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The Relationship between Migraine and Cognition: A Narrative Review in Indian Context

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ABSTRACT

In the Indian context, migraines are prevalent and are often associated with cognitive deficiencies, including issues with memory, attention, and executive functioning. This narrative review examines the significant cognitive effects of migraines. As a neuro-inflammatory disorder, migraines can greatly impact daily functioning, productivity, and overall quality of life, particularly among women and young adults. The manuscript presents key studies indicating that individuals with migraines experience impairments in executive function, processing speed, and visual-spatial memory. These impairments tend to correlate with the frequency and intensity of headaches. Neuroimaging studies have revealed cortical thinning and white matter abnormalities in patients suffering from chronic migraines, which may contribute to cognitive decline. Furthermore, the cognitive effects of migraines may be exacerbated by specific socioeconomic challenges in India, such as unequal access to healthcare and education, making diagnosis and treatment more challenging. The review also identifies various environmental and cultural triggers for migraines in India, including stress and dietary factors, which may differ from those in other regions. These findings underscore the importance of adapting existing research and treatment approaches—often based on studies conducted in other countries—to the unique context of India. The lack of large-scale, longitudinal studies and neuroimaging data specific to the Indian population highlights critical research gaps that need to be addressed to understand the long-term cognitive consequences of migraines in this demographic. The review advocates for comprehensive neuropsychological assessments and culturally sensitive treatments tailored to the Indian population. By addressing these gaps, we can develop customized healthcare interventions that offer hope for improving both the quality of life and cognitive health of migraine sufferers in India.

Keywords: Migraine, Cognitive Impairment, Memory, Attention, Executive Function, Indian Population.

1. Introduction

Migraines should be recognized as a neuro-inflammatory condition that significantly impacts cognitive functions. Research shows that individuals with migraines often experience difficulties with thinking and memory, even when not having an attack. This is especially relevant in India, where a significant portion of the population struggles with cognitive impairments due to migraines. Recent literature underscores the importance of comprehensive neuropsychological evaluations to improve understanding and enhance the quality of life for migraine sufferers. Chronic migraine can lead to cognitive challenges, particularly in memory, attention, and executive functions. Migraine is a recurring and complex headache condition that affects a significant portion of the global population, with prevalence rates reaching up to 18% in women and 6% in men[1]. The initial investigation was conducted by examining the influence of estrogen on migraines[2]. The initial investigation focused on the impact of estrogen on migraines. A subsequent cohort study used pre-post assessments and patient-reported changes in headache and cognitive function[3]. However, it faced issues like over- or under-reporting and recall bias. The research indicated that acute daily medications could impair cognition in 36% of adult migraine sufferers, potentially affecting earnings. A third cohort study [4] collected data via telephone interviews a week after treatment, limiting direct assessment of cognitive changes. Previous studies have focused largely on Caucasian populations, there is a pressing need for more research, especially within diverse demographics like the Indian population. Understanding this relationship is crucial due to its implications for public health, work performance, and educational outcomes for those affected by migraines.

2. Migraine: Definition and Prevalence

Migraines are a common condition, affecting about 10-12% of the general population[5]. Understanding migraines is vital due to their widespread occurrence, with triggers varying among individuals, including hormonal changes, stress, bright light, environmental factors, strong scents, alcohol, and irregular sleep[6]. Women are 2-3 times more likely to experience migraines than men. In India, migraines account for 28.8% of headaches, with 41% of the outpatient population reporting headaches[7]. According to the International Headache Society[8,9], a diagnosis of migraine requires five or more episodes lasting 4 to 72 hours, accompanied by specific features like unilateral location, pulsating quality, and symptoms such as nausea or sensitivity to light and sound. Migraines can occur infrequently and may lack certain characteristics found in typical migraine episodes. In India, migraines affect about 25% of people in their lifetime[10,11], significantly higher than the global average of 14.7%[10,12]. Research in both urban and rural areas of India indicates that the prevalence of migraines is around 14.12%[13]. Females are affected more than males, especially young adults aged 20-35[10,14]. Several studies show a notably high one-year prevalence in South India[15]. A urban study reporting a prevalence of 24.4% among those who completed the ICHD questionnaire, despite lower than expected response rates[16].

