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Review Article

Non-Pharmacological Migraine Care in India: A Critically Appraised Narrative Review

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ABSTRACT

Migraine is a highly prevalent and disabling neurological disorder that affected an estimated 2.9 billion people worldwide in 2023 and remains a leading contributor to global disability. In India, population-based surveys report a one-year prevalence of approximately 25 per cent in some states, underscoring its scale as a public health concern. This narrative review critically appraises the evidence for non-pharmacological approaches to migraine care, including neuromodulation, behavioural therapies, and digital health technologies, and considers their feasibility within the Indian health system. Several modalities show meaningful benefit: remote electrical neuromodulation demonstrates moderate-certainty efficacy for both acute and preventive migraine care, and yoga is associated with significant reductions in headache frequency and migraine-related disability across independently conducted Indian trials. Substantial barriers nonetheless constrain scale-up in India, including the high cost of neuromodulation devices and a shortage of personnel trained to deliver behavioural interventions. Migraine remains excluded from national non-communicable disease policy despite its considerable burden. Realising the public-health potential of non-pharmacological migraine care in India will require dedicated research investment, equitable access strategies, and formal recognition of migraine within national health policy.

KEYWORDS: Migraine, Neuromodulation, Cognitive behavioural therapy, Yoga, India, Health policy.

1. INTRODUCTION

Migraine is a recurrent, disabling primary headache disorder characterised by moderate-to-severe pain, often accompanied by nausea, photophobia, and phonophobia; in a subset of patients, attacks are preceded by a transient neurological warning sign known as aura. The underlying pathophysiology is thought to involve cortical and brainstem hyperexcitability with impaired central pain processing, although the precise mechanisms remain incompletely understood.

According to the Global Burden of Disease Study 2023, headache disorders affected approximately 3 billion people worldwide in 2023, corresponding to roughly 35% of the global population.[1,2] Migraine is the principal driver of headache-related disability, with women more than twice as likely as men to be disabled by the condition. Overuse of acute medication to manage frequent attacks can itself worsen headache burden, a phenomenon termed medication-overuse headache. Through its effects on work productivity and caregiving capacity, migraine also carries a substantial economic cost.

Regional epidemiological studies confirm a substantial burden of migraine across India, although reported prevalence varies by methodology and geography.[3-7] A community-based survey in Karnataka found that 25% of respondents had experienced migraine in the preceding year[3,4], and a separate estimate places national prevalence at approximately 14%. Consistent with global patterns, Indian data show a higher migraine burden among women than men, and among rural compared with urban populations.

Despite this burden, migraine has not received commensurate attention within Indian health policy, which has historically prioritized mortality-related

conditions over those that are disabling but non-fatal. Pharmacological options such as analgesics and triptans can help, but are associated with side effects and are not always affordable or readily available in India; overuse of these medications can, in turn, aggravate headache frequency.

Non-pharmacological approaches — including neuromodulation, behavioural therapy, and lifestyle-based interventions such as yoga — offer an alternative that does not carry the same overuse risk as medication. This review appraises the evidence for these approaches, considers their feasibility for delivery in India, and examines how they might be made accessible given the country's healthcare system and cultural context.

2. MATERIALS AND METHODS

This is a narrative review informed by a transparent and reproducible, but not formally systematic, search strategy. It does not state adherence to PRISMA reporting standards because it lacks a pre-registered protocol, dual independent screening and a complete risk-of-bias assessment of all primary studies presented. If a systematic review, meta-analysis or clinical practice guideline is cited, the certainty and strength-of-evidence ratings reported are those of the cited review, meta-analysis or clinical practice guideline; if per-study data are cited directly, this is explicitly stated, and the evidence does not get upgraded beyond the evidence provided by the study design.

