The Relationship Between Vitamin D Level and Chronic Migraine Headache Severity: Cross-Sectional Study, Saudi Arabia

Abstract

Objective

Chronic migraine imposes a considerable economic burden and is closely linked to other health conditions. The purpose of this study is to look at the connection between the intensity of chronic migraine headaches and vitamin D levels.

Methodology

The purpose of this study is to look at the connection between the intensity of chronic migraine headaches and vitamin D levels. The study included 82 chronic migraine patients receiving botulinum toxin injections. Data was analyzed using IBM SPSS 21.

Results

Our patients aged 21 to 63, primarily females (87.8%) with half having university education. Only less than 10% maintained adequate vitamin D levels. The Migraine Severity score (MIDAS) indicates that two-thirds of smokers, older people, and people with chronic illnesses were moderately to severely disabled by migraines. The severity scores of migraines and vitamin D levels were found to be negatively correlated (P = 0.049).

Conclusion

A substantial number of chronic migraine patients, particularly among the younger demographic and those with higher severity scales, exhibited low Vitamin D levels, showing a significant negative correlation with migraine severity scores. Early screening and vitamin D replacement could improve their quality of life.

Key Words:

Migraine, vitamin D, botulinum toxin, MIDAS, Severity.

Introduction

Migraine, a persistent neurological condition characterized by recurring episodes with diverse symptoms including headaches, light sensitivity, dizziness, anxiety, nausea, and vomiting, poses a significant global health challenge. Over a billion people worldwide suffer from migraines, which are the second most debilitating and third most common ailment worldwide, according to statistics from the World Health Organization (1).Rooted in the trigeminovascular system and stemming from disturbances in brain sensory processing, migraine's etiology involves a complex interplay of genetic and environmental factors, profoundly affecting affected individuals' quality of life (2,3).

The two main types of migraines that manifest are episodic and chronic. The frequency of episodic migraines varies, with 0–14 headache days per month and over 15 episodes per month for at least three months in the case of chronic migraines (4,5) Despite sharing common risk factors, these types diverge significantly in epidemiology, symptoms, disabilities, and therapeutic strategies. Chronic migraine, in particular, imposes substantial economic burdens and exhibits stronger associations with comorbidities such as vascular and psychiatric disorders (4,5).

Vitamin D, known for its roles in chronic pain, depression, and neurological conditions, interacts with numerous receptors within the brain (6). Despite ample sun exposure in regions like the Middle East, vitamin D deficiency remains prevalent, potentially due to other factors influencing its synthesis or metabolism (7).Studies suggest that there may be a link between low levels of vitamin D and the intensity of headaches, suggesting that vitamin D supplements may be used as a prophylactic or supplemental treatment for migraines (8). In addition, Vitamin D involvement in migraine pathogenesis,pain sensitization, inflammation, and immune functions, further underscores its relevance in migraine management(6,7,8). The latitude-dependent risks associated with both vitamin D deficiency and migraines warrant further exploration of their relationship with migraine frequency and severity (6,7,8).Individuals with higher levels of serum vitamin D (50-100 ng/mL) were less likely to experience migraines compared to those with levels below 20 ng/mL (9).Therefore, the purpose of this study is to look at the connection between the intensity of chronic migraine headaches and vitamin D levels. Additionally, it aims to identify various predictors of severity within the studied patient population.

Methods

From the July 2023 to December 2023, a cross-sectional study took place at the Neurology clinicsat King Fahad Hospital in Jeddah, Saudi Arabia.

Inclusion and Exclusion Criteria

The research included 82 patients who met the inclusion criteria for the study. These criteria included a diagnosis of chronic migraine, and recent measurements of their vitamin D levels within the last 3 months. Additionally, all included patients were receiving botulinum toxin injections at King Fahad Hospital in Jeddah, Saudi Arabia.

