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THE ROLE OF SLEEP QUALITY IN PHYSIOTHERAPY REHABILITATION OUTCOME-A NARRATIVE REVIEW

Narrative Review

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ABSTRACT

Background: Sleep is a fundamental biological process that supports neuroplasticity, muscle repair, immune regulation, and pain modulation, all of which are essential for effective physiotherapy rehabilitation. Growing evidence indicates that poor sleep quality negatively affects functional recovery, reduces tolerance to therapeutic exercise, and amplifies pain perception, particularly in individuals with musculoskeletal conditions. Despite this, sleep remains underassessed in routine physiotherapy practice, and most existing evidence is observational, limiting causal inference and clinical translation.

Objective: This review aimed to evaluate sleep-related outcomes in adults receiving physiotherapy and to clarify the bidirectional relationship between sleep quality and pain. Additionally, it sought to inform practical strategies that physiotherapists can adopt to optimize recovery and functional performance by addressing sleep-related factors.

Methods: A rapid review was conducted using PubMed, Google Scholar, MDPI, and Scopus databases. Peer-reviewed studies published between 2015 and 2025 were considered. Eligible studies included longitudinal, quasi-experimental, descriptive, and observational designs involving adults aged ≥18 years undergoing physiotherapy for musculoskeletal or rehabilitation-related conditions. Studies evaluating sleep quality, insomnia severity, pain, functional outcomes, or biological recovery markers were included. Non-English articles, animal studies, pediatric populations, and unpublished data were excluded. Data were narratively synthesized, focusing on clinical and functional outcomes relevant to physiotherapy.

Results: Across included studies, sleep disturbance was consistently associated with poorer rehabilitation outcomes. Patients with insomnia demonstrated higher pain scores, greater functional limitation, and reduced quality of life. In one cohort, only 33% of patients achieved a clinically meaningful improvement in insomnia severity, while 62% shifted to a lower insomnia category by discharge. Poor sleep was linked to increased inflammatory activity and delayed tissue healing, whereas improvements in sleep quality were associated with better pain control, enhanced therapy participation, and superior physical health–related quality of life.

Conclusion: Sleep quality significantly influences physiotherapy rehabilitation outcomes. Integrating routine sleep assessment and basic sleep-focused strategies into physiotherapy practice may improve pain control, functional recovery, and long-term rehabilitation success.

Keyword: Pain, Physical Therapy Modalities, Rehabilitation, Sleep Deprivation, Sleep Quality, Treatment Outcome.

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INTRODUCTION

Sleep is a fundamental biological process that underpins physical recovery, cognitive function, and overall health, making it indispensable for maintaining daily activities and supporting healing across the lifespan. In contemporary societies, however, chronic sleep insufficiency and poor sleep quality have become increasingly prevalent, contributing to a wide range of physical, psychological, and functional impairments (1). These disturbances are particularly relevant within rehabilitation settings, where optimal recovery depends on the complex interaction between rest, tissue repair, neuromuscular adaptation, and psychosocial well-being (2). Despite growing recognition of sleep as a determinant of health, it remains under-addressed in routine rehabilitation practice, representing an important gap in holistic patient care. Physical therapists, as professionals with a core focus on function, mobility, and wellness, are uniquely positioned to address sleep-related issues within clinical practice (3). Their role extends beyond exercise prescription to include screening for sleep disturbances, identifying impairments linked to disordered sleep, and implementing targeted interventions aimed at minimizing the functional consequences of inadequate rest (4). In addition, physical therapists play a key educational role for patients, caregivers, and healthcare providers, promoting healthy sleep behaviors and highlighting the bidirectional relationship between sleep, pain, activity tolerance, and overall quality of life. Monitoring sleep duration and quality, and referring patients to sleep specialists when necessary, may enhance rehabilitation outcomes and support sustained functional gains (5,6).

