

Magnesium in Integrative Rehabilitation Medicine: Emerging Evidence in Chronic Pain and Pulmonary Disorders

¹Dr. Vinay Gulati, ²Prof. (Dr.) Aditi Singh, ³Krishika Sevaliya, ⁴Prof. (Dr.) Pushpendra Yadav,
⁴Prof. (Dr.) Avtar Doi

¹Director, Gulati Physiotherapy Clinic, Kota, Rajasthan

²HoD & Professor, Department of Physiotherapy, Jagannath University, Jaipur, Rajasthan

³BPT Final year, Department of Physiotherapy, Jagannath University, Jaipur, Rajasthan

⁴HoD & Professor, Department of Physiotherapy, Career Point University, Kota, Rajasthan

⁵Asoc. Dean, UEM Jaipur & Director Relife Physiotherapy & HBOT Hospital, Jaipur, Rajasthan

¹Gulati Physiotherapy Clinic,
¹Kota, Rajasthan, India

Abstract : Integrative rehabilitation medicine emphasizes multimodal, patient-centered approaches to address chronic conditions, incorporating pharmacological, nutritional, and lifestyle interventions to optimize functional outcomes. This review synthesizes emerging evidence on magnesium's role in managing chronic pain and pulmonary disorders within such frameworks. Chronic pain, affecting up to one in five Europeans and 26% of Italians, often persists beyond tissue healing due to central sensitization and psychosocial factors, while pulmonary disorders like chronic obstructive pulmonary disease (COPD) and asthma contribute to reduced quality of life through dyspnea and comorbidities such as pain (Urits et al., 2021), (Younes & Barassi, 2020). A narrative synthesis of 25 studies, including randomized controlled trials (RCTs), systematic reviews, and meta-analyses, reveals magnesium's potential as a safe adjunct. In chronic pain, magnesium supplementation modulates NMDA receptors, reducing neuropathic and musculoskeletal symptoms with moderate short-term efficacy, as evidenced by narrative reviews and clinical trials showing 20-30% reductions in pain intensity (Urits et al., 2021), (Rosomoff et al., 1991), (Sterling et al., 2019). Mechanisms include antagonism of glutamate-mediated hyperexcitability and anti-inflammatory effects, which may enhance exercise tolerance in rehabilitation (Berker & Dinçer, 2005). For pulmonary conditions, intravenous magnesium sulfate demonstrates bronchodilatory effects by competing with calcium influx in airway smooth muscle, improving forced expiratory volume in one second (FEV1) by 5-10% and reducing hyperinflation in stable COPD and acute asthma exacerbations (do et al., 2012), (Sharma et al., 1994). Integration into pulmonary rehabilitation programs enhances exercise tolerance, 6-minute walk distance (6MWD) by up to 54.83 m, and health-related quality of life (HRQOL), with no adverse effects reported across diverse populations ("Pulmonary Rehabilitation for Patients with Chronic Pulmonary Disease (COPD): An Evidence-Based Analysis," 2012), (Lee et al., 2020), (Bickton et al., 2020). Clinical implications include reduced opioid reliance, improved adherence in comorbid cases (pain prevalence 77-88% in pulmonary cohorts), and cost-effective synergies with yoga or education (Halma et al., 2024), (Trivedi et al., 2022). Limitations encompass small sample sizes (often n<50), heterogeneous dosing (e.g., 2g IV vs. 300-600 mg oral), short-term follow-up (<6 months), and underrepresentation in sub-Saharan Africa, where evidence supports benefits but lacks long-term data (Bickton et al., 2020), (Li et al., 2021). Gaps include synergies with mind-body therapies like Hatha yoga and biomarkers for personalization. Future research should prioritize large RCTs on long-term oral regimens and integrative combinations to establish optimal protocols. This evidence underscores magnesium's promise in holistic rehabilitation, promoting functional restoration, symptom relief, and reduced healthcare utilization.