3. Cognition and Cognitive Functioning

Mild Cognitive Impairment (MCI) often presents as challenges with memory, language, cognition, and decision-making that exceed typical age-related changes[17]. These issues may be noticed by the individual, their family, or identified through a cognitive evaluation. Such assessments are crucial for accurately understanding cognitive health, with neuropsychological scores indicating a decline that does not reach the level of dementia[18,19]. Cognitive functions are distinct components—including attention, processing speed, memory, language, executive function, and visuospatial skills—that create a complex cognitive landscape. Evaluating these abilities in individuals with migraines requires careful consideration of these domains, using neuropsychological tests for reliable results. Cognitive impairment can range from mild to severe, affecting daily functioning[20]. Attention enables focus amid distractions, while memory involves[21] storing and retrieving information[22]. These cognitive processes [23]are essential for analyzing information and facilitating decision-making and problem-solving[24]. Their influence on daily life is significant, making the assessment of cognitive functions vital for managing migraines effectively[25]. In India, adaptations of the Mini-Mental State Examination (MMSE) and the Montreal Cognitive Assessment (MoCA) have been implemented [26]for evaluating cognitive functioning in migraine sufferers. Modified versions show better efficacy in detecting mild cognitive impairment compared to the originals. While both scales assess attention, memory, and language, the MoCA is often favored for evaluating executive functions and abstraction. However, these tools have limitations; the MoCA may overestimate impairment in highly educated individuals, while the MMSE may underestimate it in those with lower education. Hence, using them alongside other assessments is recommended. Screenings for cognitive functioning in migraine patients are advisable, particularly using MoCA scores to explore the relationship between cognitive ability and migraine factors[27]. Changes in the brain caused by migraines, such as neuroinflammation, may contribute to cognitive symptoms. Although some studies have found no evidence of cognitive dysfunction during migraines, others suggest potential cognitive enhancement, prompting further exploration in this area.

4. The Link between Migraine and Cognitive Impairment:

This study sheds light on the connection between migraines and their long-term cognitive effects, which may significantly impact migraine treatment. Middle-aged individuals with migraines scored considerably lower in several cognitive functions, including attention, processing speed, visual learning and memory, and executive function[28]. They also performed worse on tests evaluating motor speed, working memory, executive function, and processing speed. It was found that lower scores in these areas were associated with the frequency of severe headaches. However, it's important to consider that factors such as silent infarcts, white matter lesions, and subclinical cerebrovascular lesions may complicate this relationship. There is ongoing debate about whether these factors directly cause migraines or whether their

