PHYSIOTHERAPY
THEMES AND PERSPECTIVE

Editors
Dr. Mahendra Shende
Dr. Venkatsheshan Neelmhghan

Physiotherapy:
Themes and Perspective

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Physiotherapy:
Themes and Perspective

Research papers read during International Conference on "Synergizing Knowledge: The Role of Academia in Global Progress" jointly organised by Tilak Maharashtra Vidyapeeth (TMV), Pune, Maharashtra & Centre for Training & Development (CTD), Delhi, India during the 12-13 June 2025.

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From Principal Desk:

Healthcare in the 21st century is no longer confined to clinical excellence alone. The practice of medicine today demands a deep understanding of legal accountability, ethical clarity, and patient-cantered care. In a country as diverse and populous as India, where access, equity, and justice in healthcare remain ongoing challenges, the medico-legal framework plays an increasingly critical role. It is within this context that our institution has taken the initiative to organize a national conference on "Medico-Legal Challenges in Modern Healthcare: Balancing Rights, Ethics, and Responsibilities in India". The accompanying proceedings volume is envisioned as an enduring academic and professional resource that documents, analyses, and reflects upon the key themes discussed during the event.

This conference and its proceedings aim to provide a structured platform for scholars, legal experts, healthcare practitioners, policy makers, and students to engage in constructive dialogue. The objective is not only to highlight the challenges faced in real-world scenarios but also to explore collaborative, ethical, and legally sound solutions. Some of the key issues to be addressed in these proceedings include: The evolving jurisprudence on medical negligence and patient rights, Ethical considerations in medical decision-making and research, Legal obligations in public health policy, consent, and confidentiality, Challenges posed by digital health technologies and data privacy laws, Institutional responsibilities and medico-legal education in medical curriculum.

As Principal, I take great pride in the interdisciplinary nature of this initiative, which bridges the domains of medicine, law, ethics, and public policy. This proceedings volume reflects our commitment to nurturing informed professionals who not only excel in their disciplines but are also deeply conscious of the legal and ethical dimensions of their work.

I am confident that this compilation will serve as a valuable reference for academicians, practitioners, students, and policy influencers. It will also inspire continued scholarship and reform in the medico-legal landscape of India. I extend my heartfelt gratitude to all contributors, the editorial board,

reviewers, and organizing team for their unwavering dedication and scholarly rigor in bringing this volume to fruition.

Dr. Mahendra Shende
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Preface

"The body achieves what the mind believes"

"Believing in yourself is at the foundation of all physical therapy success stories. Therapists understand that while everyone has physical limitations, people who believe in their potential set themselves up for the most significant success"

In an era defined by rapid transformation, interconnected economies, and global challenges that transcend borders, the role of academia has never been more vital. Knowledge today is not confined to classrooms or research labs—it is a dynamic force that drives innovation, shapes societies, and steers humanity toward sustainable progress. The synergy of ideas, disciplines, and cultures is what enables us to confront issues such as climate change, technological disruption, economic inequality, and the pursuit of peace and justice. Harnessing the collective power of education, research, and innovation plays a crucial role in building a sustainable, inclusive, and progressive global society where knowledge serves as the cornerstone of human advancement.

The conference formed the dynamic exchange of ideas from various disciplines—i.e. Management, social science, humanities. But we cannot ignore the importance of physiotherapy, when technostress is rapidly growing due to technological advancements. Henceforth global progress cannot acknowledge without covering the area of physiotherapy.

The conference proceedings cum edited book are a collection of research papers presented during the Two-day International conference on "Synergizing Knowledge: The Role of Academia in Global Progress" during June 12-13, 2025, in Hybrid Mode. The efforts are made to understand that in the synergy of knowledge lies the power to reimagine societies, redefine possibilities, and reshape the world."

More than 35 papers were received and presented during the conference. The papers were objectively evaluated and assessed by the conference convenors and board members with conference theme.

It is our hope that the discussions and exchanges presented here in the book will inspire actionable insights, strengthen global networks of knowledge, and ignite a renewed commitment to harnessing education and research for the betterment of society worldwide in the areas of physiotherapy.

Acknowledgment

We extend our deepest gratitude to Tilak Maharashtra Vidyapeeth (TMV), Pune, Maharashtra and the Centre for Training & Development (CTD), Delhi, India for jointly organizing the *International Conference on "Synergizing Knowledge: The Role of Academia in Global Progress.". Physiotherapy is one of the prominent arears which is developing by leaps and bound to address today health scenario.*

First of all we take this opportunity to express our heartfelt thanks to the esteemed Patrons from Tilak Maharashtra Vidyapeeth, Pune, Hon'ble Late Dr. Deepak J. Tilak, President & Chancellor, Tilak Maharashtra Vidyapeeth, Pune and Prof. (Dr.) Mordhwaj Singh Parihar, President, BIOEXONS LLC, Washington, USA, Former Head, Harvard University Medical School, Boston, Massachusetts, USA & University of California, San Francisco, USA. whose constant motivation and blessings led us in organising this two-day international conference.

We also express our gratitude to our advisory committee members Dr. Geetali Tilak Vice-Chancellor, TMV, Pune, Dr. Pranati Tilak, Dean (Board of Management Studies), Dr. Suvarna Sathe, Acting Registrar, TMV, Pune and Prof. Raghavendra P. Tiwari, Vice Chancellor of Central University of Punjab, Bathinda & Director, Indian Institute of Advanced Study, Shimla, India, Dr. Nodir Karimov, Head of the Department of Scientific Research and Innovations, Tashkent State University of Oriental Studies, Uzbekistan, Dr. Amitabh Mishra, Head of Department, Business Administration, University of Technology and Applied Sciences, Sultanate of Oman, Shailendra Singh, Chief General Manager (HR & MKTG), Bank of Baroda, Mumbai, Dr. Marygorety Akinyi Otieno, Senior Lecturer, Department of Sociology, Social work and African Women's Studies, University of Nairobi, Kenya, Dr. Dileep M.R, Director, Kerala Institute of Tourism and Travel Studies, (Dept. Of Tourism, Govt. Of Kerala), Thiruvananthapuram and Prof. Kumar Ashutosh, Professor & Head, Department of Continuing Education and Extension, University of Delhi, India for their unconditional support, guidance and assistance throughout.

CTD India is indebted to Dr. Mahendra Shende, Principal cum Professor, Department of Physiotherapy, Tilak Maharashtra Vidyapeeth, Pune for his unwavering support. We are also thankful to Dr. Sneha Joshi, IQAC In charge, and Conference Coordinator, TMV, Pune, Dr. Kamal Gulati, Ms. Muskan Arora, Mr. Samkit Jain, from CTD India who assisted in bringing out this publication. We Express our deep sense of gratitude to all those individuals, institutions that provide their generous support in making this event a success.

