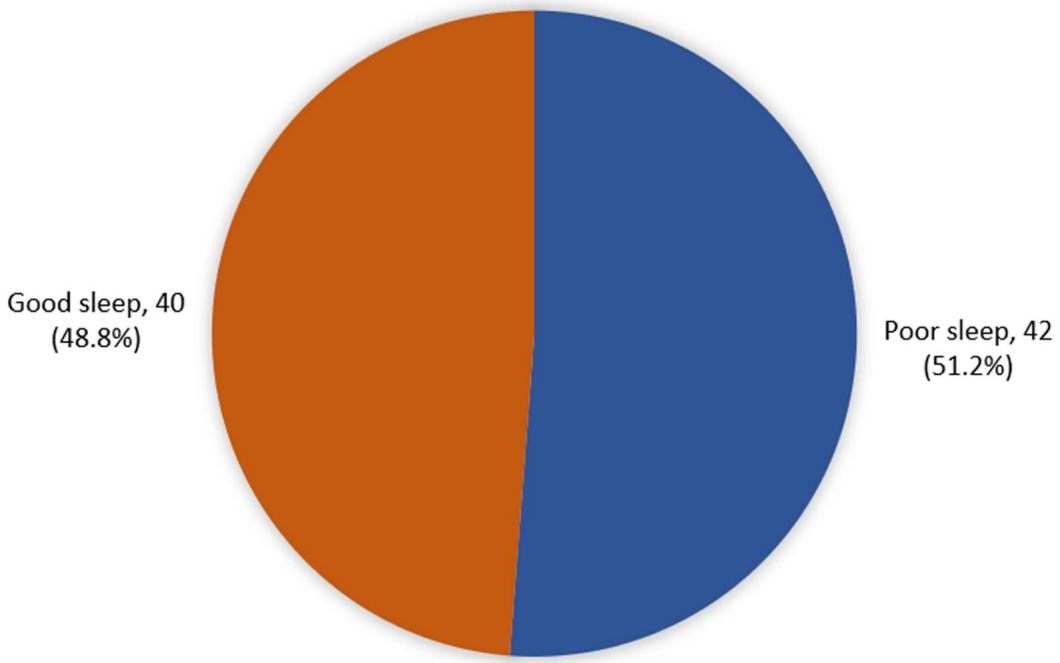


Figure 2. Sleep quality among migraine patients who received Botox, King Fahad General Hospital

Table 3. Relation between vitamin D level and sleep quality among migraine patients who received Botox

Vitamin D level	Sleep quality				p-value	OR (95% CI)
	Poor sleep		Good sleep			
	No	%	No	%		
Severe deficiency	2	100.0%	0	0.0%	.582	1.9 (0.7-2.6)
Deficient	16	50.0%	16	50.0%		1.0 (0.5-3.4)
Inadequate	20	50.0%	20	50.0%		1.0 (0.6-2.8)
Adequate	4	50.0%	4	50.0%		Ref
Mean ± SD	32.8 ± 12.8		35.8 ± 15.7		.359#	

P: Exact probability test *#; Independent t-test*
OR: Odds ratio *CI: Confidence interval*