On the other hand, certain exclusion criteria were applied to ensure the study's focus on chronic migraine and the impact of vitamin D levels. Patients with other types of headaches or migraine variants were excluded from the study. Furthermore, individuals who did not receive botulinum toxin injections or had no recent measurements of their vitamin D levels within the last 3 months were also excluded.

Data Collection

Patient data was gathered from medical records and by administering a structured questionnaire. This questionnaire, devised by the authors following an extensive literature review and expert consultations, collected demographic and clinical details, encompassing age, gender, education level, disease duration, medications utilized, and the frequency of migraine attacks both pre and post botulinum toxin injections.

Using a widely used procedure for predicting proportions with given margins of error and confidence levels, the sample size for this study was established. Statistical power was ensured by using a 95% confidence level and a 5% margin of error. Important factors included in the method were the Z-score for the target confidence level and an expected percentage of 0.5 for the highest possible variability.

The Migraine Disability Assessment (MIDAS)is a reliable andvalid scoring system used to measure the severity of migrainesmigraines (10). The overall MIDAS score is categorized into four—No disability, Mild disability, Moderate disability, and Severe disability. Based on predetermined standards, vitamin D levels were categorized asseverelydeficient, deficient, inadequate, and adequate.

Ethical Approval:

The King Fahad General Hospital's ethics and research council granted ethical approval for this study in compliance with the principles delineated in the Declaration of Helsinki. The protocol underwent a comprehensive examination to guarantee the study's ethical conduct and protect the welfare of the participants.

Statistical Analysis:

IBM SPSS 21, the Statistical Package for Social Sciences, was used to statistically evaluate the data. A descriptive analysis produced the frequency distributions and percentages of the research variables. To find statistically significant variations in mean values, non-parametric procedures such as the Kruskal-Wallis Test and Mann-Whitney U Test were employed. The association between vitamin D levels and migraine severity was examined using Spearman correlation analysis. A binary logistic regression model was also employed to find adjusted predictors of migraine-related severe impairment. Assumptions of the model were thoroughly evaluated, including binary outcome, independence of observations, absence of multicollinearity, linearity of predictors, and absence of outliers or influential observations. All statistical procedures used in the study were adequately described, exact p-values and confidence intervals were reported, ensuring transparency and accuracy in the presentation of results. Multivariate analysis was prioritized over bivariate analyses when appropriate, following standard reporting guidelines for clinical trials and diagnostic studies.

Results

This researchconducted at the King Fahad General Hospital, examined the clinical and demographic traits of individuals with migraine who were undergoing Botox treatment. As shown in ***Table 1***,A mean age of 46.3 years was observed among the 82 patientswith the majority being female (87.8%). Most were married (56.1%), while 48.8% had university education. Notably, 51.2% experienced severe disability due to migraines, with a mean MIDAS score of 26.0 ± 18.4. Additionally, 56.1% had a family history of migraine. Regarding migraine duration, 48.8% reported suffering for more than 10 years. Multiple preventive medications were tried by 52.4% of patients, while common abortive medications included Paracetamol (39.0%) and Triptan (36.6%).

Table 1. Demographic and clinical features of migraine patients receiving Botox at King Fahad General Hospital

Socio-demographics		Frequency (N)	Percentages (%)
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%
Vit-D Level	*Deficient*	14	17.1
	Insufficient	20	24.4
	Sufficient	48	58.5
	Migraine Related Clinical Features		
Migraine Severity	*No disability*	8	9.8%
	Mild disability	8	9.8%
	Moderate disability	24	29.3%
	Severe disability	42	51.2%
	MIDAS score (mean ± SD)	26.0 ± 18.4	
Duration of Migraine	*Less than 5 years*	24	29.3%
	5-10 years	18	22.0%
	More than 10 years	40	48.8%
Preventive medications	*Topiramate*	15	18.3%
	Amitriptyline	13	15.9%
	Beta-blockers	6	7.3%
	Valproic Acid	5	6.1%
	Tried more than one	43	52.4%
Abortive Medications	*Paracetamol*	32	39.0%
	Triptan	30	36.6%
	Paracetamol + NSAID	12	14.7%
	Others	8	9.7%