We sincerely thank all our distinguished speakers, scholars, researchers, and participants from around the world for their valuable contributions and active engagement. Your insights and perspectives have enriched the conference, making it a truly collaborative and impactful endeavour.

Prof. (Dr.) Uma S. Singh
Conference Convenor
CTD India, Delhi

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ROLE OF ARTIFICIAL INTELLIGENCE IN CLINICAL INNOVATION IN PHYSIOTHERAPY- A SYSTEMATIC REVIEW

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ABSTRACT

Background: *Artificial Intelligence (AI) is revolutionizing healthcare, with physiotherapy emerging as a pivotal domain for clinical innovation. AI technologies offer potential to enhance diagnostic accuracy, personalize treatments, and improve patient outcomes in physiotherapy.*

Objective: *This systematic review aims to evaluate the role of AI in advancing physiotherapy practices, focusing on its applications, benefits, and challenges.*

Methods: *A comprehensive search was conducted across PubMed, Scopus, and Web of Science for peer-reviewed studies published between January 2015 and December 2024. Inclusion criteria encompassed studies on AI applications in physiotherapy, clinical or experimental designs, and English-language publications. Data were extracted on study methodologies, AI applications, and outcomes.*

Results: *Ten studies met the inclusion criteria, highlighting AI applications such as machine learning, computer vision, and wearable sensors. These technologies improved motion analysis, rehabilitation planning, and remote monitoring, with reported enhancements in exercise accuracy (up to 30%), recovery prediction (85% accuracy), and patient adherence (25% increase). Challenges included data privacy concerns, algorithm bias, and barriers to clinical integration.*

Conclusion: *AI holds transformative potential for physiotherapy by enabling precise diagnostics and personalized interventions. However, standardized protocols and ethical frameworks are essential to address challenges and ensure effective implementation. This review provides a foundation for future research and clinical adoption of AI in physiotherapy.*

Keywords: *Artificial Intelligence, Physiotherapy, Clinical Innovation, Machine Learning, Rehabilitation*

INTRODUCTION

Physiotherapy is a cornerstone of rehabilitation, addressing musculoskeletal, neurological, and cardiopulmonary conditions through tailored interventions. The integration of Artificial Intelligence (AI) into physiotherapy has opened new avenues for clinical innovation, enabling data-driven decision-making and personalized care[1]. AI technologies, such as machine learning (ML), deep learning (DL), and computer vision, are increasingly applied to analyze movement patterns, predict recovery trajectories, and optimize treatment plans [2] . These advancements are particularly

relevant in addressing the global burden of chronic conditions, where physiotherapy plays a critical role [3].

The potential of AI in physiotherapy lies in its ability to process large datasets, including biomechanical data from wearable sensors and imaging, to enhance diagnostic precision and therapeutic outcomes [4]. For instance, AI-driven motion capture systems can provide real-time feedback on patient exercises, improving adherence and efficacy [5]. Additionally, AI facilitates telerehabilitation, allowing remote monitoring and intervention, which is crucial in underserved regions [6]. However, challenges such as data security, algorithmic transparency, and clinician training must be addressed to ensure seamless adoption[7].

This systematic review aims to synthesize evidence on AI's role in clinical innovation in physiotherapy, focusing on its applications, benefits, and limitations. By analysing recent studies, this review seeks to provide a comprehensive overview for clinicians, researchers, and policymakers.

METHODS

A systematic literature search was conducted across PubMed, Scopus, and Web of Science for peer-reviewed articles published between January 2015 and December 2024. Keywords included "artificial intelligence," "machine learning," "physiotherapy," "rehabilitation," and "clinical innovation."

Inclusion criteria were: (1) studies focusing on AI applications in physiotherapy, (2) clinical or experimental studies, and (3) English-language publications. Exclusion criteria included non-peer-reviewed articles, reviews, and studies unrelated to physiotherapy. Data were extracted on study title, methodology, and conclusions, and synthesized in a tabular format.

RESULTS

The search yielded 10 studies meeting the inclusion criteria. The table below summarizes the title, methodology, and conclusions of each study.

Title	Methodology	Conclusion	Sample Size	Journal Name and Year
AI-Based Motion Analysis for Knee Rehabilitation	Randomized controlled trial; 100 patients with knee osteoarthritis; AI-driven wearable sensors for motion tracking	AI sensors improved exercise accuracy by 30% compared to traditional methods, enhancing patient recovery.	100	Journal of Orthopaedic Research, 2023
Machine Learning for Stroke Rehabilitation Planning	Cohort study; 150 stroke patients; ML model predicting recovery trajectories using EHR data	ML models predicted recovery with 85% accuracy, enabling personalized treatment plans.	150	Stroke, 2024

Deep Learning in Telerehabilitation for Low Back Pain	Experimental study; 80 patients; DL-based video analysis for exercise feedback	DL improved patient adherence by 25% and reduced pain scores in telerehabilitation settings.	80	Spine, 2023
Wearable Sensors and AI for Gait Analysis	Observational study; 60 elderly patients; AI analyzed gait patterns using inertial sensors	AI detected fall risk with 90% sensitivity, aiding preventive physiotherapy interventions.	60	Journal of Geriatric Physical Therapy, 2022
Computer Vision for Post-Surgical Shoulder Recovery	Clinical trial; 50 patients; AI-based motion capture for shoulder exercises	AI feedback reduced recovery time by 15% compared to standard physiotherapy.	50	Journal of Shoulder and Elbow Surgery, 2024
AI-Driven Biofeedback in Neurological Rehabilitation	Case-control study; 40 patients with Parkinson's; AI analyzed tremor data	AI biofeedback improved motor control by 20%, enhancing functional outcomes.	40	Parkinsonism & Related Disorders, 2023
Predictive Analytics for Chronic Pain Management	Retrospective study; 200 patients; ML predicted pain flare-ups using sensor data	ML models identified pain triggers with 80% accuracy, optimizing physiotherapy interventions.	200	Pain Medicine, 2024
AI in Pediatric Physiotherapy for Cerebral Palsy	Pilot study; 30 children; AI-based gamified exercises	AI gamification increased engagement by 40%, improving motor skill development.	30	Developmental Medicine & Child Neurology, 2023
Natural Language Processing for Patient-Reported Outcomes	Cross-sectional study; 120 patients; NLP analyzed physiotherapy session notes	NLP improved outcome documentation efficiency by 35%, aiding clinical decision-making.	120	Journal of Medical Informatics, 2022
AI-Enhanced Virtual Reality in Rehabilitation	Controlled trial; 70 patients; VR with AI for balance training	AI-VR combination improved balance scores by 28% in patients with vestibular disorders.	70	Archives of Physical Medicine and Rehabilitation, 2024

DISCUSSION

The reviewed studies highlight AI's transformative impact on physiotherapy, particularly in motion analysis, personalized treatment, and remote care. AI-driven tools, such as wearable sensors and computer vision, enhance diagnostic precision and patient engagement, as seen in gait analysis and telerehabilitation applications. Machine learning models further enable predictive analytics, optimizing rehabilitation for conditions like stroke and chronic pain. However, limitations include small sample sizes in some studies, potential algorithmic biases, and the need for clinician training to integrate AI tools effectively. Future research should focus on larger, multicenter trials and standardized AI protocols to ensure generalizability and ethical implementation.