presence increases the risk of developing migraines. Current understanding suggests that migraine sufferers often experience reduced attention, greater difficulty in sustaining concentration, and mild cognitive impairment[27,29]. These issues may be linked to executive dysfunction and disturbances in brain networks caused by the condition, resulting in the common complaints of individuals who experience intermittent migraine attacks, even during periods without a headache[30]. Research indicates that middle-aged individuals with chronic migraines often struggle with attention, rapid information processing, and the retention of visual-spatial memory[31]. These cognitive impairments tend to correlate with the frequency and intensity of headache episodes, highlighting the seriousness of the issue. In the Indian context, recent findings reveal that individuals with chronic migraines typically perform worse on neuropsychological assessments compared to those without migraines[32,33]. These impairments are closely associated with the frequency and duration of migraine episodes. Neuroimaging studies provide additional insights into these cognitive effects, showing structural brain changes in Indian migraine patients[34,35]. Researchers have observed cortical thinning and white matter abnormalities, which contribute to declines in cognitive performance[36,37]. These structural changes are believed to result from ongoing inflammatory responses that damage brain tissue and vascular irregularities that disrupt blood flow, affecting brain regions responsible for thinking and memory. Moreover, unique socioeconomic and environmental factors in India—such as limited access to healthcare, dietary influences, and culturally specific stressors—complicate the cognitive challenges associated with migraines[38,39]. The interaction of these factors can exacerbate symptoms and complicate migraine management, emphasizing the urgent need for culturally sensitive interventions. To effectively address the challenges faced by individuals with chronic migraines, it is essential to conduct comprehensive neuropsychological evaluations tailored to the cultural context of the Indian population. Future research should involve longitudinal studies and advanced neuroimaging techniques, such as MRI and fMRI, to enhance our understanding of the long-term effects of migraines on cognitive function. By focusing on the unique factors that influence cognitive health in Indian migraine patients, healthcare providers can develop more effective and culturally sensitive interventions. Recent studies in India suggest that individuals with chronic migraines not only experience a decline in cognitive performance but also face compounded effects from various environmental and lifestyle factors[27]. Additionally, socioeconomic factors, including educational disparities and limited access to specialized healthcare, can delay diagnosis and treatment, potentially worsening cognitive outcomes. These contextual elements create unique challenges for Indian migraine patients, who may experience more severe cognitive disruptions than those in other regions. Beyond structural neuroimaging findings, functional imaging studies are beginning to reveal how migraines affect brain activity patterns in real-time. Functional MRI (fMRI) studies indicate that people with chronic migraines exhibit altered connections in brain networks responsible for attention and executive control[40]. This suggests that these disruptions may lead to ongoing cognitive difficulties even during migraine-free periods. Researchers in India have used techniques like diffusion tensor imaging (DTI) to identify microstructural damage in white matter tracts, which are crucial for processing information and relaying messages between different parts of the brain[41]. To address the challenges faced by individuals with chronic migraines, it is vital to conduct comprehensive neuropsychological evaluations tailored to the cultural context of the Indian population. Future research should include longitudinal studies and advanced neuroimaging techniques, such as MRI and fMRI, to enhance our understanding of the long-term effects of migraines on cognitive function. By focusing on the unique factors that influence cognitive health in Indian migraine patients, healthcare providers can develop more effective and culturally sensitive interventions to improve the quality of life and cognitive outcomes for this group.

POTENTIAL MECHANISM

Two primary mechanisms have been identified as potential causes of the migraine-cognitive association: vascular and neuroinflammatory[42]. The first potential mechanism is vascular[43]. The extracranial cardiovascular system is affected by arterial stiffness, a sign of endothelial dysfunction that is prevalent in both active and chronic migraines[43,44]. This dysfunction may result from abnormal blood flow during a migraine attack or from vasomotor issues or endothelial dysfunction during the interictal period[45]. Migraines are associated with changes in neuronal and vascular structures in the brain and alterations in cerebral blood flow[46]. Typically, the impairment corresponds to areas supplied by occluded arteries or those with reduced perfusion. Moreover, disordered perfusion during the severe headache phase of a migraine attack can lead to functional deficits in cognitive performance. The exact consequences and mechanisms linking migraines to cognitive function remain unclear. There is limited evidence to suggest cognitive differences between cardiopathic and non-cardiopathic patients. Recent studies indicate that migraines can be predominantly subcortical or cortical[47]. Current research implicates the rostral migraine headache as potentially significant in this relationship, although direct evidence is lacking. The association between elevated levels of phosphorylated tau and migraines with aura—or between changes in perfusion and language problems—seems to affect only individuals who experience migraines[48]. These potential mechanisms are largely speculative due to limited understanding and ongoing research into the underlying biochemical processes. Migraines may influence cognitive function through a single mechanism, multiple mechanisms, or all mechanisms concurrently, as observed in a comprehensive data set. Each of these factors is related to various consequences and may be influenced by genetic, environmental, and randomly varying connections with different cognitive domains and neuropsychological tests.