2.1 Search Strategy

Databases searched included PubMed/MEDLINE, Cochrane CENTRAL, Embase, Scopus, and Google Scholar, from January 2000 to July 2026, with a preference for publications from 2019–2025 to capture the post-CGRP, post-neuromodulation-device era of migraine care. The search terms included "migraine" and "headache" as well as India-specific terms and intervention terms ("neuromodulation", "remote electrical neuromodulation", "transcranial direct current stimulation", "vagus nerve stimulation", "cognitive behavioral therapy", "mindfulness", "yoga", "biofeedback", "digital health", "telemedicine", and "artificial intelligence"). Hand-searching was performed on the following society statements and guidelines: American Headache Society [21,22], European Headache Federation [23], International Headache Society, and World Health Organisation[25], and GBD 2021 and GBD 2023 publications.

2.2 Eligibility and Evidence Hierarchy

Systematic reviews and meta-analyses of RCTs were given priority, followed by individual RCTs (double blind and sham- or placebo-controlled RCTs given higher priority than open-label or single-arm RCTs), followed by large population-based epidemiological studies for burden estimates, and finally, society consensus statements for translation into practice. Case reports, editorials, and non-peer-reviewed sources were not included in the evidence base, although selected editorials are cited for policy comments and identified as such.

2.3 Certainty of Evidence

Where a formal certainty assessment was reported, or permitted to be derived from the underlying source, certainty is reported using GRADE-informed language (high, moderate, low or very low); where a formal certainty assessment was not available, the study design (e.g., "single open label trial") is instead reported as evidence without an invented rating. The common downward limitations of this literature are small sample sizes, sponsorship by device or drug company, brief follow-up periods, heterogeneous outcome measures and stimulation protocols, and the lack of trials specifically in South Asian populations.

2.4 Limitations of This Review

This manuscript is presented as a narrative and not a systematic review, and therefore presents selection and citation bias and may not include relevant literature. Contextual information about Indian health policy and NCD programming is based on publicly available sources as of the authors' knowledge. It should be checked against the latest government documents before submission.

3. RESULTS AND DISCUSSION

3.1 Classification of Interventions

Neuromodulation techniques modify the excitability of the neurons by applying external electrical or magnetic stimuli to the brain, specifically to the cortical spreading depression, trigeminovascular activation, and central pain-processing networks. Currently available or under late-stage development are remote electrical neuromodulation (REN), transcranial direct current stimulation (tDCS), non-invasive vagus nerve stimulation (nVNS), and single-pulse or repetitive transcranial magnetic stimulation (sTMS/rTMS). Behavioural interventions include cognitive behavioural therapy (CBT), mindfulness-based stress reduction (MBSR), relaxation training, biofeedback and behavioural sleep modification, which target cognitive, emotional and physiological factors contributing to migraine [14]. Integrative approaches include yoga, meditation, and physiotherapy-based exercise, all of which are related to autonomic regulation, musculoskeletal alignment, and stress reduction; of these, yoga is particularly relevant in India, both culturally and from the point of view of delivery infrastructure and several Indian-conducted randomised trials.[17,18,19]