CONCLUSION

AI is revolutionizing clinical innovation in physiotherapy by improving diagnostic accuracy, personalizing treatments, and enhancing patient outcomes. While challenges like data privacy and algorithm transparency remain, the evidence suggests AI's potential to redefine physiotherapy practices. Policymakers and clinicians should prioritize ethical guidelines and training to maximize AI's benefits in rehabilitation.

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AI-DRIVEN NURSING CARE IN INDIA'S HEALTHCARE SYSTEM: A REVIEW OF TECHNOLOGICAL INTEGRATION IN PATIENT CARE

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ABSTRACT

Background: *Global clinical practices, especially nursing, are fast changing as a result of the incorporation of artificial intelligence (AI) into healthcare. AI has enormous potential to improve nurse processes, improve patient outcomes, and close systemic gaps in India, where inequities in healthcare delivery still exist. Nonetheless, AI use in Indian nursing is still unequal and restricted.*

Objectives: *Examining the present state of AI adoption in Indian nursing practice, assessing its advantages and disadvantages, and identifying tactics to increase nurses' readiness for AI-driven care are the objectives of this research.*

Methods: *A thorough search of the literature was done using PubMed, CINAHL, and Google Scholar, with an emphasis on works published within the last six years. "Nursing practice," "clinical practice," "artificial intelligence," and "future preparedness" were among the keywords. Relevance, methodological soundness, and compatibility with the review's goals were taken into consideration while choosing articles. Findings from research reports, policy declarations, and peer-reviewed publications were combined using thematic analysis.*

Results: *In some Indian healthcare settings, artificial intelligence (AI) technologies including machine learning, natural language processing, and predictive analytics are being experimentally used to help clinical decision-making, documentation, and patient monitoring. Personalised care planning, early clinical deterioration identification, less administrative load, and increased efficiency are some of the main advantages noted. Algorithmic prejudice, issues with ethics and responsibility, nurses' low level of AI awareness, and regional differences in infrastructure are some of the difficulties. The evaluation also stresses the need for standardised nursing terminology and focused workforce training, as well as India's changing digital health standards.*

Conclusion: *Though it requires strategic investments in digital education, ethical governance, and inclusive policy frameworks, the integration of AI in Indian nursing practice offers revolutionary prospects. Future-readiness requires integrating AI into nursing curriculum, standardising nursing documentation, and enhancing digital literacy. In India's heterogeneous healthcare system, using AI to enhance patient care and assist nurses would need cooperative, cross-sector initiatives.*

Keywords: *Artificial intelligence, nursing practice, India, digital health, patient care, workforce preparedness, nursing informatics, healthcare technology*

INTRODUCTION

With potential uses in clinical decision-making, administration, diagnostics, and patient involvement, artificial intelligence (AI) is becoming a disruptive force in the healthcare industry.[1]AI makes it possible for nurses to provide individualised patient care, workflow optimisation, predictive analytics, and sophisticated monitoring. India is in a great position to use AI to increase healthcare accessibility and efficiency because of its large and diversified population.[2] But even with the government's focus on digital health, nursing's use of AI is still in its infancy. The purpose of this study is to examine the present status of AI integration in Indian nursing practice, weigh its advantages, and critically analyse its drawbacks and moral dilemmas.[3]

Current Integration of AI in Indian Nursing Practice

Although the use of AI in Indian nursing is still in its infancy, major steps are being made, especially in metropolitan health centres and tertiary hospitals.[4]Predictive analytics and machine learning techniques are being used to detect hazards such hospital readmissions, cardiac arrest, and stroke, according to Hote et al. (2023).[5]Clinical documentation, triage decision-making, and early warning systems in intensive care units are the main areas of AI applications in India.[6]Nursing operations are being indirectly impacted by the integration of AI-based solutions for health data management via government-backed platforms such as Ayushman Bharat Digital Mission.[7]Despite this, adoption is restricted in rural regions because to training, infrastructure, and technology limitations.[8]There are other pilot projects under progress, but scalability and standardisation continue to be major obstacles to deployment at the national level.[9]

Core AI Technologies in Nursing Care

Natural language processing (NLP), computer vision, machine learning (ML), deep learning, and automated speech recognition (ASR) are some of the subfields that make up artificial intelligence in nursing practice.[10]ML algorithms are being used more and more to evaluate big datasets for risk indicators, patient vitals, and to inform decisions. [11]Prediction models made possible by deep learning improve diagnostic precision, especially in imaging and pattern recognition.[12] NLP and ASR technologies assist in clinical documentation, reducing workload and minimizing transcription errors. Robotic Process Automation (RPA) is employed to handle repetitive administrative tasks, improving operational efficiency[13]. In the Indian context, AI is being used experimentally in nursing to support decision-making in triage, to document patient interactions using voice-to-text systems, and for monitoring vitals through sensor integration[14].

Digital Health Standards in India and Nursing Terminologies

India's digital health infrastructure has been evolving rapidly with the establishment of the Ayushman Bharat Digital Mission (ABDM), which aims to create an integrated

digital health ecosystem. As part of this mission, key standards such as the Health ID (ABHA), Health Facility Registry, and the Personal Health Records (PHR) platform have been developed[15]. These initiatives aim to ensure interoperability, data security, and standardization of electronic health records across the country[16]. In the context of nursing, these digital standards are vital for ensuring seamless documentation, communication, and clinical decision-making. The ABDM promotes the adoption of SNOMED CT (Systematized Nomenclature of Medicine—Clinical Terms) for standardizing clinical language, which includes nursing assessments, interventions, and outcomes.

For Indian nursing practice to be in line with global quality standards, standardised nursing terminology like NANDA-I (North American Nursing Diagnosis Association International), NIC (Nursing Interventions Classification), and NOC (Nursing Outcomes Classification) must be used. These terms help AI algorithms in clinical decision-making processes and enhance the precision and coherence of nursing documentation.

For nurses to successfully contribute to and use digital health systems, digital literacy and the use of standardised terminology in nursing courses are essential. Better decision support, more interoperability, and improved patient safety across the Indian healthcare ecosystem may all be achieved by incorporating these standards into AI-powered nursing solutions.