From a neurorehabilitation perspective, sleep has been shown to be critical for motor learning and memory consolidation. Substantial evidence in healthy young adults demonstrates that sleep following motor practice facilitates off-line motor skill learning, leading to performance improvements without additional training (7). Although this sleep-dependent learning effect appears attenuated in healthy older adults, emerging research suggests that individuals with brain injury, particularly those recovering from stroke, may retain or regain the capacity for sleep-facilitated motor skill enhancement. Given that stroke rehabilitation relies heavily on the acquisition of new motor skills and the re-learning of previously established ones, understanding the contribution of sleep to post-practice motor consolidation has important implications for the timing, structure, and effectiveness of physical therapy interventions (8,9). Beyond neuromotor recovery, sleep plays a vital role in regulating inflammation, immune function, and tissue repair, all of which are central to successful rehabilitation outcomes. Inadequate or fragmented sleep has been associated with poorer mental and physical health, impaired immune responses, and suboptimal physiological adaptation, particularly in individuals undergoing pulmonary rehabilitation. These effects may exacerbate respiratory limitations, increase vulnerability to complications, and reduce adherence to rehabilitation programs. Integrating structured pulmonary rehabilitation with strategies that promote healthy sleep habits is therefore expected to yield meaningful improvements in lung function, functional capacity, and overall health status, while fostering long-term engagement in therapeutic interventions (10,11). In light of this evidence, a critical question emerges regarding how systematically addressing sleep within physical therapy practice can optimize rehabilitation outcomes across diverse patient populations. Therefore, the objective of this study is to examine the role of sleep in rehabilitation and to rationalize the integration of sleep screening and sleep-focused strategies within physical therapy to enhance functional recovery, health, and overall well-being.

METHODS

This review was conducted to synthesize contemporary evidence on the role of sleep quality in physiotherapy rehabilitation outcomes. A methodical literature search was performed using PubMed, Google Scholar, and MDPI (Multidisciplinary Digital Publishing Institute) databases to identify relevant studies published between 2015 and 2025. The search strategy was developed using combinations of predefined keywords, including *sleep*, *physiotherapy*, and *recovery*, to ensure comprehensive coverage of the topic. Reference lists of eligible articles were also screened to identify additional pertinent studies. Only peer-reviewed, English-language publications involving human participants were considered, while animal studies, unpublished data, conference abstracts, editorials, and non-English articles were excluded to maintain methodological rigor and clinical relevance (12,13). Eligible studies included randomized controlled trials, observational studies, cohort studies, and narrative or systematic reviews that examined the association between sleep quality and physiotherapy or rehabilitation outcomes. The population of interest comprised adult participants aged 18 years and older, irrespective of gender, with a particular focus on individuals presenting with musculoskeletal conditions such as chronic low back pain, neck pain, fibromyalgia, post-surgical pain, neurological impairments, or pulmonary conditions. Studies evaluating sleep-related variables in conjunction with physiotherapy interventions, rehabilitation programs, or functional recovery outcomes were included. Outcomes of interest encompassed pain intensity, functional performance, quality of life, rehabilitation adherence, neurophysiological markers, and

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overall therapeutic effectiveness. Studies that relied exclusively on non-questionnaire-based sleep assessments, pediatric populations, or unrelated medical interventions were excluded (14,15).

Data collection methods varied across included studies but predominantly involved validated self-reported questionnaires and biochemical assessments. In one included comparative study, participants with chronic back pain were divided into two groups: individuals with comorbid insomnia (case group, n = 38) and individuals without insomnia (control group, n = 41). Sleep quality, pain, and health-related quality of life were assessed using standardized instruments, including the McGill Pain Questionnaire and its short form (SF-MPQ), the Insomnia Severity Index (ISI), and the European Quality of Life Questionnaire (EQ-5D). In addition, laboratory-based enzyme-linked immunosorbent assay (ELISA) techniques were used to quantify biomarkers of nervous tissue damage, including neurofilament polypeptide (NEF), neuron-specific enolase (NSE), and protein S100B, to explore potential neurobiological correlates of impaired sleep and rehabilitation outcomes (12). Several studies emphasized the importance of routine sleep screening within physiotherapy practice. Broad, structured interview questions were commonly used to identify sleep disturbances during patient assessment, even when sleep was not the primary reason for referral. Evidence from prior research highlighted that patients with fibromyalgia, back pain, neck pain, and post-surgical pain are particularly susceptible to sleep disorders. Screening approaches included the use of general sleep-related questions proposed for physiotherapists, which addressed sleep duration, perceived restfulness, sleep quality, daytime sleepiness, and symptoms suggestive of insomnia, obstructive sleep apnea, or restless leg syndrome. Affirmative responses to specific items prompted further assessment or referral for specialized evaluation (13).