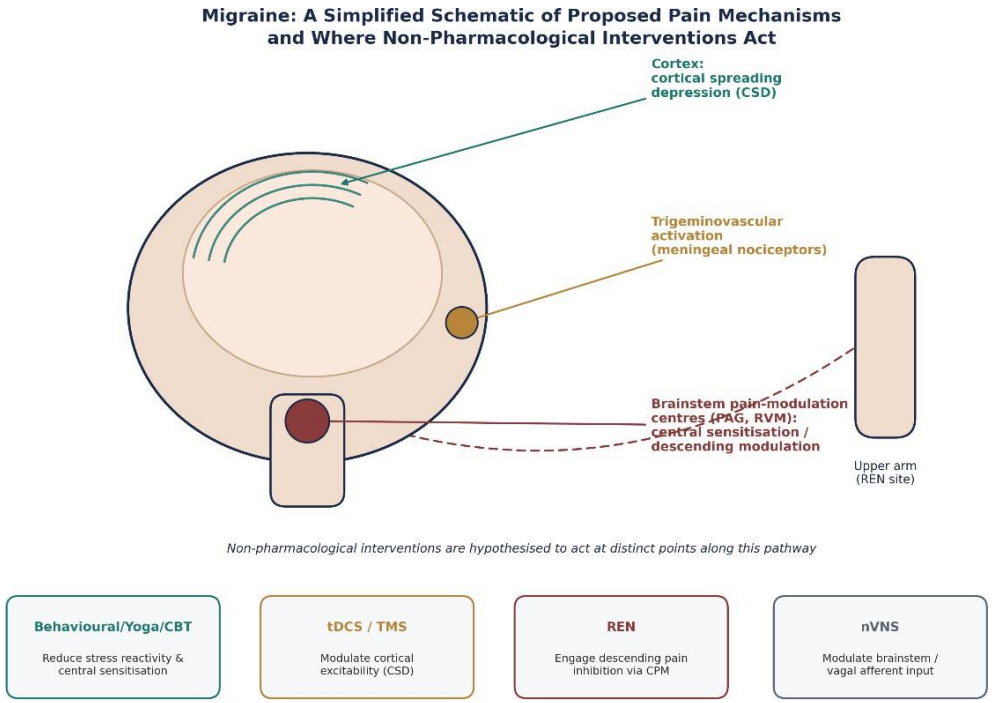

Figure 1: Simplified schematic of proposed migraine pain mechanisms and the points at which the reviewed non-pharmacological interventions are hypothesized to act. Cortical spreading depression, trigeminovascular activation, and brainstem pain-modulation centers are shown as illustrative, simplified targets rather than a complete or validated mechanistic model.

3.2 Neuromodulation

There are two double blind sham controlled multi-center RCTs of REN for acute migraine treatment. In the pivotal trial (N=252, intention-to-treat analysis), 66.7% of the patients who received active REN experienced pain relief at 2 hours, and 37.4% of the patients experienced pain freedom at 2 hours, whereas the incidence of adverse events was low and limited primarily to transient warmth or numbness in the treated arm.[10] A separate double-blind, sham-controlled RCT that evaluated REN every other day as a preventive therapy showed a mean reduction of 4.0 monthly migraine days in the REN arm compared with 1.3 in the sham arm ($p<0.001$), and a corresponding reduction in acute-medication days [11]. The certainty of these findings is moderate, based on the involvement of company-affiliated co-authors in trial design and analysis, and the sponsorship of the study by the device manufacturer, but reasonably confident effect estimates are provided by the double-blind, sham-controlled methodology and adequate sample size. In a systematic review and meta-analysis of 12 studies (9,912 participants, mixed single-arm, observational, and RCT designs) published in 2025, significant pain reduction and pain-free status at 2 hours were seen in single-arm data.[9]

A systematic review and meta-analysis of 11 RCTs (425 participants) published in 2022 identified a reduction in monthly migraine days compared with sham for tDCS over the motor cortex (M1) or visual cortex.[12] A more recent 2025 meta-analysis of six RCTs (172 participants) also reported a decrease in monthly migraine days and attack frequency with both cathodal and anodal occipital or motor-cortex tDCS compared to sham.[13] The certainty of GRADE is low, due to imprecision, inconsistency between stimulation protocols and electrode montages, and the lack of any trial site in India or South Asia. The evidence for non-invasive vagus nerve stimulation and transcranial magnetic stimulation is more limited and is most promising in refractory migraine and in migraine with aura; certainty is low to very low for both of these modalities until further controlled trials are conducted.

3.3 Behavioural Therapies

The most recent and rigorous synthesis is a systematic review and meta-analysis of 63 RCTs of behavioural interventions for migraine prevention in children and adults commissioned by the Agency for Healthcare Research and Quality (AHRQ) for the American Headache Society.[14,15] Low-strength evidence of mindfulness-based therapies reducing the frequency of migraine/headache attacks and low-strength evidence of education alone targeting behavioural improvements improving migraine-related disability were identified in this review. There was not enough evidence to conclude on biofeedback, acceptance and commitment therapy, and hypnotherapy. The great majority of behavioural comparisons have low GRADE/strength-of-evidence, due to small trials, inconsistent outcome measures and incomplete reporting, not because there is no plausible benefit. The 2022 AHRQ synthesis supersedes an earlier systematic review and meta-analysis of 11 RCTs specific to CBT, which found statistically significant reductions in headache frequency and Migraine Disability Assessment (MIDAS) scores[16] (this review predates the

2025 AHRQ synthesis and is informative for CBT specifically). Digital delivery formats (app-based CBT and neurofeedback) have extended access to specialist services when they are not available, but there are some significant challenges in terms of adherence and engagement over time.