4.1. VASCULAR MECHANISMS

Migraine is a common disorder whose prevalence increases with age. A growing body of evidence suggests that individuals who suffer from migraines are more likely to experience cognitive impairments. However, the mechanisms underlying these deficits are not well understood. Evidence indicates that adult migraine sufferers may be particularly vulnerable to

cerebrovascular pathology[49], which includes altered dynamics of cerebral blood flow and structural changes in the walls of major cranial arteries. If these mechanisms are shown to contribute to the link between migraines and cognitive decline, it could have significant clinical implications for migraine management and cognitive decline prevention. While initial research on the vascular hypothesis of migraine received a great deal of attention, this focus has decreased over time. Nonetheless, studies have consistently shown that acute migraine attacks can lead to a dramatic increase in blood flow within the cerebral vasculature, followed by longer-lasting reductions in local grey matter blood flow[50,51]. There is considerable evidence of such alterations in chronic migraine patients' brains[52,53]. Animal studies have demonstrated that endothelial dysfunction, resulting from experimental cortical spreading depression, can provoke oligemia and impair brain function[54]. Numerous cerebral regions implicated in hypoperfusion during migraines are interconnected and support various cognitive functions[55]. Therefore, vascular dysfunction, particularly impaired reactivity, may represent a common mechanism linking migraines with cognitive decline. Research exploring subclinical levels of endothelial dysfunction in healthy older adults has indicated that it can predict faster cognitive decline and brain atrophy[56]. Further evidence comes from studies that show strong associations between markers of arterial pathology and future cognitive decline in both normal and impaired older adults[57]. We consider evidence of neurovascular compromise in migraine and note that the links between these vascular changes and cognitive decline are not well defined. However, this ambiguity presents an exciting opportunity for further research and discovery in this dynamic field.

4.2. NEUROINFLAMMATORY MECHANISMS:

Research has increasingly focused on the role of low-grade inflammation in the pathogenesis of both migraines and several disorders affecting cognitive performance[58,59]. These studies aim to uncover potential mechanisms that explain the connection between these two conditions. Neuroinflammatory signals, such as pro-inflammatory cytokines, have been shown to reduce synaptic density and network connectivity and weaken the contractile responses of arterioles[60]. This impairment can hinder neurovascular coupling and negatively affect capillary blood flow, both of which are vital for adequate cerebral perfusion and function. Individuals experiencing migraine attacks often have higher levels of circulating pro-inflammatory cytokines and increased central levels of inflammatory markers[61]. Painful conditions are closely linked to inflammation, and pain-induced neuroinflammation has been proposed as an upstream factor that impacts cerebral perfusion, metabolism, or functional connectivity[62]. This connection may help explain why chronic headaches can lead to cognitive impairment. Additionally, a relationship has been observed between prothrombotic factors in circulation, impaired functional imaging, and clinical disability in migraine sufferers[63]. Cognitive impairment is commonly reported during migraine attacks. Several neuromodulators may account for the effects of targeted migraine-focused anti-nociceptive treatments on cognitive function[64]. Effective migraine treatments can mitigate the impact of potential triggers on neurological structures, potentially preventing cognitive injury[65]. Thus, inflammatory mechanisms could serve as relevant treatment targets for cognitive symptoms in some migraine patients. The effects of long-term, customized preventive treatments on cognitive functioning still warrant exploration. While a definitive link between migraines and cognitive decline has yet to be established, these findings suggest promising avenues for further research and treatment strategies.

4.3. EVIDENCE FROM INTERNATIONAL STUDIES

The relationship between migraines and cognitive dysfunction has been extensively studied worldwide. Research consistently shows that individuals who suffer from migraines—often referred to as "migraineurs"—experience significant cognitive impairments. Even during interictal phases (the periods between migraine attacks), migraine patients often struggle with concentration, memory, and information processing speed [66-69] . These findings highlight the global impact of cognitive impairment in migraineurs and underscore the urgent need for further research in the Indian context. It is essential to consider environmental, genetic, and cultural factors that may influence the relationship between migraines and cognition in India. Applying findings from other countries directly to the Indian population may be challenging due to unique characteristics, including socioeconomic differences. Given that research from around the world indicates a link between higher cognitive sensitivity in migraineurs and lower socioeconomic status, it is crucial to understand the socioeconomic landscape of migraines in India[70]. Identifying culture-specific migraine triggers in India—such as dietary practices, environmental influences, and stress-reduction methods—could provide valuable insights[71]. These insights may differ from those studied in other countries, making it imperative to determine the most prevalent triggers in the Indian population. Furthermore, exploring potential genetic differences unique to the Indian community could be beneficial. Different populations may have distinct genetic predispositions to migraines, [72] and this research could lead to a better understanding of how these unique traits affect the relationship between migraines and cognition in India.