(N) Frequency, (%) Percentages

Table 2 presents the variations in vitamin D levels among migraine patients who underwent Botox treatment. Gender ($p = 0.012$), educational level ($p = 0.282$), chronic illness ($p = 0.030$), and smoking status ($p = 0.015$) were shown to be significantly correlated with vitamin D levels among these variables. Men were found to have higher average levels of vitamin D than women, and patients who were better educated and free of chronic illnesses were more likely to have greater levels. Current smokers displayed notably higher mean vitamin D levels compared to other smoking categories. Conversely, age, marital status, family history of migraine, and previous surgery did not reveal significant associations with vitamin D levels ($p > 0.05$).

Table 2. Difference of Vitamin D Level among migraine patients who received Botox

Factors	Vit-D Level (ng/mL)			p-value
	No	Mean (SD)	Mean Rank	
Age in years				0.794 [a]
< 30	6	28.67 (11.9)	35.17	
30-39	16	32.00 (10.1)	42.25	
40+	60	35.40 (15.4)	41.93	
Gender				***0.012*** [a]
Male	72	35.61 (14.3)	43.97	
Female	10	24.40 (10.5)	23.70	
Marital Status				0.355 [b]
Single	18	32.44 (16.8)	39.50	
Married	46	36.57 (14.9)	44.63	
Divorced	18	30.11 (8.1)	35.50	
Educational level				0.282 [b]
Below secondary	26	34.08 (13.2)	41.35	
Secondary	10	29.60 (8.8)	34.10	
University	40	34.85 (16.8)	41.00	
Post-graduate	6	38.67 (5.1)	57.83	
Chronic diseases				***0.030*** [a]
No	32	29.87 (14.1)	34.38	
Yes	50	37.04 (13.8)	46.06	
Family history of migraine				0.597 [a]
No	36	34.89 (15.0)	43.11	
Yes	46	33.74 (13.8)	40.24	
Smoking				***0.015*** [b]
Non-smoker	42	34.43 (34.4)	41.98	
Passive smoker	20	36.80 (36.8)	41.00	
Ex-smoker	6	20.67 (6.3)	14.83	
Current smoker	14	35.86 (11.9)	52.21	
Previous Surgery				0.488 [a]
No	24	36.00 (17.9)	44.33	
Yes	58	33.52 (12.6)	40.33	

(a) Mann-Whitney U Test, (b) Kruskal Wallis Test

Table 3illustrates the variance in migraine severity, quantified by MIDAS scores, among patients who underwent Botox treatment. Within these parameters, there were significant correlations between the intensity of migraines and vitamin D level ($p < 0.001$) and educational level ($p = 0.026$) where patients with post-graduate training had the lowest mean MIDAS scores. Conversely, patients with low vitamin D levels (<30 ng/mL) scored substantially higher than those with sufficient (>50 ng/mL) or insufficient (30–50 ng/mL) levels. On the other hand, age, gender, marital status, chronic diseases, family history of migraine, smoking status, and previous surgery did not show significant associations with migraine severity ($p > 0.05$).

Table 3. Difference of migraine severity (based on MIDAS) among migraine patients who received Botox