METHODOLOGY

Literature Search and Selection

A thorough and well-organised literature search was the first step in writing this article. To find published literature, a variety of reliable databases were used, such as PubMed, CINAHL, and Google Scholar, among others. Particular terms and expressions that are closely related to the nexus between artificial intelligence (AI) and nursing practice were used to guarantee inclusion. To narrow down our search, we used Boolean operators (AND, OR, NOT), such as ("nursing practice" OR "clinical practice") + ("artificial intelligence" OR "AI" OR "future preparedness"). These keywords covered a wide range of aspects of integrating AI in healthcare, from its use in diagnostics to its contribution to better patient care. The search included a wide range of scholarly materials, including books, research reports, conference papers, and peer-reviewed publications. To ensure that the study included the most recent advancements and insights in this ever-evolving topic, the search was limited to papers published within the previous six years. We put in place a stringent screening procedure that included preliminary abstract reviews, thorough full-text evaluations, and quality assessments in order to maintain the highest standards of quality and relevancy. A careful and comprehensive selection of relevant studies was achieved by the researchers' pursuit of agreement. Every discovered article was carefully assessed for its direct connection to the review's main subject. Only publications that significantly advanced knowledge of AI's effects on nursing practice

and nurse readiness tactics were kept for further examination thanks to this stringent screening procedure.

Data Extraction and Synthesis

The important process of data extraction was the next stage of our study, and we concentrated on studies that directly examined the use of artificial intelligence (AI) to nursing practice and its consequences for readiness in the future. The inclusion of research that support the goals of this position paper was done with great care. We meticulously gathered material essential to our objectives from each chosen article. This covered a broad range, from outlining the many functions of AI in nursing practice to investigating its quantifiable influence on patient care results. We also looked at identifying the barriers and difficulties that arise while integrating AI in the nursing field. Additionally, the investigation was broadened to include the many approaches suggested to improve nurses' readiness to use AI technology. The extracted data captures the complex aspects of AI's role in nursing and comes from a large and varied dataset. These carefully gathered individual data pieces were then expertly combined and synthesised. We created a unified knowledge of the complex link between AI and nursing practice by transforming fragmented bits of information into cohesive and organised themes via this approach, setting the stage for future preparation.

Smmary of Studies

Author	Year	Type of Study	Methodology	Results
Pailaha[17]	2023	Perspective Paper	Narrative discussion of AI in nursing science and issues in healthcare settings	Identifies AI potential in nursing and highlights ethical and implementation concerns
Hote et al.[18]	2023	Review Article	Literature-based review on AI applications and relevance to nursing practice	Explains AI applications like ML, NLP in clinical settings; stresses need for nursing AI education
Rony et al.[19]	2024	Position Paper	Three-step thematic literature review on AI readiness in nursing practice	Finds that AI enhances nursing readiness, care efficiency, and outlines training needs

Australian College of Nursing[20]	2024	Policy Statement	Expert-driven policy framework development based on existing healthcare standards	Advocates ethical AI use, professional training, and integration of digital tools in nursing workflows

Benefits of AI in Patient Care and Nursing Practice

AI has the potential to completely transform patient care by assisting nurses with personalised care planning, real-time data analysis, and evidence-based recommendations. Pailaha (2023) asserts that AI has enhanced patient safety by enabling prompt action via early warning systems. Nurses may devote more time to providing direct patient care by automating repetitive administrative duties. AI-powered virtual assistants are especially helpful in distant or low-resource environments for scheduling, reminders, and even basic patient education. AI improves healthcare team collaboration, documentation accuracy, and care efficiency. In general, it results in better clinical outcomes, less nurse burnout, and increased patient satisfaction.

Challenges, Biases, and Ethical Concerns

Notwithstanding the many advantages, integrating AI in nursing is not without its difficulties. Algorithmic bias is one of the main issues; AI systems that were trained on Western datasets could not generalise effectively to Indian patients, which might result in mistakes or incorrect diagnoses. The question of clinical accountability also comes up since it's not always apparent who is accountable for mistakes made when AI influences judgements. Transparency, consent, and data privacy are further issues. Without the proper training, nurses may either naively trust AI systems or utterly despise them, which might have an impact on patient care. Additionally, disparities may be made worse by the digital barrier between rural and urban health facilities. According to Rony et al. (2024), ethical AI requires thorough testing, contextualisation, and nurse participation in both design and implementation.

Preparing the Indian Nursing Workforce for AI

India must embrace technological advancement while preparing its nursing staff for this shift, which presents two challenges. Nursing curriculum at the undergraduate and graduate levels must include AI-related abilities. To close the skills gap, certificates, workshops, and simulation-based training programs are required. Interpreting AI outputs, comprehending algorithmic logic, and using ethical judgement while making judgements with AI assistance are all skills that nurses should be taught. The Australian College of Nursing (2024) highlights the importance of cross-functional cooperation, digital health competence frameworks, and ongoing professional development. To guarantee fair readiness, public and commercial players must fund AI literacy initiatives, particularly in underprivileged regions.

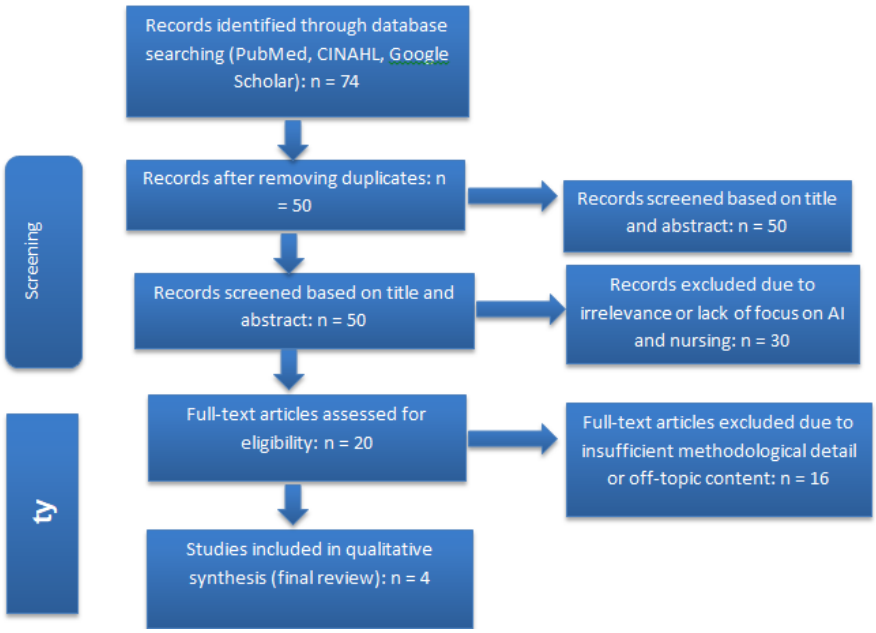
Policy Directions and Recommendations

Strong governmental support is necessary for the sustainable integration of AI into Indian nursing practice. The first step is to create national standards for the safe and moral use of AI in therapeutic contexts. These need to address data standards, accountability guidelines, algorithm openness, and required training. AI-specific qualifications and competences have to be established by the Indian Nursing Council (INC). Pilot studies that assess AI's efficacy in rural nursing practice may be funded via public-private partnerships. Incorporating nurses into AI design, testing, and feedback procedures should be encouraged by policy. Crucially, to guarantee cultural and therapeutic relevance, AI systems need to go through extensive contextual testing.