3.4 Integrative Modalities: Yoga

There are a few RCTs conducted in India that have been evaluated for yoga. A preliminary study (N=72) showed that yoga therapy for migraine without aura resulted in a significant reduction in headache frequency, severity, and McGill pain scores compared to self-care.[17] A second Jaipur-based RCT (N=70, ITT analysis) showed significant decreases in self-reported pain frequency, intensity, and duration of migraine, as well as decreased migraine medication use and depression scores, at 6-month follow-up.[18] In the CONTAIN trial, a prospective, open-label, randomised superiority trial with blinded outcome assessment in New Delhi, yoga as an adjunct to medical therapy yielded significantly greater reduction in headache frequency, intensity, Headache Impact Test (HIT-6) score and MIDAS score compared to medical therapy alone, with 12.3% of the yoga group becoming headache-free.[19] In 2022, a meta-analysis of yoga RCTs for migraine (five to six trials, around 350 participants) found that there was a significant reduction in headache frequency, duration, and pain intensity, but noted that the evidence was not yet strong enough to recommend yoga unconditionally due to the high level of heterogeneity between the different trial designs.[20] The certainty of evidence is low to moderate, due to open-label designs and lack of blinding, but the direction and magnitude of the effect across independently conducted Indian trials is unusual, given the low cost and cultural embedding of the intervention, compared to imported neuromodulation technologies.

3.5 Digital Health and Artificial Intelligence

Digital health platforms, including teleconsultation for headache diagnosis and follow-up, delivery of CBT via apps, and AI-based predictive or triage tools, are increasingly suggested as scalable additions to systems that are already under-resourced by specialists, like India's. The evidence base for AI-driven migraine prediction and adherence tools is still largely proof-of-concept or single-arm feasibility studies; in this search, no sufficiently powered controlled trial of an AI-driven migraine management tool was identified, and any claims of improved adherence or outcomes from these platforms should be considered very-low-certainty, hypothesis-generating evidence, not a standard of care. The challenges of implementation for this modality are data-privacy governance, digital literacy differences between urban and rural populations, and the lack of regulatory pathways for the classification of software-as-a-medical-device for migraine-prediction algorithms in India.