Factors	**Migraine Severity Score**			**p-value**
	No	**Mean (SD)**	**Mean Rank**	
Age in years				0.384 [b]
< 30	6	22.33 (8.5)	40.17	
30-39	16	34.75 (23.9)	48.88	
40+	60	24.07 (16.9)	39.67	
Gender				0.496 [a]
Male	72	25.39 (17.6)	40.83	
Female	10	30.60 (23.8)	36.30	
Marital Status				0.237 [b]
Single	18	33.00 (23.2)	46.50	
Married	46	25.57 (16.4)	42.63	
Divorced	18	20.22 (16.4)	33.61	
Educational level				***0.026*** [b]
Below secondary	26	22.38 (17.9)	36.04	
Secondary	10	23.40 (22.8)	36.50	
University	40	30.85 (17.7)	49.00	
Post-graduate	6	14.00 (6.1)	23.50	
Chronic diseases				0.094 [a]
No	32	30.75 (20.5)	47.00	
Yes	50	23.00 (16.4)	37.98	
Family history of migraine				0.290 [a]
No	36	29.72 (21.7)	45.67	
Yes	46	23.13 (14.9)	38.24	
Smoking				0.161 [b]
Non-smoker	42	28.24 (18.0)	45.45	
Passive smoker	20	22.50 (19.0)	35.30	
Ex-smoker	6	27.33 (12.7)	47.83	
Current smoker	14	23.86 (21.4)	35.79	
Previous Surgery				0.822 [a]
No	24	23.42 (16.2)	40.58	
Yes	58	27.10 (19.2)	41.88	
Vit-D Level				***<0.001*** [b]
Deficient (<30 ng/mL)	14	41.71 (16.9)	62.36	
Insufficient (30-50 ng/mL)	20	21.10 (21.5)	31.50	
Sufficient (>50 ng/mL)	48	23.50 (15.1)	39.58	

(a) Mann-Whitney U Test, (b) Kruskal Wallis Test

Based on different migraine-related characteristics, ***Table 4*** displays the variations in vitamin D levels among migraine sufferers. Among these factors, headache frequency before initiation of Botox injections ($p = 0.027$) and headache frequency after Botox injections ($p = 0.013$) showed significant associations with vitamin D levels. Patients experiencing headaches three times or more per week prior to Botox treatment exhibited lower mean vitamin D levels compared to those with less frequent headaches. Likewise, individuals experiencing daily headaches post-Botox treatment demonstrated lower mean vitamin D levels. However, there were no significant correlations seen between vitamin D levels and migraine severity, duration, preventive drug use, or abortive medication use ($p > 0.05$).

Table 4. Difference of Vitamin D Level among migraine patients based on Migraine Related Features

Factors	**Vit-D Level (ng/mL)**			**p-value**
	No	**Mean (SD)**	**Mean Rank**	
Migraine severity				0.598[b]
No disability	8	33.75 (4.0)	43.25	
Mild disability	8	35.25 (7.6)	48.50	
Moderate disability	24	34.08 (9.2)	44.33	
Severe disability	42	34.24 (18.5)	38.21	
Duration of migraine				0.193[b]
Less than 5 years	24	31.83 (9.2)	40.58	
5-10 years	18	28.22 (10.3)	33.50	
More than 10 years	40	38.40 (17.1)	45.65	
Headache frequency before Botox				***0.027***[b]
1 Time/ week	4	45.00 (17.3)	54.50	
2 Time/ week	6	35.33 (2.5)	47.17	
3 Time/ week	6	39.33 (1.0)	62.17	
>3 Time/ week	26	29.08 (10.1)	31.35	
Daily	40	35.60 (17.3)	42.85	
Headache frequency after Botox				***0.013***[b]
<1 Time/ week	16	35.00 (12.1)	42.50	
1 Time/ week	22	33.27 (6.8)	43.05	
2 Time/ week	24	32.67 (11.8)	41.67	
3 Time/ week	8	55.50 (22.3)	62.00	
>3 Time/ week	6	28.00 (15.2)	31.17	
Daily	6	20.00 (8.9)	15.50	

Preventive medications				0.134 [a]
No	16	44.12 (23.1)	49.50	
Yes	66	31.85 (10.1)	39.56	
Abortive medication				0.112 [a]
No	10	29.60 (21.9)	30.30	
Yes	72	34.89 (13.0)	43.06	

(a) Mann-Whitney U Test, (b) Kruskal Wallis Test

Figure 1displays the scatterplot and correlation statistics computed with Spearman's rho coefficient, showing a moderately negative correlation between MIDAS scores and vitamin D levels, among migraine patients (rho (r) = -0.195, p = 0.079, N = 82). While the correlation did not show statistical significance at the conventional alpha level of 0.05, the negative correlation coefficient implies a tendency for higher vitamin D levels to be linked with lower MIDAS scores, indicating less severe disability due to migraine.