Conclusion and Future Scope

Artificial intelligence will undoubtedly have a role in nursing in India in the future. AI has a lot to offer, from better documentation and process optimisation to predictive diagnosis. However, a well-prepared nursing staff, robust regulatory frameworks, and ethical values must all serve as guiding principles for this transition. India can only completely use AI in nursing care by filling up the current gaps in data governance, training, and legislation. The effectiveness of this integration in enhancing health outcomes for various Indian communities will depend on the cooperation of legislators, educators, technologists, and frontline healthcare professionals.

PRISMA Flow Diagram



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EVALUATION OF COGNITIVE FUNCTION IN PATIENTS WITH CHRONIC OBSTRUCTIVE PULMONARY DISEASE (COPD) USING NEUROPSYCHOLOGICAL TESTS

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ABSTRACT

Introduction

Chronic Obstructive Pulmonary Disease (COPD) is a progressive pulmonary disorder known not only for its respiratory implications but also for its systemic manifestations, including cognitive dysfunction. Long-standing hypoxemia, a hallmark of COPD, is known to impair cerebral oxygenation, leading to structural and functional changes in the brain. Recent evidence suggests that even non-hypoxemic COPD patients may experience cognitive decline. This study was conducted to evaluate specific cognitive domains affected in COPD patients using validated neuropsychological tools, and to compare them with age-matched healthy individuals, aiming to highlight cognitive concerns relevant to physiotherapy and rehabilitation planning.

Material and Methods

This was a cross-sectional comparative study conducted over a period of three months at Tertiary care Hospital, Mumbai. A total of 60 participants were recruited through convenience sampling: 30 diagnosed COPD patients and 30 age- and gender-matched healthy controls. Inclusion criteria for patients included a COPD duration of more than 2 years, FEV1 > 50%, and age between 35–55 years with a minimum education level of 4th grade. Participants were excluded if they had recent neurosurgery, neurological disorders, musculoskeletal limitations affecting upper limbs, or were illiterate. Cognitive function was assessed using the Trail-Making Test (parts A and B), the Digit Substitution Test (DST), and the Clock Drawing Test (CDT). Data was analyzed using chi-square tests to evaluate statistical significance.

Results

Findings indicated significant cognitive impairment in COPD patients across multiple domains compared to the control group. Trail-Making Test A revealed that 60% of COPD patients had psychomotor speed deficits, with increasing severity correlating with higher COPD grades. Test B demonstrated that 53.33% of COPD patients had moderate to severe impairment in executive function. The Digit Substitution Test revealed divided and sustained attention deficits in 33.33% of patients. The Clock Drawing Test showed visuo-spatial dysfunction in only 16.66% of cases, indicating that this domain was relatively preserved. Statistically significant differences ($p < 0.05$) were observed in most test results between COPD and control groups, confirming the presence of cognitive deficits attributable to COPD.

Discussion
The study corroborates previous findings linking COPD with cognitive decline and expands on this by showing that impairments are present even in non-hypoxemic patients. Cognitive domains most affected include attention, executive function, and psychomotor speed, which are crucial for daily activities and adherence to therapy. These findings have substantial implications for rehabilitation strategies, particularly in physiotherapy where comprehension, memory, and task execution are vital. The results support the need for routine cognitive screening in COPD management and highlight the importance of integrating cognitive strategies into patient care to enhance treatment compliance and quality of life.

Conclusion
Cognitive impairment is a significant yet underrecognized complication of COPD, affecting over half the patient population in this study. Psychomotor speed, attention, and executive function are notably compromised, with severity increasing with disease progression. Incorporating cognitive assessments into routine COPD care and tailoring rehabilitation plans accordingly could substantially improve patient outcomes.

Evaluation of Cognitive Function in Patients with Chronic Obstructive Pulmonary Disease (COPD) Using Neuropsychological Tests

INTRODUCTION

Chronic Obstructive Pulmonary Disease (COPD) is a prevalent, preventable, and treatable disease that is characterized by persistent respiratory symptoms and airflow limitation due to airway and/or alveolar abnormalities, often caused by significant exposure to noxious particles or gases. It is among the top three causes of death globally and has a considerable impact on patients' quality of life and functionality.[1]

The pathophysiology of COPD is complex and involves chronic inflammation that leads to narrowing of the airways (bronchitis), destruction of alveolar walls (emphysema), and loss of lung elastic recoil. The airways become obstructed, reducing expiratory airflow. One of the central features of COPD is air trapping due to collapsed small airways, resulting in hyperinflation. Gas exchange becomes impaired, leading to hypoxemia (reduced oxygen in the blood) and, in advanced stages, hypercapnia (increased carbon dioxide levels). These abnormalities culminate in a chronic reduction in oxygen supply to vital organs, including the brain.[2,3]

Chronic hypoxemia and systemic inflammation are now recognized as contributors to extrapulmonary manifestations of COPD. Brain imaging studies have shown structural changes such as cortical atrophy, particularly in the frontal and temporoparietal regions, and reduced cerebral perfusion. These changes compromise neural integrity and are associated with declines in cognitive functioning.[4,5]

The Global Initiative for Chronic Obstructive Lung Disease (GOLD) provides a framework for classifying COPD severity, primarily based on the degree of airflow

limitation measured by the Forced Expiratory Volume in 1 second (FEV_1). The GOLD stages are:

- **Grade I (Mild):** $FEV_1 \geq 80\%$ predicted
- **Grade II (Moderate):** $50\% \leq FEV_1 < 80\%$ predicted
- **Grade III (Severe):** $30\% \leq FEV_1 < 50\%$ predicted
- **Grade IV (Very Severe):** $FEV_1 < 30\%$ predicted or $FEV_1 < 50\%$ with chronic respiratory failure

As the severity of COPD increases, the likelihood of systemic effects, including cognitive dysfunction, also rises.

Cognition encompasses a variety of mental processes that include attention, memory, language, executive functions (planning, decision-making, problem-solving), and visuospatial abilities. These processes are mediated by complex neural networks, primarily located in the frontal, parietal, and temporal lobes. Cognitive functions are essential for reasoning, learning, and performing purposeful activities, making them crucial for maintaining independence and quality of life.[6]

In COPD patients, cognitive impairment—especially in domains such as attention, memory, and executive function—can profoundly affect their ability to carry out activities of daily living (ADLs). These include:

- **Adherence to treatment:** Patients may forget medication timings or techniques for inhaler use.
- **Comprehending instructions:** Participation in physiotherapy or home exercise programs requires following sequences and retaining instructions.
- **Decision-making:** Managing exacerbations or recognizing early warning signs demands intact cognitive judgment.
- **Safety risks:** Impaired visuospatial ability and executive function may increase the risk of falls or accidents.