Validated sleep questionnaires were central to data collection across studies. The Pittsburgh Sleep Quality Index (PSQI) was frequently used as a standardized tool to quantify subjective sleep quality and disturbances, with previous research demonstrating moderate to high reliability across diverse populations. Additionally, the Basic Nordic Sleep Questionnaire, consisting of 21 items scored on reference scales from 1 to 5, was employed in studies conducted in Nordic regions as a reliable measure of sleep quality and sleep-related problems. These instruments were favored due to their feasibility, low cost, ease of administration, and suitability as first-line screening tools in clinical and research settings, despite their inherent reliance on self-reported data (13,14). The study selection process followed a transparent and systematic approach. Titles and abstracts identified through database searches were initially screened, followed by full-text assessment of potentially eligible articles. Screening and selection were conducted by independent reviewers, with disagreements resolved through discussion to achieve consensus. Reference management software was used to organize citations and remove duplicates. The overall study selection process was documented using a PRISMA flow diagram to enhance transparency and reproducibility. Data analysis across included studies primarily involved descriptive statistics, hypothesis testing, and univariate and multivariate regression models, depending on study design and outcome measures. This structured methodological approach was intended to ensure a comprehensive, reliable, and clinically meaningful synthesis of current evidence on sleep quality and physiotherapy rehabilitation outcomes (12,15).

Table1: General questions (Siengsukon, Al-Dughmi & Stevens 2017)

1	**How long do you usually sleep each night?**
2	Do you feel well rested when you wake up?
3	Does your condition affect your sleep? How?
4	How would you describe the quality of your sleep?
5	Does daytime sleepiness affect your daily activities?
6	Do you struggle to go back to sleep at night or wake up too early? (May indicate insomnia)
7	Do you snore a lot or stop breathing during sleep? (May indicate obstructive sleep apnea)
8	Do you often feel a strong need to move your legs while trying to sleep? (A possible sign of restless leg syndrome)

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RESULTS

The literature search yielded a substantial body of evidence addressing the relationship between sleep quality and physiotherapy rehabilitation outcomes. After removal of duplicates, the retrieved records were screened based on titles and abstracts, followed by full-text assessment for eligibility. Studies that did not meet predefined inclusion criteria—such as non-English publications, animal studies, pediatric populations, or those lacking clear rehabilitation or sleep-related outcomes—were excluded. The final synthesis included a focused set of studies that directly examined sleep quality, insomnia severity, neurobiological markers, and functional outcomes relevant to physiotherapy rehabilitation. The study selection process was documented using a PRISMA flow diagram to ensure transparency and reproducibility of the screening procedure. The included studies comprised observational studies, comparative clinical studies, and rehabilitation-based intervention research involving adult participants with musculoskeletal and neurological conditions, particularly chronic low back pain and other pain-related disorders. Sample sizes varied across studies, with participant numbers ranging from small to moderate cohorts. Most studies included both male and female participants aged over 18 years, with comparable baseline clinical characteristics. Sleep quality and insomnia severity were commonly assessed using validated questionnaires such as the Insomnia Severity Index, while pain, functional interference, and health-related quality of life were measured using standardized instruments. Several studies incorporated biochemical analyses, including enzyme-linked immunosorbent assay techniques, to assess neurobiological markers associated with neuronal injury. A summary of study characteristics, including authors, publication year, study design, sample size, assessment tools, and primary outcomes, was compiled in tabular form to facilitate comparison across studies.

Assessment of methodological quality revealed an overall moderate risk of bias across the included literature. Most studies demonstrated appropriate use of validated outcome measures and clearly defined participant groups; however, common limitations included reliance on self-reported sleep questionnaires, absence of long-term follow-up, and limited control for potential confounding factors such as comorbid psychological distress or medication use. Selection bias and reporting bias were noted in some observational studies, while blinding of participants and assessors was rarely feasible due to the nature of rehabilitation interventions. Despite these limitations, the consistency of findings across multiple studies strengthened the overall reliability of the evidence. Across studies, poor sleep quality and higher insomnia severity were consistently associated with adverse rehabilitation outcomes. Elevated levels of neurofilament polypeptides, recognized biomarkers of neuronal injury, were observed in individuals with poor sleep quality, suggesting an underlying neurobiological mechanism through which sleep disturbances may impair recovery and reduce the effectiveness of physical therapy interventions. Inadequate sleep was shown to impede tissue healing, exacerbate pain, and diminish functional gains achieved through rehabilitation. Greater severity of insomnia was negatively correlated with pain intensity, physical functioning, and emotional well-being, indicating a broad impact of sleep disturbances on both physical and psychosocial dimensions of recovery (16). Intervention-based findings demonstrated clinically meaningful improvements in sleep and rehabilitation-related outcomes over the course of physiotherapy programs. Approximately one-third of patients with mild, moderate, or severe insomnia at baseline achieved a clinically significant improvement in Insomnia Severity Index scores, defined as a reduction of eight or more points, by the time of discharge. Notably, the majority of patients transitioned to a lower insomnia severity category following treatment, reflecting a positive shift in sleep health. Improvements in sleep were accompanied by reductions in pain interference and enhancements in physical health–related quality of life, underscoring the interconnected nature of sleep and functional recovery. Conversely, persistent insomnia symptoms were associated with poorer rehabilitation outcomes, reinforcing the negative influence of inadequate sleep on pain modulation, inflammatory regulation, and overall physiotherapy effectiveness (16,17). Collectively, the results indicate that sleep quality plays a critical role in determining the success of physiotherapy rehabilitation. The convergence of subjective outcomes, functional measures, and biological markers provides robust evidence that inadequate sleep adversely affects healing, pain processing, and functional restoration, while improvements in sleep are associated with better rehabilitation trajectories and patient-reported outcomes.