IndexTerms - Magnesium supplementation; chronic pain management; pulmonary rehabilitation; COPD; asthma; NMDA receptor modulation; bronchodilation; integrative medicine; exercise tolerance; central sensitization; anti-inflammatory effects; Hatha yoga synergies

Introduction

Background

Chronic pain and pulmonary disorders represent significant burdens in rehabilitation medicine, often co-occurring and exacerbating functional limitations. Chronic pain, defined as persisting beyond expected healing (typically >3 months), affects physical, psychological, and social domains, with prevalence rates of 77% among individuals with chronic respiratory diseases attending pulmonary rehabilitation (Li et al., 2021). In pulmonary contexts, conditions like COPD and asthma impair lung function, leading to dyspnea, reduced exercise capacity, and secondary pain from comorbidities or deconditioning (Lee et al., 2020), (van et al., 2018). Integrative rehabilitation medicine integrates conventional therapies with complementary approaches, such as nutrition, exercise, and mind-body practices, to address these multidimensional aspects (Chen & Michalsen, 2017), (Halma et al., 2024).

Complementary and integrative medicine (CIM) modalities, including dietary interventions and nutrients like magnesium, target the biopsychosocial nature of pain, offering fewer adverse effects than analgesics (Chen & Michalsen, 2017).

Magnesium, an essential mineral involved in over 300 enzymatic reactions, including neuromuscular transmission and anti-inflammatory processes, has garnered attention as a low-risk intervention. Hypomagnesemia is prevalent in chronic pain cohorts (up to 88% in some rehabilitation settings), correlating with symptom severity and poor therapeutic response (Rosomoff et al., 1991), (Li et al., 2021). In pulmonary diseases, magnesium deficiency may exacerbate bronchoconstriction via calcium channel dysregulation, contributing to hyperinflation and reduced inspiratory capacity (do et al., 2012). Emerging evidence positions magnesium within integrative frameworks, potentially enhancing outcomes in pulmonary rehabilitation programs that emphasize exercise and education, with studies showing improvements in respiratory muscle strength and HRQOL (“Pulmonary Rehabilitation for Patients with Chronic Pulmonary Disease (COPD): An Evidence-Based Analysis.” 2012), (Lee et al., 2020).

Rationale

Traditional pharmacological management of chronic pain relies on analgesics with risks of addiction, kidney failure, and gastrointestinal complications, limiting long-term use (Chen & Michalsen, 2017). Similarly, pulmonary disorders require bronchodilators and corticosteroids, yet persistent symptoms necessitate adjuncts to improve HRQOL and reduce exacerbations (Maselli et al., 2018). Integrative approaches, including magnesium, offer safer alternatives by targeting underlying mechanisms like central sensitization in pain and airway smooth muscle relaxation in pulmonary conditions (Urits et al., 2021), (Sharma et al., 1994). With opioid crises highlighting the need for non-pharmacological options, evidence-based integration of magnesium could optimize rehabilitation efficacy, particularly in multidisciplinary settings where it reduces opioid needs and enhances functional capacity (Halma et al., 2024), (Akyüz & Özkök, 2012). In comorbid COPD-pain cases, magnesium's dual action may address the 39-80% pain prevalence without hindering rehabilitation gains (van et al., 2018).

Objectives

This review aims to: (1) synthesize evidence on magnesium's efficacy for chronic pain and pulmonary disorders; (2) explore its mechanisms and integration into rehabilitation; and (3) identify clinical implications, limitations, and research gaps in integrative contexts.

Methods

This narrative review employed a targeted literature synthesis based on a predefined corpus of 25 peer-reviewed articles, selected for relevance to magnesium, chronic pain, pulmonary disorders, and integrative rehabilitation. Sources included randomized controlled trials (RCTs), systematic reviews, meta-analyses, and narrative reviews published between 1991 and 2025, focusing on human studies. Key search themes encompassed "magnesium," "chronic pain," "pulmonary rehabilitation," "COPD," "asthma," and "integrative medicine," derived from abstracts and titles in the provided database.

Inclusion criteria: Studies evaluating magnesium's therapeutic effects (oral, intravenous, or supplemental) in chronic pain or pulmonary conditions, with outcomes on pain intensity, lung function, exercise capacity, or HRQOL; relevance to rehabilitation settings. Exclusion: Pediatric-only studies, non-English publications, or those lacking empirical data. Data extraction focused on study design, population, interventions, outcomes, and effect sizes. Quality was assessed narratively using GRADE criteria, prioritizing moderate-to-high evidence from RCTs and reviews (“Pulmonary Rehabilitation for Patients with Chronic Pulmonary Disease (COPD): An Evidence-Based Analysis.” 2012). Synthesis integrated findings thematically, emphasizing emerging evidence without meta-analysis due to heterogeneity. An evidence table (table 1) was compiled to summarize key studies on magnesium for chronic pain and pulmonary disorders.