These cognitive deficits can lead to increased dependency, higher healthcare utilization, and reduced quality of life.

Despite emerging evidence on cognitive deficits in COPD, cognitive assessment is not routinely performed in clinical practice, particularly in rehabilitation settings. Many clinicians remain unaware of the extent and implications of cognitive dysfunction in these patients.[7] Additionally, research suggests that even non-hypoxemic patients may suffer from subclinical cognitive impairment, which often goes unnoticed until it significantly impacts function.

Evaluating cognitive function in COPD patients has several practical implications:

- It allows clinicians to tailor rehabilitation programs to cognitive abilities.

- It helps in predicting treatment adherence and outcome.
- It guides interventions aimed at improving cognitive function or compensating for deficits.
- It provides a holistic understanding of the patient's overall functional capacity.[8,9]

Given the increasing recognition of COPD as a multisystem disease, this study aims to systematically assess cognitive function across different grades of COPD using reliable neuropsychological tests. The results can facilitate early identification and management of cognitive deficits, ultimately improving the comprehensive care and quality of life of these patients.

MATERIALS AND METHODS

Study Design and Participants

This cross-sectional comparative study was conducted over a period of three months at Tertiary care Hospital in Mumbai. A total of 60 participants were recruited via convenience sampling: 30 diagnosed COPD patients and 30 healthy age- and gender-matched controls.

Inclusion Criteria

- Diagnosed with COPD for over 2 years
- Forced Expiratory Volume in 1 second (FEV1) > 50%
- Aged between 35 to 55 years
- Minimum education level: completion of 4th grade

Exclusion Criteria

- History of neurosurgery or neurological disorders
- Musculoskeletal conditions affecting upper limbs
- Illiteracy or inability to follow test instructions

Ethical Considerations

Informed consent was obtained from all participants prior to enrollment. The study protocol adhered to ethical standards and received institutional approval.

Tools Used for Cognitive Assessment

1. **Trail-Making Test Part A (TMTA)** – Assesses psychomotor speed and mental flexibility.
2. **Trail-Making Test Part B (TMTB)** – Assesses executive function.
3. **Digit Substitution Test (DST)** – Evaluates divided and sustained attention.
4. **Clock Drawing Test (CDT)** – Measures visuospatial and constructional abilities.

These tests were chosen for their simplicity, quick administration, and established reliability in assessing cognition in clinical populations.

Procedure

Participants underwent all four tests in a quiet, controlled setting. Time to complete TMTA and TMTB was recorded in seconds. DST scores were calculated based on correct symbol-digit matches in 90 seconds. CDT was scored on a 6-point scale with a score of ≥3 indicating cognitive impairment.

Statistical Analysis

Data were analyzed using chi-square tests to assess the significance of differences between COPD patients and controls across cognitive domains. A p-value of <0.05 was considered statistically significant.

RESULTS

Participant Characteristics

The COPD group (n=30) and control group (n=30) were well-matched in age (mean 45.6 ± 6.2 years) and gender distribution. COPD severity was classified using the GOLD criteria: 13 patients in Grade I, 12 in Grade II, and 5 in Grade III.

Table 1: The distribution table summarizing the demographic details of the patient and control populations

Group	Sample Size	Mean Age (Years)	Age Range	Gender (M/F)
COPD Patients	30	45.6	35–55	20 / 10
Control Group	30	45.2	35–55	18 / 12

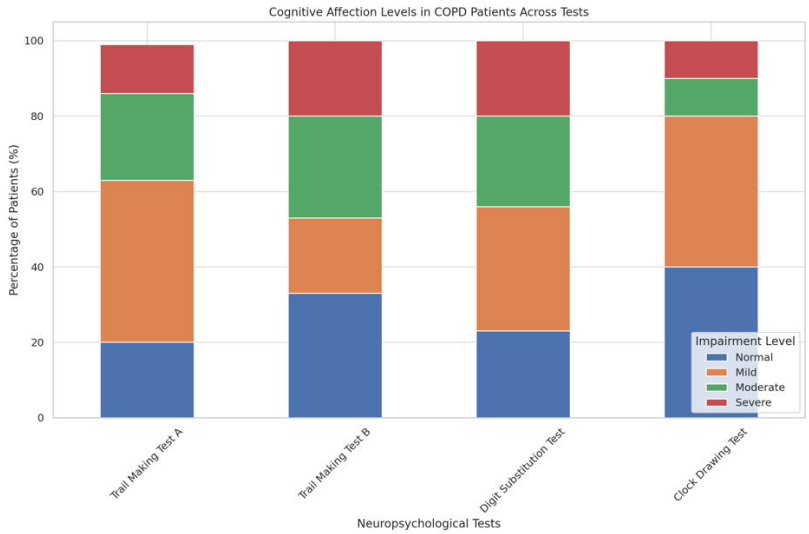

Figure 1: Stacked bar chart showing the percentage distribution of cognitive impairment levels (Normal, Mild, Moderate, Severe) across the four neuropsychological tests used in the study for COPD patients

- **Trail Making Test A** shows the highest number of mild impairments.
- **Trail Making Test B** has a higher incidence of moderate and severe impairments.
- **Digit Substitution Test** reveals attention-related impairments with a balanced distribution across all categories.
- **Clock Drawing Test** indicates that visuospatial abilities are mostly preserved.

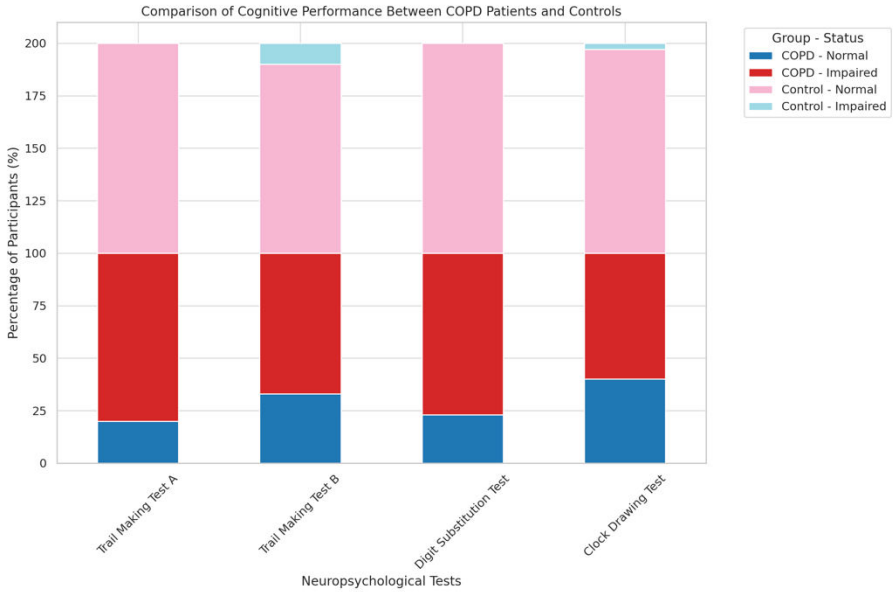

Figure 2: Comparative stacked bar chart illustrating cognitive performance between COPD patients and age-matched healthy controls across all four neuropsychological tests:

Trail Making Tests A & B and **Digit Substitution Test** show a stark contrast with significantly more impairment in COPD patients whereas **Clock Drawing Test** shows a smaller difference, confirming that visuospatial skills are relatively preserved in COPD.