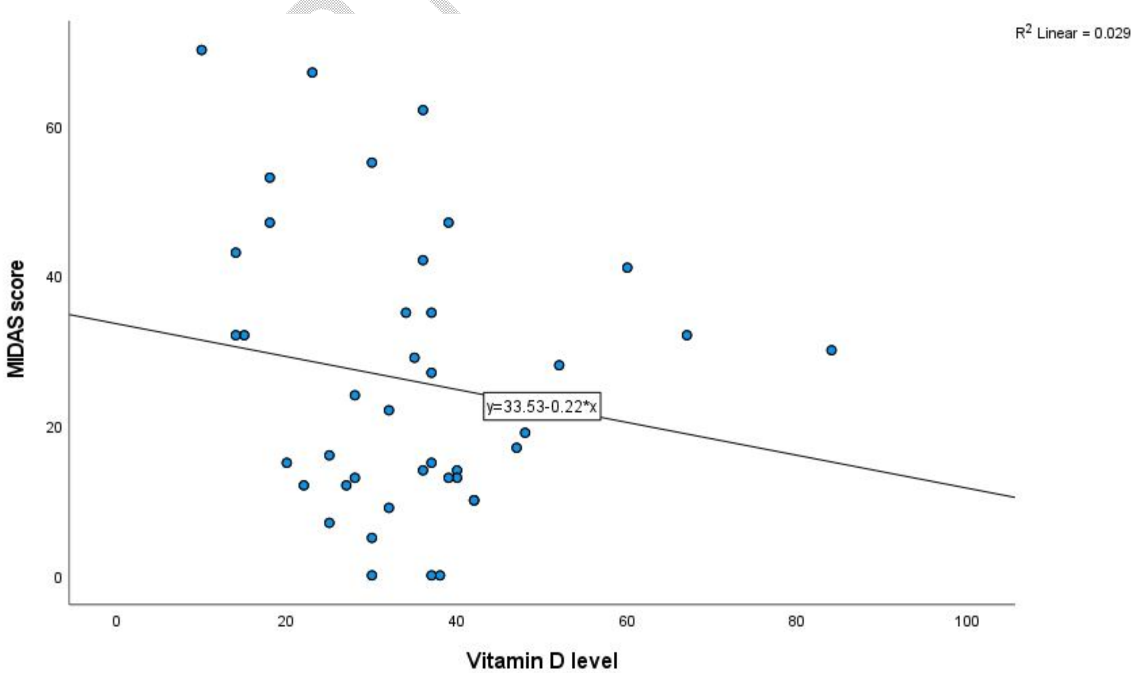

Figure1. Correlation plot between vitamin D level and migraine severity (MIDAS) among study patients (r=-0.195; P=.079 calculated with Spearman Correlation)

Table 5 shows the result of binary logistic regression model evaluated predictors of severe disability due to migraine, as indicated by MIDAS scores. Among the factors analyzed, gender showed some trend (p = 0.166), with males having 3.556 times higher odds of severe disability compared to females. Educational level also shows trend (p = 0.068), indicating that individuals with higher education had 1.983 times higher odds of severe disability. The odds ratio for vitamin D level (Exp(B) = 0.969, 95% CI: 0.920 - 1.020) did not achieve statistical significance (p = 0.229), indicating no substantial association between vitamin D levels and severe disability due to migraine. Other factors, including age, marital status, presence of chronic disease, family history of migraine, and smoking status, did not show statistically significant associations with severe disability.