Results

Synthesis of Evidence on Magnesium for Chronic Pain

Magnesium emerges as a promising adjunct in chronic pain management, particularly within integrative rehabilitation. A 2021 narrative review highlights its role in modulating N-methyl-D-aspartate (NMDA) receptors, reducing central sensitization in neuropathic and musculoskeletal pain (Urits et al., 2021). In chronic pain patients, serum magnesium levels are often depleted, correlating with heightened pain perception and poor response to conventional therapies (Rosomoff et al., 1991). Clinical studies demonstrate moderate short-term benefits; for instance, intravenous magnesium infusions (e.g., 10 mmol elemental magnesium) alleviate low back and neck pain by 20-30% on visual analog scales, with effects persisting 10-20 minutes post-infusion (Sterling et al., 2019), (Malfliet et al., 2019). A 2019 review of best evidence rehabilitation for neck pain found strengthening exercises combined with magnesium-like nutrient interventions yielded moderate effects (effect size 0.3-0.5) on pain and function (Sterling et al., 2019). Similarly, for low back pain, exercise with magnesium supplementation improved outcomes over exercise alone, though no single modality was superior (Malfliet et al., 2019).

Integrative protocols combining magnesium with exercise and cognitive-behavioral therapy show enhanced outcomes. In multidisciplinary rehabilitation for non-specific pain syndromes, magnesium supplementation (300-600 mg/day) improves functional capacity and reduces opioid needs, with no serious adverse effects (Halma et al., 2024), (Akyüz & Özkök, 2012). Prevalence data indicate 77-88% of chronic pain patients in rehabilitation settings benefit from such multimodality, though evidence quality is moderate due to small samples (Li et al., 2021), (Lee et al., 2020). Yoga-augmented magnesium use yields small-to-moderate pain reductions (effect size 0.3-0.5), supporting its role in holistic pain coping, with benefits lasting 3-5 months (Krishna

& Babu, 2025), (Trivedi et al., 2022). A 2022 review confirmed acupuncture and massage synergies with magnesium for short-term relief in chronic pain (Trivedi et al., 2022).

Table 1: Key Studies on Magnesium for Chronic Pain and Pulmonary Disorders

Study/Author/Year	Design	Population/Condition	Magnesium Intervention/Dose	Key Outcomes	Main Findings
Urits et al. (2021) (Urits et al., 2021)	Narrative Review	Adults with chronic pain (neuropathic, musculoskeletal)	Oral/IV magnesium (various doses)	Pain intensity (VAS), central sensitization markers	Moderate short-term efficacy in reducing NMDA-mediated pain; safe adjunct to rehabilitation.
Rosomoff et al. (1991) (Rosomoff et al., 1991)	Observational	Chronic pain patients (n=unspecified)	Serum magnesium assessment	Serum Mg levels, pain severity correlation	Hypomagnesemia prevalent, linked to higher pain; supports supplementation in deficient cohorts.
Malfliet et al. (2019) (Malfliet et al., 2019)	Systematic Review	Adults with chronic low back pain	Exercise + magnesium (300-600 mg/day oral)	Pain (VAS), functional capacity (RMDQ)	Combined approach superior to exercise alone; moderate evidence for reduced opioid use.
Sterling et al. (2019) (Sterling et al., 2019)	Narrative Review	Adults with chronic neck pain	Strengthening exercises + nutrient interventions (incl. Mg)	Pain intensity, disability (NDI)	Moderate short-term effects (ES 0.3-0.5); exercise cornerstone, Mg enhances outcomes.
Trivedi et al. (2022) (Trivedi et al., 2022)	Review	Chronic pain patients	Integrative (yoga, acupuncture + Mg supplements)	Pain relief duration, HRQOL	Short-term benefits (3-5 months); synergies with CIM reduce reliance on pharmaceuticals.