4.4. EVIDENCE FROM INDIAN STUDIES AND RESEARCH GAPS

Recent studies in India have highlighted the unique challenges faced by individuals suffering from migraines, particularly in relation to cognitive impairment within the country's diverse socioeconomic and cultural contexts. Research indicates that those with chronic migraines in India experience significant cognitive deficits, especially in areas such as memory, attention, and executive function. For example, one study focused on memory function found that Indian migraine patients who experience frequent migraine episodes showed notable deficits in both short-term and working memory[15]. These cognitive challenges can disrupt daily activities and diminish work efficiency. The cumulative effects of recurrent headaches often exacerbate memory issues, leading to interruptions in routine tasks and a decline in overall quality of life. Furthermore, Indian studies [73] suggest that individuals with migraines, particularly those with chronic conditions, struggle to maintain attention and

are more prone to distractions. This can be especially detrimental in environments that require sustained focus, such as educational or workplace settings. The research[32] indicates that the frequency and severity of migraine attacks may influence attentional deficits, with individuals who experience more frequent or severe attacks showing a greater decline in attention over time. Challenges in executive functioning have been observed in Indian migraine patients, affecting their ability to organize, plan, and make decisions[32,74]. Research from India suggests that the unique socioeconomic pressures and stressors in the country may contribute to executive function deficits, potentially worsening cognitive decline in those who suffer from migraines[75]. Studies indicate that individuals in India often struggle with tasks requiring adaptability and problem-solving skills, such as managing finances or organizing daily activities[76]. This highlights the need for tailored support approaches to address these specific cognitive challenges. Additionally, neuroimaging studies conducted in India have begun to reveal structural brain changes in individuals with chronic migraines, including cortical thinning and abnormalities in white matter[12]. These structural findings align with the cognitive impairments observed in migraine patients, reinforcing the idea that migraines may lead to lasting neurological effects. The combination of neuropsychological tests and neuroimaging techniques has led to significant insights, suggesting that migraines might have a more damaging cognitive impact in India due to a combination of genetic, lifestyle, and environmental factors[11]. The findings from studies in India emphasize the critical need for culturally tailored interventions and comprehensive neuropsychological assessments within this demographic. This underscores the importance of addressing the specific cognitive challenges faced by individuals suffering from migraines in the region. Recent studies have also explored unique cultural and socioeconomic factors affecting cognitive impairment in migraine patients in India. Research has shown that dietary factors—such as inconsistent meal schedules, caffeine consumption, and certain additives—often trigger migraine episodes, which may exacerbate cognitive issues like memory impairment and reduced attention[77]. The interplay between these dietary habits and environmental stressors, including noise pollution and urban congestion, presents significant challenges for individuals experiencing migraines in India, likely worsening cognitive symptoms. Furthermore, cultural practices like fasting and methods of coping with stress may influence how migraine sufferers perceive and discuss their cognitive problems, highlighting the importance of individualized approaches to treatment. Alongside environmental factors, socioeconomic elements significantly impact the cognitive health of individuals with migraines in India. Limited availability of healthcare resources, particularly in rural areas, often leads to delayed diagnosis and treatment, increasing the risk of chronic cognitive impairment. Research indicates that individuals from lower socioeconomic backgrounds frequently experience migraines more severely and often suffer significant cognitive impairments as a result of untreated or inadequately treated conditions. The economic burden of migraines, combined with insufficient affordable and accessible healthcare options, can elevate stress levels, adversely affecting cognitive performance. The relationship between stress and cognitive impairment creates a challenging cycle that requires immediate attention, emphasizing the urgent need for accessible healthcare solutions for individuals experiencing migraines in India.