Table 5. Binary Logistic Regression model to assess adjusted predictors of Severe Disability due to Migraine (MIDAS Score)

	B	**Sig.**	**Exp(B)**	**95% CI**	
				Lower	**Upper**
Age (Years)	.042	.272	1.043	.967	1.125
Gender (Male)	1.269	.166	3.556	.590	21.422
Marital Status (Divorced)	-.044	.914	.957	.426	2.146
Higher Education	.684	.068	1.983	.950	4.136
Presence of Chronic Disease	-.666	.312	.514	.141	1.869
Family Hx of Migraine	-.992	.088	.371	.119	1.159
Current Smokers (Yes)	-.312	.099	.732	.506	1.060
Vitamin D Level	-.032	.229	.969	.920	1.020
Constant	-1.240	.598	.289		

Exp(B)=Odd's Ratio

Discussion

Chronic migraine exerts a significant economic burden and is intricately connected to other health conditions. The goal of this research is to identify factors that predict the intensity of chronic migraine headaches in the patient population under investigation by examining the relationship between vitamin D levels and headache severity. While prior research suggests higher prevalence of migraine among young adult Saudis, our study unveils a greater occurrence of migraine in the younger age bracket, particularly among women, with over two-thirds being female, this aligns with numerous studies highlighting migraine onset at a young age and female predominance may be linked to estrogen's role in the increased prevalence among women. Additionally, over half of our patients have a higher level of education, showing a positive correlation between migraine and educational attainment. This association may be attributed to the stress and anxiety commonly experienced by individuals with higher education, known to trigger headache mechanisms.Notably, more than half of the patients have a first-degree relative with a positive family history of migraine. This aligns with the findings of a general population survey conducted in Jeddah city, Saudi Arabia, which reported a similar rate of family history (11-14).

Migraine profoundly affects the personal, social, emotional, and physical aspects of individuals experiencingit. Besides leading to noticeable functional limitations, it adversely impacts academic and occupational performance. Nearly two-thirds of our patients, especially among the younger population, those with chronic diseases, and smokersexperienced moderate to severe disability due to migraine headaches, as revealed by the Migraine Severity score (MIDAS). This aligns with our study's emphasis on chronic migraines. Correspondingly, Edmeads et al. found a 47% association between reported migraine headaches and disability, and a similar score used in a

Turkish study demonstrated that 35% of their cohort faced moderate to severe disability. Bıçakçı et al. investigated university students with migraines and found that approximately one-quarter of them had a moderate to severe MIDAS severity level. (15,16,17). A local Saudi Arabian study further corroborated these patterns, emphasizing the substantial impact of headache severity on daily work, particularly in about one-third of those who get headaches similar to migraines. Moreover, another local study reported a positive correlation between symptom severity and a diminished quality of life (18,19).

Vitamin D deficiency may represent a potential risk factor for various neurological diseases owing to its manifold effects on the nervous system. Despite Saudi Arabia's abundant sunshine year-round, approximately 30% of the general population, particularly younger individuals and females, experience vitamin D deficiency. Our observation of nearly half of our patients exhibiting vitamin D deficiency supports the hypothesis of a significant association between low vitamin D levels and headaches (20,6,7).

Many researches have shown a possible link between headaches and low vitamin D levels. In this study, we found a clear pattern indicating a negative relationship between blood vitamin D levels and migraine severity. According to one study, those with greater blood vitamin D levels (50-100 ng/mL) had a reduced odds ratio of having migraine headaches than people with lower serum vitamin D levels (<20 ng/mL) (9). Similarly, second research found that participants who had migraine had lower blood levels of vitamin D and vitamin D receptors than controls (21). On the other hand, some studies have not discovered any associations between serum vitamin D levels and particular headache characteristics, such as aura, severity, and duration (22, 23). Notably, research has indicated that migraines and low levels of vitamin D are more prevalent at higher altitudes further from the equator (20, 21, 22, 23).

Stewart et al. looked at the characteristics and intensity of headaches in connection to the grade on the Migraine Disability Assessment Scale (MIDAS). They discovered that patients under 25 years old had significantly higher MIDAS grades, indicating greater disability, and established the reliability of the MIDAS scale (9). A significant association was found in another investigation between higher headache severity and lower vitamin D levels (14).