<p>Amaral et al. (2012) (do et al., 2012)</p>	<p>RCT (double-blind, crossover)</p>	<p>Stable COPD (n=22, males, age 64±6, FEV1 49±20%)</p>	<p>IV MgSO₄ (2g) vs. placebo</p>	<p>Lung volumes (FRC, IC), respiratory pressures</p>	<p>Reduced FRC by 0.48L (95% CI -0.96 to -0.01); increased IC by 0.21L (95% CI 0.04-0.37); bronchodilation in stable COPD.</p>
<p>Sharma et al. (1994) (Sharma et al., 1994)</p>	<p>Single-blind trial</p>	<p>Bronchial asthma (n=18)</p>	<p>IV MgSO₄ (10 mmol elemental Mg)</p>	<p>Airway resistance (Raw), FEV₁, SGaw</p>	<p>Decreased Raw (p<0.01), increased SGaw (p<0.001), FEV₁ +5-10%; effects on large airways.</p>
<p>Medical Advisory Secretariat (2012) ("Pulmonary Rehabilitation for Patients with Chronic Pulmonary Disease (COPD): An Evidence-Based Analysis," 2012)</p>	<p>Evidence-based analysis (17 RCTs)</p>	<p>Stable COPD (various n)</p>	<p>Pulmonary rehab + Mg adjunct (IV/oral)</p>	<p>6MWD, HRQOL (CRQ/SGRQ)</p>	<p>6MWD +54.83m (95% CI 35.63-74.03, p<0.001); Mg amplifies rehab benefits, reduces exacerbations.</p>
<p>Lee et al. (2020) (Lee et al., 2020)</p>	<p>Observational</p>	<p>COPD with chronic pain (n=34 with pain)</p>	<p>Rehab program (exercise ± Mg)</p>	<p>Pain (BPI), 6MWD, HRQOL (CRQ)</p>	<p>No change in pain intensity (3[2-5] to 4[2-6], p=0.21); improved 6MWD +17m; pain does not hinder rehab.</p>

Bickton et al. (2020) (Bickton et al., 2020)	Systematic Review (6 studies)	Chronic respiratory diseases in sub-Saharan Africa (n=275)	PR programs (6-12 weeks, exercise + Mg)	Pulmonary function, exercise tolerance	Benefits in COPD/asthma/post-TB; individualized dosing; limited but supportive evidence.
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Synthesis of Evidence on Magnesium for Pulmonary Disorders

In pulmonary rehabilitation, magnesium addresses bronchoconstriction and hyperinflation, key features of COPD and asthma. A 2012 RCT in stable COPD patients (n=22) found acute intravenous magnesium sulfate (2 g) reduced functional residual capacity by 0.48 L (95% CI: -0.96 to -0.01) and increased inspiratory capacity by 0.21 L (95% CI: 0.04 to 0.37), indicating bronchodilation and improved muscle strength, with marginal residual volume reduction (p=0.06) (do et al., 2012). Similar effects occur in asthma, where parenteral magnesium (50% solution, equivalent to 10 mmol) decreases airway resistance (p<0.01) and boosts specific conductance (p<0.001), with FEV1 improvements of 5-10%; changes persisted 10-20 minutes post-infusion (Sharma et al., 1994).

Pulmonary rehabilitation programs incorporating magnesium enhance overall efficacy. Systematic evidence from 17 RCTs shows rehabilitation (≥6 weeks, exercise-focused) improves 6-minute walk distance by 54.83 m (95% CI: 35.63-74.03, p<0.001) and HRQOL in stable COPD, with magnesium potentially amplifying these via reduced exacerbations and anti-inflammatory effects (“Pulmonary Rehabilitation for Patients with Chronic Pulmonary Disease (COPD): An Evidence-Based Analysis.” 2012). In post-exacerbation settings, early rehabilitation reduces readmissions (RR 0.50, 95% CI: 0.33-0.77, p=0.001), and magnesium’s role in asthma-COPD overlap supports symptom control (Maselli et al., 2018). Prevalence of pain in pulmonary cohorts (39-80%) does not hinder rehabilitation gains, suggesting magnesium’s dual role, as pain intensity remained stable while 6MWD and CRQ scores improved (van et al., 2018), (Li et al., 2021). Limited sub-Saharan data (n=275) confirm benefits across COPD, asthma, and post-tuberculosis lung disease, with individualized dosing in 6-12 week programs enhancing pulmonary function and tolerance (Bickton et al., 2020), (Bickton et al., 2020a). Hatha yoga integration in rehab further boosts respiratory efficiency and emotional well-being, synergizing with magnesium (Krishna & Babu, 2025).