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Table 2: Characteristics of Studies Included in the Review

Author / Year	Study Design	Population / Condition	Sample Size (n)	Sleep Assessment Tools	Rehabilitation / Intervention Focus	Primary Outcomes
Various studies (2015–2025)	Observational studies	Adults ≥18 years with musculoskeletal pain (including chronic low back pain)	Small to moderate cohorts	Insomnia Severity Index (ISI), sleep questionnaires	Routine physiotherapy programs	Pain intensity, sleep quality, functional limitation, quality of life
Various studies (2015–2025)	Comparative clinical studies	Adults with chronic pain with and without insomnia	~70–80 participants (case vs control groups)	ISI, validated sleep questionnaires	Physiotherapy-based rehabilitation	Insomnia severity, pain interference, physical health–related quality of life
Various studies (2015–2025)	Rehabilitation-based intervention studies	Adults undergoing physiotherapy for musculoskeletal and neurological conditions	Variable	ISI, self-reported sleep quality tools	Structured physiotherapy interventions	Change in insomnia category, pain reduction, functional recovery
Selected studies	Observational / laboratory-linked	Adults with poor vs good sleep quality	Small cohorts	ISI, sleep questionnaires	Physiotherapy rehabilitation	Neurofilament polypeptides, NSE, S100B (neuronal injury biomarkers)
Selected studies	Longitudinal observational	Adults with chronic musculoskeletal disorders	Moderate cohorts	ISI, quality-of-life instruments	Ongoing physiotherapy care	Sleep quality trajectories, pain persistence, rehabilitation outcomes

DISCUSSION

The findings of this review underscored the central role of sleep in optimizing physiotherapy rehabilitation outcomes, reinforcing the view that sleep is not merely a passive state but an active biological process essential for recovery and functional restoration. The evidence indicated that adaptive neural plasticity and reinforcement of motor memory occur predominantly during sleep, processes that are critical for relearning and refining movement patterns during rehabilitation. These neurophysiological mechanisms provided a plausible explanation for why patients with adequate sleep demonstrated more efficient motor recovery and improved responsiveness to physical therapy interventions, aligning with established models of sleep-dependent learning and neural reorganization (11,13). The results were consistent with prior literature demonstrating that deep sleep is closely associated with growth hormone secretion, which plays a pivotal role in muscle repair, tissue regeneration, and overall anabolic balance. Adequate sleep was therefore shown to function as a biological facilitator of the structural and metabolic adaptations required during rehabilitation. Conversely, sleep deprivation was linked to impaired protein synthesis, reduced anabolic signaling, and diminished exercise tolerance, which collectively increased the

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difficulty of engaging in and benefiting from physiotherapy programs. These findings supported the interpretation that sleep quality may be as influential as exercise prescription itself in determining rehabilitation success (17,18). The review also highlighted the high prevalence of sleep disturbances among individuals with musculoskeletal pain and the clinical relevance of systematically assessing sleep within physiotherapy practice. Evidence suggested that validated sleep questionnaires provided a feasible and clinically meaningful approach for identifying sleep-related impairments that contribute to heightened pain perception, functional limitations, and delayed recovery. Although these tools relied on subjective self-report and lacked the objectivity of polysomnography or actigraphy, their practicality and accessibility rendered them valuable for routine clinical use. Integrating sleep assessment into physiotherapy evaluations was therefore interpreted as a pragmatic strategy to support a more holistic, patient-centered model of care, enabling clinicians to address modifiable sleep-related factors that may otherwise undermine treatment effectiveness (19).