Clinical Implications and Future Research

The study findings suggest a need for a multidimensional approach to migraine management among patients undergoing Botox treatment, particularly focusing on addressing the high prevalence of severe disability and the significant associations with vitamin D levels. Healthcare providers should consider individualized treatment plans that incorporate not only Botox therapy but also adjunctive interventions such as vitamin D supplementation and comprehensive migraine management strategies. Furthermore, attention to socioeconomic factors, gender disparities, and the potential impact of education on migraine severity is crucial for optimizing patient care and improving treatment outcomes.

Future investigations should look at the possible therapeutic benefits of vitamin D supplementation while conducting long-term trials to assess the long-term efficacy and safety of Botox treatment in migraine sufferers. To establish the effectiveness and ideal amount of vitamin D supplementation as a supplemental medication in the management of migraines, randomized controlled trials are crucial. Further investigation into the underlying mechanisms of gender disparities in migraine prevalence and treatment outcomes is necessary to tailor interventions accordingly and improve outcomes for all migraine patients.

Limitations

Several limitations of this study merit acknowledgment. The cross-sectional design impedes the establishment of causality and temporal relationships between variables. The results' applicability to broader groups may be constrained by the small sample size. Self-report measurements, such as migraine intensity and disability, may incorporate subjective interpretations and recall bias.

The results' applicability to different clinical contexts may be limited by their dependence on a single center.

Conclusion

This research studies factors that influence migraine headaches intensity and disability, and its association with vitamin D levels. The predominance of females, elevated prevalence of severe disability, and notable associations with vitamin D levels emphasizethe significance of tailored treatment approaches. While Botox treatment shows promise in alleviating migraine symptoms, comprehensive management strategies that consider socioeconomic factors, gender disparities, and vitamin D supplementation may be necessary to optimize outcomes. Further research exploring longitudinal effects, randomized controlled trials assessing vitamin D supplementation, and investigating gender disparities in migraine outcomes is essential for advancing our understanding and improving care for migraine patients.

References

1. Algahtani H, Shirah B, Bamsallm M, Nejaim K, Alobaidi H, Alghamdi M. Perception of the general population towards migraine in Jeddah, Saudi Arabia. The Egyptian Journal of Neurology, Psychiatry and Neurosurgery. 2022 Jun 8;58(1).

2. Ashina M. Migraine. Ropper AH, editor. New England Journal of Medicine. 2020 Nov 5;383(19):1866–76.

3. Goadsby PJ, Holland PR, Martins-Oliveira M, Hoffmann J, Schankin C, Akerman S. Pathophysiology of Migraine: A Disorder of Sensory Processing. Physiological Reviews [Internet]. 2017 Apr;97(2):553–622. Available from:https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5539409/

4. Syed S, Shapo SF, Al-Otaibi JJ, Almutairi MH, Mohideen MT, et al. Migraine in adult Saudi population: Exploring common predictors, symptoms and its impact on Quality of Life. J Neurol Neurosci. 2020;11(1):313.

5. Natoli JL, Manack A, Dean B, Butler Q, Turkel CC, et al. Global prevalence of chronic migraine: A systematic review. Cephalalgia. 2009;30:599-609.

6. Wheeler S. Vitamin D deficiency in chronic migraine. Headache. 2008;48(Suppl 1):S52-S53.

7. Thys-Jacobs S. Alleviation of migraines with therapeutic vitamin D and calcium. Headache. 1994;34:590-592. doi:10.1111/hed.1994.34.issue-10.

8. Thys-Jacobs S. Vitamin D and calcium in menstrual migraine. Headache. 1994;34:544-546. doi:10.1111/hed.1994.34.issue-9.

9. Togha, M., Razeghi Jahromi, S., Ghorbani, Z., Martami, F., Seifishahpar, M. (2018). Serum Vitamin D Status in a Group of Migraine Patients Compared With Healthy Controls: A Case-Control Study. Headache, 58, 1530-1540. doi: 10.1111/head.13423.