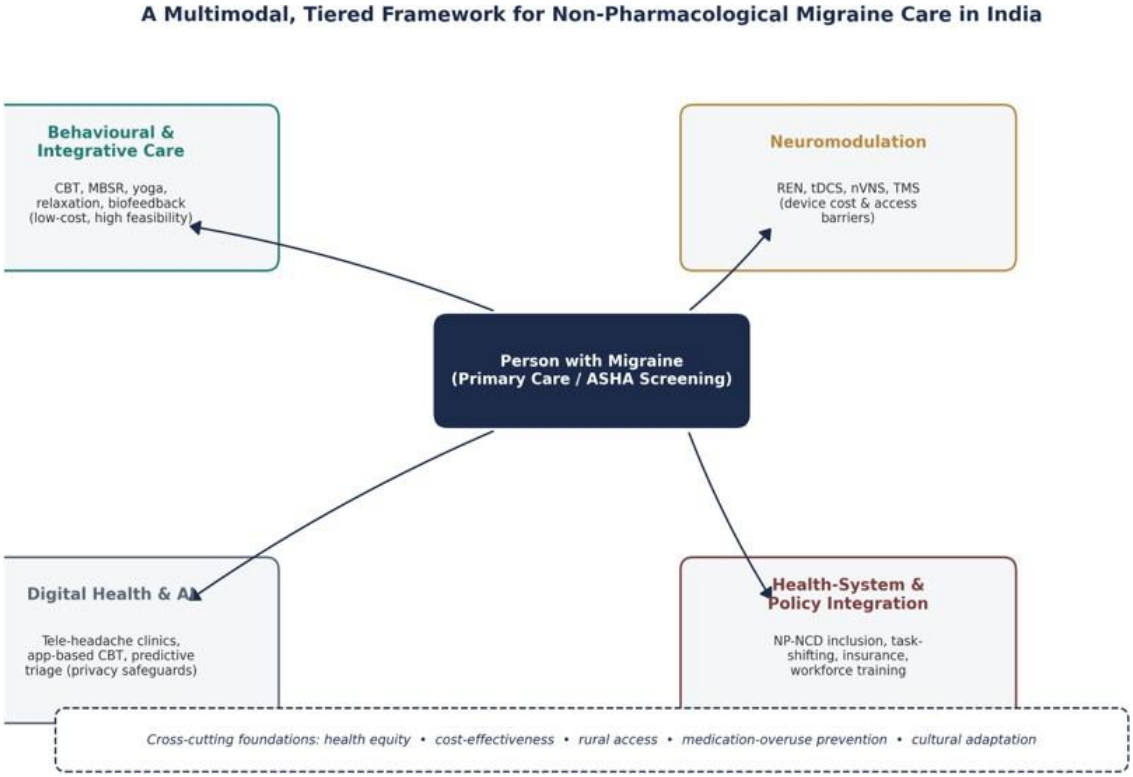

Figure 2: A multimodal, tiered conceptual framework for non-pharmacological migraine care in India. Care is anchored in primary-care and community-level screening (including task-shifted ASHA involvement), from which patients may be directed toward behavioural/integrative care, neuromodulation, digital-health tools, or health-system/policy-level interventions according to clinical need, cost, and access.

3.6 Graded Evidence Summary

Table 1: Graded evidence summary for non-pharmacological migraine interventions.

Intervention	Representative outcome	GRADE certainty	Indian feasibility	Key research gap
REN (acute)	66.7% pain relief, 37.4% pain freedom at 2 h vs sham (RCT, N=252) [10]	Moderate	Low-Moderate (device cost; wearable, no clinic infrastructure needed)	No India-based trial; real-world adherence data
REN (preventive)	-4.0 vs -1.3 monthly migraine days vs sham (RCT) [11]	Moderate	Low-Moderate (recurring device/app cost)	Long-term (>6 month) effectiveness; cost-effectiveness modelling
tDCS	Reduced monthly migraine days & pain intensity vs sham; small heterogeneous trials (<=430 pooled) [12,13]	Low	Low (requires trained personnel; device access concentrated in tertiary centres)	Standardised protocols; adequately powered India-based RCT
nVNS / TMS	Moderate efficacy signals in refractory migraine/aura; limited recent large meta-analysis	Low-Very low	Very low (device availability, cost)	Basic efficacy replication; head-to-head comparison
CBT / mindfulness-based therapy	Low-strength evidence of reduced attack frequency (AHRQ SR/MA, 63 RCTs) [14]	Low	Moderate-High (trainable non-specialist cadres; digital delivery possible)	India-specific trials; long-term adherence data
Yoga	Significant reductions in frequency, intensity, duration, disability across Indian RCTs [17-19]; meta-analysis confirms benefit with heterogeneity [20]	Low-Moderate	High (existing AYUSH/community infrastructure)	Standardised protocol; blinding-robust trial design; comparative-effectiveness vs CBT
Digital health / AI tools	Proof-of-concept and single-arm feasibility data only	Very low	Moderate (smartphone penetration rising; rural digital-literacy gap)	India-based controlled trials; data-privacy and regulatory framework

Strength of recommendation is expressed qualitatively in the text rather than as a formal GRADE panel judgement, since this narrative review did not convene a structured guideline panel.

Table 2: Gap analysis for scaling non-pharmacological migraine care in India.