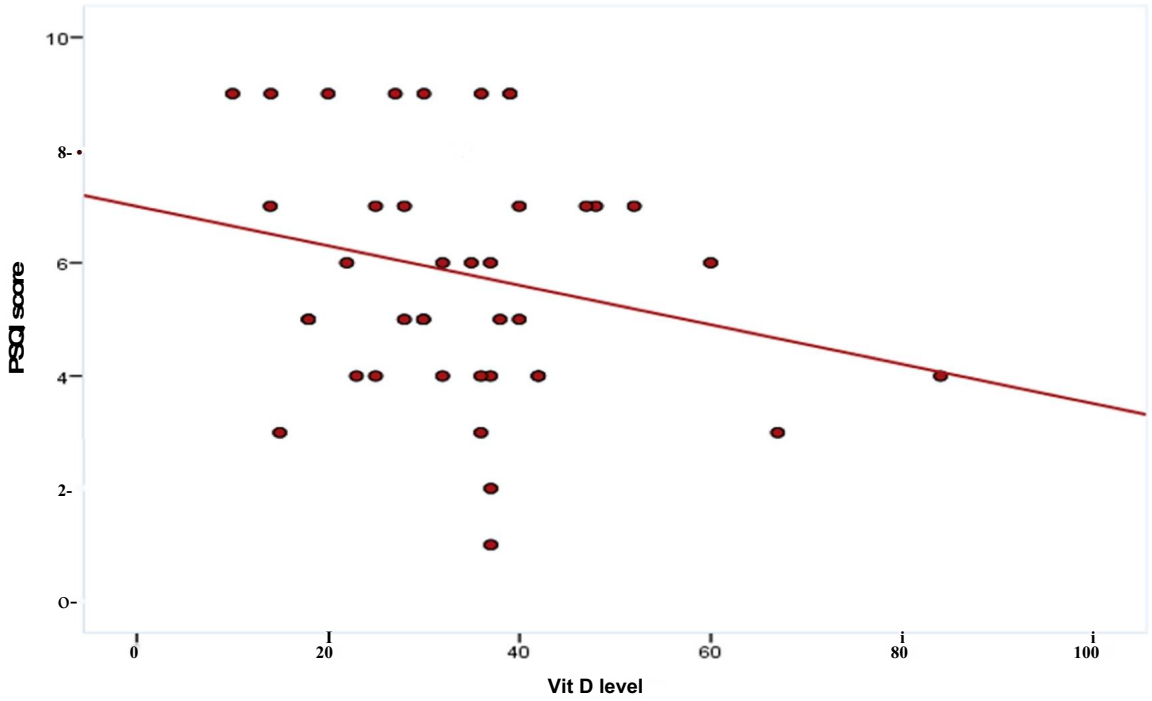


Figure 3. Scatter plot for correlation between vitamin D level and sleep quality among study migraine cases

Table 4. Multiple logistic regression model for factors associated with sleep quality among study cases

Factors	p-value	AOR	95% CI	
			Lower	Upper
Age in years	.480	0.97	0.91	1.05
Female gender	.143	0.22	0.03	1.66
Marital stams	.592	1.30	0.50	3.36
Higher education	.008*	0.26	0.10	0.70
Have chronic disease	.443	1.71	0.43	6.80
Smoking	.775	1.11	0.55	2.24
Migraine duration	.330	0.71	0.35	1.42
Abortive medications	.049*	6.55	1.00	54.79
MIDAS score	.048*	1.04	1.00	1.07
Vitamin D level	.048*	1.02	1.09	1.15

A OR: Adjusted odds ratio *CI: Confidence interval*
** P < 0.05 (significant)*

Sleep quality among migraine patients who underwent Botox treatment was associated with various factors. Notably, 68.4% of patients aged 40 years or older experienced poor sleep, contrasting with 27.3% of those aged 30-39 years (P=.OO7). Additionally, individuals with a lower educational level exhibited a higher prevalence of poor sleep, with 76.9% reporting suboptimal sleep quality compared to 33.3% of those with a higher educational level (P=.O17). Similarly, 75% of cases with moderate migraine severity reported poor sleep quality, in contrast to 52.4% of those with severe disability and none among those with no migraine-associated disability (P=.001) (Table 2). In evaluating the association between vitamin D levels and sleep quality among migraine patients who received Botox, it was observed that all cases with severe vitamin D deficiency experienced poor sleep, compared to 50% of those with deficient/inadequate levels and an equal percentage among those with adequate vitamin D levels. While no statistically significant association was reported, a higher association was found with severe deficiency (OR=1.9; 95% CI: 0.7-2.6) (Table 3). A significant intermediate negative correlation emerged in Figure 3, illustrating the relationship between study cases' vitamin D levels and their PSQI scores (r=-0.23; P=.036). Within the multiple logistic regression model assessing factors linked to sleep quality among study cases, higher education demonstrated a 74% reduced likelihood of poor sleep (OR=0.26). Conversely, an increased need for abortive medications was associated with a 6.5 times higher likelihood of poor sleep (OR=6.55). A higher MIDAS score corresponded to a higher likelihood of poor sleep (P=OR=1.04), while lower vitamin D levels were also associated with an increased probability of poor sleep (OR=1.02) (Table 4).

Discussion

Early detection of migraine-associated factors allows for timely interventions, impacting prevention, treatment, and prognosis. This study explores the correlation between sleep quality and chronic migraine severity, investigates the relationship between vitamin D levels and migraines, and identifies predictors of poor sleep quality in the studied patient population. The prevalence of migraine in Saudi Arabia is considerably higher than global averages. A regional investigation found a migraine prevalence of 37.2%, notably higher among females (81.1%) and most prevalent among students. Our study similarly affirms a higher occurrence of migraines in the younger age group, especially among women, constituting over two-thirds of the cases. This concurs with existing research emphasizing the youthful onset of migraines, with the female predominance potentially associated with the role of estrogen in heightened prevalence among women [11_12_13].