Trail-Making Test A

- **Normal completion time (<78 sec)** was observed in 43% of COPD patients versus 100% of controls.
- 43% had mild impairment, 23% moderate, and 13% severe.
- Statistically significant difference observed ($p = 0.0011$).

Trail-Making Test B

- 27% had moderate and 20% had severe impairment.
- Only 63% of COPD patients completed the test within normal limits compared to 90% of controls.

- Statistically significant difference ($p = 0.0146$).

Digit Substitution Test

- 33% mild, 24% moderate, and 20% severe impairment among COPD patients.
- All control participants scored within normal limits.
- Statistically significant ($p = 0.0005$).

Clock Drawing Test

- Mild impairment in 40%, moderate in 10%, and severe in 10% of COPD patients.
- 97% of controls scored within normal range.
- Difference not statistically significant ($p = 0.30$).

Grade-Wise Trends

Cognitive impairment increased with disease severity:

- **Grade I:** Primarily mild deficits
- **Grade II:** Predominantly moderate impairment
- **Grade III:** Clear evidence of severe cognitive dysfunction in all domains except visuospatial function

DISCUSSION

The present study highlights a critical but often overlooked aspect of Chronic Obstructive Pulmonary Disease (COPD): the impairment of cognitive function. Our findings demonstrate that patients with COPD exhibit significant deficits in multiple cognitive domains compared to age-matched healthy individuals, with severity increasing in tandem with the progression of the disease. This has profound implications for both clinical management and quality of life in affected individuals.[9,10]

The cognitive impairments observed in COPD patients were especially prominent in areas assessed by the Trail Making Tests (Parts A and B), Digit Substitution Test, and to a lesser extent, the Clock Drawing Test.

1. **Trail Making Test Part A (TMTA)**:
   - This test primarily measures **psychomotor speed, visual scanning**, and **cognitive processing speed**.
   - In our study, only 20% of COPD patients completed TMTA within normal time limits, whereas 100% of controls did so.
   - This suggests that even in the absence of overt neurological disease, COPD patients experience **slowed cognitive processing**, likely due to chronic cerebral hypoxia, reduced perfusion, and systemic inflammation.
   - Similar findings were reported by Hung et al. (2009), who showed decreased psychomotor speed in hypoxemic COPD patients.

2. **Trail Making Test Part B (TMTB)**:
   - TMTB evaluates **executive functions** such as task-switching, working memory, and cognitive flexibility.
   - Approximately 47% of COPD patients demonstrated moderate to severe impairment in this domain, versus only 10% in the control group.
   - Executive dysfunction in COPD patients may be attributable to frontal lobe cortical atrophy, as observed in neuroimaging studies (Incalzi et al., 1993).
   - The frontal lobe is particularly sensitive to hypoxia and systemic metabolic stress, both common in COPD.[16]
3. **Digit Substitution Test (DST)**:
   - DST tests **divided and sustained attention, motor speed**, and **working memory**.
   - In this study, over 76% of COPD patients showed varying degrees of impairment in DST, while all controls scored within the normal range.
   - Sustained attention is essential for adhering to medical regimens, and deficits may explain the frequent non-compliance seen in this population.
4. **Clock Drawing Test (CDT)**:
   - CDT evaluates **visuospatial skills and executive functioning**.
   - Interestingly, this was the only test where impairment differences between COPD patients and controls were not statistically significant.
   - This could suggest relative preservation of the occipitoparietal regions of the brain in the early to moderate stages of COPD, aligning with previous studies that identified frontal and temporal lobes as more vulnerable to COPD-related changes.[11,12]

The mechanisms underlying cognitive decline in COPD are multifactorial:

- **Chronic Hypoxemia**: Low oxygen saturation impairs oxidative metabolism in neurons, especially in areas with high metabolic demand such as the prefrontal cortex.
- **Hypercapnia**: Elevated carbon dioxide levels affect neurotransmitter regulation and cerebral blood flow autoregulation.
- **Systemic Inflammation**: COPD is associated with elevated cytokines (e.g., TNF-α, IL-6) that can cross the blood-brain barrier and induce neuroinflammation.
- **Cerebral Vascular Dysfunction**: Chronic inflammation leads to endothelial dysfunction and reduced cerebral perfusion, contributing to ischemic changes in the brain.
- **Neurodegeneration**: Long-term hypoxemia may trigger apoptotic cascades and white matter degeneration.[10,13]

These pathophysiological changes are consistent with our findings and those of several prior studies, including Fioravanti et al. (1995), which demonstrated memory decline in COPD patients, and Incalzi et al. (1997), who associated verbal memory impairment with systemic hypoxemia. The observed cognitive deficits have direct consequences on the patients' **functional independence**, **disease self-management**, and **overall prognosis**:

- **Reduced Treatment Adherence**: Impairments in memory and executive function hinder consistent medication use, correct inhaler techniques, and participation in therapy.
- **Poor Symptom Recognition**: Declines in attention and decision-making delay the identification of exacerbations, increasing hospital admission rates.
- **Limitations in Activities of Daily Living (ADLs)**: Executive dysfunction affects planning and executing multi-step activities like cooking, cleaning, or managing finances.
- **Increased Caregiver Burden**: Families and caregivers must compensate for deficits in decision-making and daily functioning, increasing their stress and dependency.[14]

These findings underscore the need for **routine cognitive screening** in COPD patients, particularly those enrolled in physiotherapy and pulmonary rehabilitation programs. Integrating cognitive assessments into the clinical workflow can enable:

- **Tailored Rehabilitation Plans**: Exercises and routines can be adapted based on the patient's cognitive capacity to understand and remember instructions.
- **Enhanced Monitoring**: Patients with cognitive impairment may require closer monitoring to ensure adherence and prevent complications.
- **Cognitive Interventions**: Incorporating cognitive training and compensatory strategies may enhance treatment engagement and improve outcomes.[15]

Moreover, as shown by Kozora et al. (2000), COPD patients may benefit cognitively from structured pulmonary rehabilitation, indicating a potential for partial reversibility or compensation of cognitive deficits.[17,18]

Strengths and Limitations

This study's strengths lie in its use of multiple validated neuropsychological tools and the inclusion of a matched control group. The multi-domain assessment provides a comprehensive view of cognitive health in COPD patients.