Domain	Barrier	Population most affected	Proposed strategy
Access	Urban-centric neurology and device infrastructure	Rural populations (higher migraine prevalence in Karnataka data) [3,4]	Task-shifted screening and behavioural-therapy delivery via ASHA/AYUSH networks
Cost	High neuromodulation device prices; limited insurance coverage	Uninsured and lower-income patients across urban and rural settings	Tiered/subsidised device pricing; prioritise low-cost behavioural and yoga-based programmes at scale
Policy	Exclusion of migraine from NP-NCD and most state NCD screening	All migraine patients nationally	Advocacy for formal inclusion via professional bodies (Indian Academy of Neurology, Indian Headache Society)
Culture	Stigma, misattribution of migraine to "stress" or minor ailment	Women disproportionately (per Karnataka/Delhi prevalence data) [3-5]	Public awareness campaigns; integration with existing yoga/wellness messaging
Workforce	Limited headache-specific training among primary-care physicians	Primary-care attendees nationally, especially outside tertiary centres	Structured CME modules; simplified diagnostic algorithms (HARDSHIP/ICHD-3-based)
Regulatory/ digital	No settled regulatory pathway for AI-based migraine software	Users of digital-therapeutic and AI-triage tools	Define software-as-medical-device pathway; mandate data-localisation-compliant design

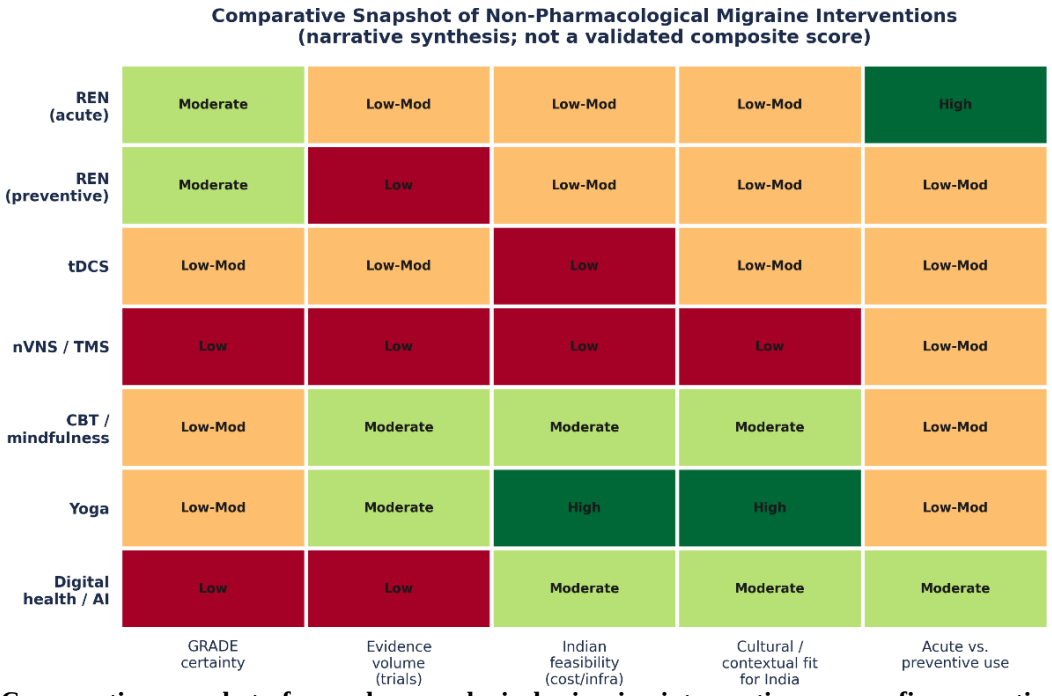

Figure 3: Comparative snapshot of non-pharmacological migraine interventions across five narrative-synthesis dimensions: GRADE certainty, relative evidence volume, Indian feasibility, cultural/contextual fit for India, and suitability for acute versus preventive use. This is a visual aid summarising the authors' qualitative synthesis and is not a validated composite score or a substitute for Table 1.