Physiological evidence further supported the role of sleep in recovery through its influence on autonomic regulation and inflammatory control. Increased parasympathetic activity during sleep was identified as a marker of restorative processes, emphasizing the importance of sleep quality and duration in maintaining autonomic balance and systemic health. Behavioral and physiological factors such as physical activity levels, body mass index, stimulant use, and daily stress were shown to interact with sleep to shape recovery trajectories. Despite this growing body of evidence, the review identified a persistent gap in physiotherapy practice, where structured sleep assessment and education had been insufficiently integrated, even though sleep disturbances were closely linked to pain, functional outcomes, and overall well-being. This gap suggested missed opportunities to enhance rehabilitation effectiveness through relatively low-cost, non-invasive strategies (20). The bidirectional relationship between sleep and pain emerged as a particularly salient theme. Poor sleep was associated with central sensitization, reduced pain thresholds, and amplification of chronic musculoskeletal pain, while persistent pain further disrupted sleep continuity and quality. Physical therapy interventions such as aerobic exercise, strengthening, and manual therapy were associated with improvements in both pain and sleep, suggesting a reciprocal therapeutic relationship. These findings supported the interpretation that addressing sleep disturbances may enhance the analgesic and functional benefits of physiotherapy, while effective pain management may, in turn, promote healthier sleep patterns (21,22).

Several strengths of this review included the integration of neurophysiological, biochemical, and clinical evidence, which allowed for a multidimensional interpretation of how sleep influences rehabilitation outcomes. The inclusion of both subjective and objective markers of recovery strengthened the biological plausibility of the findings. However, important limitations were also acknowledged. Many included studies relied on self-reported sleep measures, which are susceptible to recall and reporting bias, and few employed longitudinal designs capable of establishing causal relationships. Heterogeneity in study designs, populations, and outcome measures limited the ability to directly compare results or quantify effect sizes. In addition, confounding variables such as psychological distress, medication use, and comorbid sleep disorders were not consistently controlled across studies. Future research should prioritize well-designed longitudinal and interventional studies to clarify causal pathways between sleep quality and rehabilitation outcomes. The incorporation of objective sleep assessments alongside validated questionnaires may strengthen measurement accuracy, while standardized reporting of physiotherapy interventions and outcomes would improve comparability across studies (23). Exploring targeted sleep-focused interventions within physiotherapy programs may further elucidate whether optimizing sleep can directly enhance recovery, adherence, and long-term functional gains. Overall, the findings supported the integration of sleep assessment and education into routine physiotherapy practice as a necessary step toward more comprehensive, effective, and patient-centered rehabilitation care.

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CONCLUSION

This review concluded that sleep quality is a fundamental, yet frequently underrecognized, determinant of successful physiotherapy rehabilitation. The evidence collectively demonstrated that inadequate sleep adversely influences pain modulation, motor learning, emotional regulation, and physical recovery, thereby limiting functional progress and reducing engagement in therapy. In contrast, prioritizing healthy sleep was consistently associated with enhanced neuroplasticity, improved musculoskeletal healing, greater motivation, and more favorable functional outcomes. These findings directly addressed the objective of this review by emphasizing the need to view sleep as an integral component of rehabilitation rather than an external or secondary factor. From a practical perspective, incorporating routine sleep assessment and basic sleep-focused guidance into physiotherapy practice, alongside timely referral to sleep specialists when indicated, offers a feasible strategy to optimize rehabilitation outcomes. Recognizing and addressing sleep-related factors may therefore strengthen functional independence, improve long-term recovery trajectories, and advance a more holistic and effective model of physiotherapy care.

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AUTHOR CONTRIBUTIONS

Author	Contribution
Aakash Iqbal*	Substantial Contribution to study design, analysis, acquisition of Data Manuscript Writing Has given Final Approval of the version to be published
Tehreem Mukhtar	Substantial Contribution to study design, acquisition and interpretation of Data Critical Review and Manuscript Writing Has given Final Approval of the version to be published
Fatima Israr	Substantial Contribution to acquisition and interpretation of Data Has given Final Approval of the version to be published
Mishal Sajjad	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Maham Arshad	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Amina Shameem	Substantial Contribution to study design and Data Analysis Has given Final Approval of the version to be published
Arslan Haider	Contributed to study concept and Data collection Has given Final Approval of the version to be published

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