The Migraine Severity score (MIDAS) unveiled that nearly two-thirds of our patients, particularly among the younger age group, those with chronic diseases, and smokers, faced moderate to severe disability due to migraines. This aligns with our study's focus on chronic migraines. In line with this, Edmeads et al. discovered a 47% association

between reported migraines and disability. A corresponding local study in Saudi Arabia reinforced these findings, underscoring the substantial impact of headache severity on daily work, notably in around one-third of individuals with migraine-type headaches. Furthermore, another local study highlighted a positive correlation between symptom severity and a diminished quality of life [14-15-16]. Insufficient levels of Vitamin D may pose a potential risk for various neurological diseases, given its diverse effects on the nervous system. In our study, we found that less than a quarter of our patients had adequate Vitamin D levels, supporting the hypothesis of a stronger association between low Vitamin D and headaches. This aligns with numerous studies indicating such a link. Among our patients, while half of those with deficient/inadequate levels and an equal percentage of those with adequate vitamin D levels also experienced similar issues. Moreover, our investigation observed a noticeable trend suggesting a negative correlation between serum vitamin D levels and migraine severity Severe vitamin D deficiency correlated with poor sleep in all cases. Stewart et al., in their study on headache severity, identified significantly higher Migraine Disability Assessment Score (MIDAS) grades among patients under 25 years old, indicating increased disability and establishing the reliability of the MIDAS scale [17,22].

Patients with migraines commonly report sleep-related complaints and disorders. Sleep disorders are significantly more prevalent, up to 17 times, in individuals experiencing chronic headaches compared to the general population. Notably, the strongest association is found in patients with chronic migraine. Among individuals with chronic migraine, the most frequently reported sleep complaints include difficulty falling asleep and challenges in maintaining sleep [23,24].

Interestingly, nearly half of our chronic migraine patients exhibit suboptimal sleep quality, particularly prevalent among the older age group and those with lower education levels. This contradicts the observed pattern of more episodic migraine headaches in individuals with higher education levels and younger age groups, as indicated by a local study examining headache prevalence in Saudi Arabia. Conversely, our findings align with the trends identified by Duan et al., where a higher prevalence of poor sleep quality was noted in older individuals and those with lower education levels, but other study conducted in Iran showed poorer sleep in children age group [1V25~26]. This discrepancy underscores the complexity of the relationship between migraine characteristics, educational background, age, and sleep quality, prompting further exploration into the nuanced interplay of these factors.

The duration of sleep appears to decrease proportionally with the intensity and severity of headaches in patients with migraines. Our study highlighted a clear correlation, demonstrating that individuals experiencing more severe headaches tend to have poorer sleep quality. This observation underscores the evident impact of migraines on disrupting sleep patterns. In line with our findings, recent studies have also reported a higher prevalence of sleep quality disorders among

individuals with more severe migraines when compared to healthy controls. These consistent results emphasize the intricate relationship between migraine severity and sleep disturbances, shedding light on the potential implications for understanding and managing the interplay between these factors in individuals with migraines [27,28,29].

Vitamin D has been established as having a connection to severe headaches, and it is currently under consideration as a potential prophylactic agent or supplementary component in the overall management of migraines. Our study further contributes to this understanding, as it revealed a noteworthy association between lower vitamin D levels and a higher likelihood of poor sleep quality among migraine patients. This finding aligns with a study conducted in Korea, which also investigated the role of vitamin D in association with migraine severity and sleep quality. These collective insights suggest a potential interplay between vitamin D, migraine management, and sleep quality, warranting further exploration and consideration in the comprehensive approach to migraine care.

Conclusions:

Our study revealed that approximately half of chronic migraine patients, particularly females and individuals in the older age group with lower education levels, experienced poor sleep quality. This suboptimal sleep quality was significantly associated with an elevated risk of heightened migraine severity and low vitamin D levels. These findings emphasize the importance of early detection of factors associated with migraines, enabling timely interventions that can influence prevention, treatment, and prognosis. The intricate interplay between sleep quality, migraine severity, and vitamin D levels underscores the need for comprehensive approaches to enhance the overall well-being of individuals grappling with chronic migraines.

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