3.7 Critical Discussion

The relationship between efficacy and effectiveness is referred to as a 'translational gap'. One common thread in the neuromodulation literature is the difference between efficacy shown in highly controlled, sponsor-supported trials and effectiveness in a real-world setting where adherence, device usability, and cost of the device are variable. Whether similar adherence and effect sizes would be achieved in Indian primary-care or self-directed home-use settings has not been tested and cannot be assumed, as in the pivotal REN trials, which were conducted in specialist headache centres with structured follow-up and manufacturer involvement in trial design.[9,10,11]

3.7.2 Sponsorship and Publication Bias

This is a standard and disclosed aspect of device-approval trials, and represents a structural risk of optimistic effect reporting, which this review does not consider to be disqualifying, but does account for in its GRADE downgrading, and was disclosed in both of the principal REN trials, sponsored by the device manufacturer and involving company-affiliated statisticians and co-authors.[10,11] Another issue that is a concern throughout the neuromodulation literature is publication bias, in that negative or null device trials are less likely to be published than positive ones. In contrast, the 2025 AHRQ-commissioned behavioural-therapy review was independently funded and pre-registered, and its somewhat more conservative low-strength-of-evidence conclusions[14] are less likely to be influenced by this type of bias.

3.7.3 Heterogeneity and Methodological Limitations

Neuromodulation meta-analyses have consistently found significant variability in stimulation parameters, sample size, and outcome measures, which makes it difficult to make meaningful comparisons between devices.[12,13] This is a common limitation of all behavioural-therapy trials: measures of migraine disability are not consistently reported, and only a minority of trials in the AHRQ review 2025 were able to report data for pooled analysis of disability.[14] This heterogeneity is a methodological limitation of the primary literature used in the review and does not result from this review; it limits the recommendations to a moderate level of certainty for the best-supported modalities.

3.7.4 External Validity and Applicability to India

Most of the RCTs in the neuromodulation review (all but one) and the vast majority of the RCTs in the behavioural-therapy review (14/16) were conducted in North American or European populations.[10,11,12,13,14] There were no trials of REN or tDCS found in an Indian or South Asian population. The overall quality of yoga trials was relatively low, but a notable exception is yoga trials conducted directly in Indian tertiary-care and community settings[17,18,19] that have an unusually direct evidentiary connection to the population of interest.

3.7.5 Implementation Science Considerations

Efficacy information is not a predictor of successful implementation. To the best of the reviewers' knowledge, there is no formal trial of the task-shifted delivery of behavioural and yoga-based interventions in India for migraine specifically, although there are parallels for

other chronic conditions in the National Health Mission (NHM) that involve task shifting via community health workers (Accredited Social Health Activists, ASHAs) and AYUSH practitioners. Structured training, fidelity monitoring, and a prospective evaluation design should be used for any scale-up.

3.7.6 Cost-Effectiveness

No published cost-effectiveness analysis of a neuromodulation device, CBT or yoga specifically in the Indian health system was found. While the device cost of REN and tDCS units is high in comparison to the out-of-pocket health expenditure per capita in India, the group-based yoga and CBT programs have relatively low marginal costs after the initial investment to train the facilitators. The feasibility judgements in this review (Table 1) are based on relative cost and infrastructure needs and not on a validated incremental cost-effectiveness ratio and should be considered a priority gap for future health-economic research.

3.7.7 Health Equity and Rural Access

While data from Karnataka show a higher prevalence of migraine in rural areas compared to urban areas[3,4], there is a significant urbanization of neurology specialists and availability of neuromodulation devices in India. A scale-up approach that emphasizes device-based neuromodulation may lead to a two-tier system in which cost-effective treatments are available to a select few urban, insured patients, while rural populations (who seem to have a higher burden of disease) are provided with lower-cost behavioural options, irrespective of clinical suitability.

3.7.8 Medication-Overuse Headache

The prevalence of MOH in the general population is estimated to be 0.5-7.2% of the population globally and up to 30-50% of those attending specialised headache clinics.[24] GBD 2023 estimates that more than one-fifth of all headache-attributed YLDs are attributable to MOH, which is a preventable condition.[1,2] There is no equivalent overuse risk for non-pharmacological interventions, and increasing access to effective non-drug interventions could therefore have a secondary preventive benefit against MOH, which should be specifically assessed in future Indian effectiveness trials.