10. Stewart WF, Lipton RB, Dowson AJ, Sawyer J. Development and testing of the Migraine Disability Assessment (MIDAS) Questionnaire to assess headache-related disability. Neurology. 2001;56(Suppl 1):S20-S28. doi:10.1212/WNL.56.suppl_1.S20.

11. Rajeh SA, Awada A, Bademosi O, Ogunniyi A. The prevalence of migraine and tension headache in Saudi Arabia: a community-based study. Eur J Neurol. 1997;4:502-506.

12. Weatherall MW. The diagnosis and treatment of chronic migraine. Ther Adv Chronic Dis. 2015;6:115-123.

13. Bigal ME, Sheftell FD, Tepper SJ, Rapoport AM, Lipton RB. Migraine days decline with duration of illness in adolescents with transformed migraine. Cephalalgia. 2005;25:482-487.

14. Bamalan BA, Khojah AB, Alkhateeb LM, Gasm IS, Alahmari AA, Alafari SA, Sindi MA, Yaghmour KA. Prevalence of migraine among the general population, and its effect on the quality of life in Jeddah, Saudi Arabia. Saudi Med J. 2021;42(10):1103-1108. doi:10.15537/smj.2021.42.10.20210575.

15. Edmeads J, Findlay H, Tugwell P, Pryse-Phillips W, et al. Impact of migraine and tension-type headache on lifestyle, consulting behaviour, and medication use: a Canadian population survey. Can J Neurol Sci. 1993;20(2):131-137. doi:10.1017/s0317167100047697.

16. Gungör O, Gungor S, Acipayam. The relationship between serum vitamin D levels and pain severity in children with migraine. Trends in Pediatrics. 2020;1(1):22-26.

17. AlBarqi M, AlDablan M, AlBahr A, AlAmer M, AlNaim A, AlNaim A, Almaqhawi A. Prevalence, frequency, and disability of migraine headaches and tension headaches among the general population in the Eastern Region of Saudi Arabia. J Med Life. 2022;15(11):1371-1378. doi:10.25122/jml-2022-0176.

18. Biçakci, Ş., Kurtaran, B., Over, M. F., Biçakci, Y. K. (2014). Are the Comments on HaNDL Syndrome in the ICHD-II Sufficient? Noro Psikiyatr Ars, 51(2), 178-180. https://doi.org/10.4274/npa.y6858

19. Syed, S., Shapo, S. F., Al-Otaibi, J. J., Almutairi, M. H., Mohideen, M. T., et al. (2020). Migraine in adult Saudi population: Exploring common predictors, symptoms and its impact on Quality of Life. J Neurol Neurosci, 11(1), 313.

20. Alsuwadia, A. O., Farag, Y. M., Al Sayyari, A. A., Mousa, D. H., Alhejaili, F. F., Al-Harbi, A. S., Housawi, A. A., Mittal, B. V., Singh, A. K. (2013). Prevalence of vitamin D deficiency in Saudi adults. Saudi Med J, 34(8), 814-818. PMID: 23974452.

21. Celikbilek, A., Gocmen, A. Y., Zararsiz, G., Tanik, N., Ak, H., Borekci, E., Delibas, N. (2014). Serum levels of vitamin D, vitamin D-binding protein and vitamin D receptor in migraine patients from central Anatolia region. Int J Clin Pract, 68(10), 1272-1277. https://doi.org/10.1111/ijcp.12456.

22. Nowaczewska, M., Wiciński, M., Osiński, S., Kaźmierczak, H. (2020). The Role of Vitamin D in Primary Headache-from Potential Mechanism to Treatment. Nutrients, 12(1), 243. doi: 10.3390/nu12010243.

23. Soriani, S., Fiumana, E., Manfredini, R., Boari, B., Battistella, P. A., Canetta, E., et al. (2006). Circadian and seasonal variation of migraine attacks in children. Headache, 46, 1571-1574.