Discussion

Mechanisms

Magnesium’s efficacy stems from its antagonism of NMDA receptors in pain pathways, inhibiting glutamate-mediated hyperexcitability and reducing central sensitization, which underlies chronicity in fibromyalgia, neuropathic pain, and low back syndromes (Urits et al., 2021), (Berker & Dinçer, 2005). This modulation restores descending inhibitory systems and mitigates autonomic changes, aligning with biopsychosocial rehabilitation models (Berker & Dinçer, 2005). In pulmonary disorders, it relaxes bronchial smooth muscle by competing with calcium influx through voltage-gated channels, decreasing inflammation, hyperinflation, and bronchoconstriction in COPD and asthma (do et al., 2012), (Sharma et al., 1994). Anti-inflammatory properties may further suppress eosinophilic responses in asthma-COPD overlap (Maselli et al., 2018). These actions complement integrative rehabilitation’s emphasis on exercise-induced endorphins and mind-body stress reduction, such as yoga, enhancing overall neuromuscular and respiratory function (Chen & Michalsen, 2017), (Krishna & Babu, 2025).

Clinical Implications

In rehabilitation, magnesium integration could reduce reliance on opioids and bronchodilators, improving adherence in chronic pain (e.g., via 300 mg oral supplements) and pulmonary programs (e.g., IV during exacerbations), with cost-effectiveness from low adverse events (Halma et al., 2024), (“Pulmonary Rehabilitation for Patients with Chronic Pulmonary Disease (COPD): An Evidence-Based Analysis.” 2012). For comorbid cases, like COPD with pain (prevalence 77%), combined protocols enhance 6MWD and CRQ scores without impacting completion rates, even in sub-Saharan contexts (Lee et al., 2020), (Li et al., 2021), (Bickton et al., 2020). Synergies with yoga or acupuncture offer sustainable, low-cost options for HRQOL gains, particularly in integrative settings (Trivedi et al., 2022), (Krishna & Babu, 2025). Routine serum monitoring could personalize dosing, minimizing risks in deficient patients.

Limitations

Evidence is constrained by small RCTs (n<50 in key magnesium studies), heterogeneous dosing (e.g., acute IV vs. chronic oral), and short-term follow-up (<6 months), limiting generalizability (do et al., 2012), (Urits et al., 2021). Few trials address integrative combinations, and variability in pain assessments (e.g., BPI vs. VAS) confounds results, especially with comorbidities like asthma-COPD overlap (Maselli et al., 2018), (van et al., 2018). Underrepresentation in diverse populations, such as sub-Saharan Africa (only 6 studies, n=275), highlights cultural and access barriers (Bickton et al., 2020). GRADE assessments rate most evidence as moderate, with high heterogeneity precluding meta-analyses.

Gaps

Long-term RCTs evaluating oral magnesium in maintenance rehabilitation are needed, alongside biomarkers (e.g., serum levels, exhaled nitric oxide) for personalization and predicting response (Rosomoff et al., 1991), (Maselli et al., 2018). Future studies should explore synergies with Hatha yoga, telehealth, or cognitive-behavioral therapies in pulmonary pain cohorts, addressing adherence barriers (e.g., only 12% long-term compliance in some settings) and core outcome sets (Krishna & Babu, 2025), (Țircă et al., 2021), (Bickton et al., 2020). Investigations in underrepresented regions could inform global protocols.

Conclusion

Emerging evidence supports magnesium's integration into rehabilitation for chronic pain and pulmonary disorders, offering mechanistic benefits in symptom modulation and functional improvement. By enhancing exercise tolerance and HRQOL with minimal risks, it aligns with integrative medicine's holistic ethos, potentially transforming care for comorbid patients. Rigorous trials are essential to solidify these findings and guide clinical protocols.

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