3.7.9 Telemedicine and Digital Therapeutics

Teleconsultation for diagnosis and follow-up of headache is technically possible and is being increasingly utilized in India after the expansion of the telemedicine guidelines; however, no controlled trial in India has compared the effectiveness of teleconsultation with in-person review by a specialist specifically for migraine. CBT and digital symptom tracking via apps may be promising ways to reach specialists, but engagement tends to fall off over time.[14]

3.7.10 AI Ethics, Data Privacy, and Regulatory Issues

Ethical and regulatory issues with AI-based predictive and adherence-monitoring tools for migraine differ from those with device-based neuromodulation, such as the source and representativeness of training data (most published algorithms are developed using data from non-Indian populations), informed consent for continuous collection of personal health data among populations with varying digital and health literacy, data-localization provisions under the Digital Personal Data Protection Act, and the lack of a clear regulatory pathway in India for the classification of migraine-prediction software as a medical device.

3.7.11 Policy and Health-System Limitations

The continued lack of inclusion of migraine in national-level NCD programming in India is consistent with the pattern of systematic under-resourcing of non-fatal conditions that are disabling, as documented in the GBD, which has downstream implications for funding, training of primary-care providers, and systematic referral pathways.

3.8 Future Directions

RCTs with adequate power and sham controls of REN and tDCS in Indian clinical populations, with outcomes measured with standardized and internationally comparable measures (monthly migraine days, HIT-6, MIDAS) for cross-study and cross-modality comparisons.

- India-specific cost-effectiveness and budget impact analyses of neuromodulation devices, CBT/behavioural programs and yoga-based interventions.
- Trial delivery of behavior-based and yoga-based migraine interventions through ASHA and AYUSH networks in a formal way with pre-specified fidelity and outcome measures.
- Regulate the use of AI-driven migraine prediction and digital therapeutic tools with clear pathways, including data localization requirements and prerequisites for deployment in Indian populations.
- Promote (through the Indian Academy of Neurology and other professional organisations) the formal recognition of migraine in the national and state NCD screening and reporting systems, based on the burden of disease data from GBD 2023.
- Include structured MOH-prevention counselling in any non-pharmacological migraine program.

3.9 Practical Recommendations for Implementation in India

- Implement pilot task-shifted CBT- and yoga-based migraine programs using existing ASHA/AYUSH networks and have a built-in prospective outcome-evaluation design.
- Discuss tiered or subsidized pricing for REN/tDCS devices as a precondition for entry into the market, based on the precedent set by essential-medicine pricing mechanisms in India.

- Lobby the Indian Academy of Neurology and Indian Headache Society for the formalization of migraine in NP-NCD screening and reporting protocols based on estimates of burden from GBD 2023.
- Make India-specific effectiveness and cost-effectiveness data a prerequisite for public-insurance reimbursement of device-based neuromodulation.
- Implement data-privacy protection and digital-literacy assistance in all AI-powered migraine apps before expanding to rural areas.
- Include medication-overuse counselling in all non-pharmacological migraine programs.

4. CONCLUSION

There is a defensible, evidence-graded role for non-pharmacological interventions in the treatment of migraine, with moderate evidence for REN and low evidence for tDCS and for most comparisons of behavioural therapies, and low-to-moderate evidence, but always directionally beneficial, for yoga in Indian-conducted trials. None of these interventions should be offered to patients or policy makers with greater confidence than the trial evidence supports, and none should replace clinical assessment, especially in patients who have frequent or disabling attacks and may require a combination of non-drug and drug interventions. The main challenge to the public-health potential of non-pharmacological treatment of migraine in India is not that there is no evidence of potential effectiveness, but that policy neglect, focus on costs and infrastructure in tertiary-care centres in urban areas, and a lack of evidence of effectiveness and cost-effectiveness in India are combined. This can only be achieved through coordinated efforts in health policy, professional associations and the research community, with a focus on rigorous, well-powered trials conducted in India, rather than on extrapolating evidence from other health systems and populations.

5. ETHICAL CONSIDERATIONS

Not applicable. This manuscript is a narrative review of previously published literature; the authors did not collect new data from human or animal participants, so no Ethics Committee/Institutional Review Board approval was required for this work.

6. CONFLICTS OF INTEREST

There is no conflict of interest.

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