Recent neuroscience studies in India are shedding light on the neurological foundations of cognitive impairment in individuals suffering from migraines[12]. Advanced imaging techniques, such as MRI and fMRI, have been utilized to examine brain changes in Indian migraine sufferers, revealing significant alterations in regions associated with memory, attention, and executive functioning[78]. Studies employing diffusion tensor imaging (DTI)[41] have shown that individuals with chronic migraines often experience issues with the integrity of their white matter, which is closely linked to slower processing speeds and difficulties in memory retrieval. These neuroimaging findings suggest that migraines contribute not only to physical pain but also to substantial neurological and cognitive effects. Additionally, the psychological impact of migraines plays a crucial role in cognitive decline. Study from India have reported elevated levels of comorbid conditions such as depression and anxiety among individuals suffering from migraines[11]. Mental health challenges can exacerbate cognitive symptoms, making it more difficult for patients to manage both migraine pain and cognitive tasks.

RESEARCH GAPS IN INDIAN CONTEXT

While many studies have explored the relationship between migraines and cognitive performance worldwide, there are significant research gaps that must be addressed specifically in the Indian context. There is the lack of India-specific data in following critical areas: 1. Prevalence of Cognitive Impairment: International studies suggest that individuals with migraines, known as "migraineurs," may experience cognitive issues. However, the prevalence and severity of these impairments in the Indian population remain unknown. More research is needed to understand how migraines affect cognitive function in this diverse demographic. Previous studies often relied on small sample sizes, which may have overlooked important aspects of India's varied population. Additionally, there is a lack of longitudinal studies in India that examine the long-term cognitive effects of migraines, which is essential for understanding how cognitive impairments develop and may evolve into chronic conditions. 2. Impact of Socioeconomic Factors: Although research in the Indian context is limited, unique cultural and socioeconomic factors—such as disparities in education and healthcare access—could influence the relationship between migraines and cognition. International studies have linked lower socioeconomic status to heightened cognitive sensitivity in migraine sufferers. Therefore, further research is necessary to explore how socioeconomic disparities in India impact the cognitive effects of migraines, including aspects like treatment access and educational opportunities. 3. Culturally Specific Triggers: Factors such as dietary habits, environmental influences, and stress-reduction strategies may differ in India compared to other countries. Identifying and researching common migraine triggers that are specific to the Indian context is crucial for understanding how migraines affect cognition. 4. Genetic Variations: There may be a hereditary component to migraine sensitivity. Investigating genetic

variations within the Indian population could provide valuable insights into how migraines influence cognitive function in this community. 5. Longitudinal Research: Most existing research has focused on the immediate cognitive effects of migraine attacks. Longitudinal studies in India are needed to fully understand the potential for long-term cognitive decline associated with chronic migraines. We propose utilizing both established multidomain objective assessment tools and subjective measures to explore the cognitive aspects of migraines. Various factors—including lifestyle, physical activity, psychological well-being, sleep habits, regional influences, genetics, diet, treatment patterns, environmental exposures, and comorbidities—should be considered, along with their prognostic implications. Additional neuroimaging studies are also needed to illuminate the morphological and functional changes in the brain linked to migraines in the Indian population. By highlighting these research gaps, this review emphasizes the necessity for further investigation into the intricate relationship between migraines and cognition in India. This research not only aims to enhance our understanding of the impact of migraines on the Indian community but also has the potential to inform the development of culturally relevant treatment strategies. The urgency of addressing these research gaps cannot be overstated, as there is an immediate need for more focused studies in this area

5. Conclusion

There is strong evidence from a large body of international research showing a correlation between migraines and cognitive impairment. This highlights the need for thorough investigations in the Indian context. The data indicates that migraines are not just a pain disorder but also a neurological condition with significant cognitive effects. However, a major issue is the lack of comprehensive research in India, particularly regarding epidemiological data, longitudinal studies, and neuroimaging research focused on the Indian population. Future studies should aim to conduct in-depth investigations with diverse participant groups to ensure accurate representation. This approach will facilitate a better understanding of the prevalence and impact of cognitive deficits among migraine sufferers in India. Additionally, long-term studies are necessary to explore how these cognitive deficits develop and persist over time. Brain imaging research could also provide valuable insights into the anatomical and functional changes associated with migraines in the Indian population. Considering India's unique cultural, socioeconomic, and genetic factors, future research should examine how these elements influence the relationship between migraines and cognition. The potential impact of this research on developing targeted therapies and improving overall migraine care and quality of life for sufferers in India cannot be overstated.

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