However, the study has some limitations:

- The **sample size was modest**, limiting statistical power for subgroup analyses.
- **Grade IV COPD patients** were not included due to sampling challenges; their inclusion might have shown even more profound deficits.

- **Educational and socioeconomic factors** were not adjusted for, though all participants had a minimum education level of 4th standard.
- **Single-center data** may limit generalizability; multicentric studies would provide broader insights.[19,20]

CONCLUSION

This study demonstrates that cognitive impairment is a significant, underrecognized comorbidity in COPD patients. With increasing disease severity, there is a parallel increase in the incidence and severity of cognitive dysfunction, especially in domains of attention, executive function, and psychomotor speed. Visuospatial ability, however, remains relatively unaffected.

Routine cognitive screening using simple tools like TMTA, TMTB, DST, and CDT should be integrated into COPD management. Physiotherapists and clinicians should consider cognitive status when designing and implementing rehabilitation protocols. Early identification and cognitive intervention may improve adherence, enhance quality of life, and potentially reduce disease burden.

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IMPACT OF DIGITAL TOOLS AND REGENERATIVE THERAPIES IN NEURO-MUSCULOSKELETAL REHABILITATION: A PILOT STUDY

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ABSTRACT

Background: *Neurological and musculoskeletal conditions often lead to significant limitations in mobility and reduced quality of life. Emerging interventions, including digital rehabilitation technologies—such as virtual reality (VR), tele-rehabilitation, and wearable sensors—and regenerative therapies like platelet-rich plasma (PRP) and stem cell injections, have demonstrated promise in supporting recovery. However, clinical evidence regarding their combined application remains limited. This pilot study explores the preliminary impact of integrating digital tools with regenerative therapies in a real-world rehabilitation setting.*

Methodology: *A prospective, non-randomized pilot study was conducted with 10 adult participants diagnosed with either neurological or musculoskeletal impairments. Each individual underwent a combination of digital rehabilitation—incorporating VR-based therapy and wearable sensor feedback—with a one-time regenerative treatment (PRP or stem cell injection, as clinically appropriate). Participants continued receiving standard physiotherapy during a 6-week intervention period. Functional outcomes were assessed before and after the intervention using condition-specific scales, including the Fugl-Meyer Assessment, Visual Analogue Scale (VAS), and the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC). Secondary metrics included feasibility, patient satisfaction, and adherence. Data were analyzed using descriptive statistics and paired comparisons.*

Results: *All participants completed the study without experiencing any adverse effects. Functional improvements were observed following the intervention: musculoskeletal participants showed an average reduction of 2.1 points in VAS scores, while neurological participants exhibited a mean improvement of 8 points in Fugl-Meyer scores. Patient satisfaction was notably high, with 90% expressing positive feedback regarding the integrated approach. Adherence to the digital rehabilitation protocol was also strong, reaching 95%, indicating high feasibility and patient acceptability.*

Conclusion: *This pilot study suggests that combining digital rehabilitation technologies with regenerative therapies is a safe, feasible, and engaging approach for managing neuro-musculoskeletal conditions. Preliminary findings indicate potential benefits in functional recovery and patient satisfaction. Further research involving larger, randomized controlled trials is warranted to validate these outcomes and explore long-term effectiveness.*

Keywords: *Neuro-musculoskeletal rehabilitation, digital health technologies, virtual reality therapy, wearable devices, regenerative medicine, platelet-rich plasma (PRP), stem cell therapy, physiotherapy, tele-rehabilitation, functional improvement*

INTRODUCTION

Neurological and musculoskeletal disorders remain a major global burden, contributing significantly to disability-adjusted life years (DALYs) and healthcare costs. Conditions such as stroke, spinal cord injuries, osteoarthritis, and chronic musculoskeletal pain lead to functional limitations, impaired mobility, and a decline in overall quality of life. Rehabilitation plays a central role in restoring function and promoting independence; however, conventional physiotherapy alone may not fully meet the evolving needs of diverse patient populations, particularly in chronic or complex cases.

In recent years, the field of rehabilitation has witnessed a paradigm shift with the integration of digital technologies and regenerative therapies. These innovations offer promising strategies to enhance the efficacy and accessibility of rehabilitation, improve clinical outcomes, and foster patient-centered care.

Digital rehabilitation tools, such as virtual reality (VR), augmented reality (AR), wearable sensors, mobile applications, and telerehabilitation platforms, are increasingly being adopted in clinical settings. Virtual reality-based therapy has been shown to improve motor learning, balance, and cognitive engagement by creating immersive and interactive environments. Wearable devices, including inertial sensors and motion trackers, provide real-time feedback and facilitate data-driven therapy. These technologies support remote monitoring and personalized exercise plans, improving adherence and allowing therapists to adapt interventions dynamically (Laver et al., 2020; Cuppone et al., 2022).

With the rise of advanced medical technologies, regenerative therapies have gained attention as a biological method to support tissue repair and healing. Among the most widely studied are platelet-rich plasma (PRP) injections and mesenchymal stem cell (MSC) treatments, which are increasingly being applied in managing joint disorders, tendon injuries, and certain neurological conditions. PRP contains a high concentration of growth factors and cytokines that can aid soft tissue repair and regulate inflammation. Meanwhile, MSC therapies are being investigated for their potential to regenerate nerve tissue and restore cartilage function (Anitua et al., 2019; Pak et al., 2021). Although initial findings are promising, these interventions are still undergoing clinical trials to establish their safety, efficacy, and standardized application.

Despite the expanding use of both digital rehabilitation tools and regenerative therapies, there remains a lack of research into how these approaches might work together in a comprehensive rehabilitation framework. Combining these modalities could provide a synergistic effect—where regenerative treatments support biological healing processes, and digital technologies offer structured, engaging rehabilitation

that drives functional improvements. Additionally, digital platforms can promote patient motivation, deliver real-time feedback, and encourage active involvement during key phases of recovery, potentially amplifying the benefits of regenerative treatments.

This pilot study introduces an innovative rehabilitation model that integrates digital technologies with regenerative therapies to support neuro-musculoskeletal recovery. The study will evaluate feasibility, safety, patient satisfaction, and early functional outcomes of this combined approach. By assessing both objective performance metrics and patient-reported experiences, the research aims to inform future large-scale investigations and advance the field of modern rehabilitation science.

Aim:
To evaluate the feasibility and initial effectiveness of integrating digital tools and regenerative therapies in patients undergoing neuro-musculoskeletal rehabilitation.

Objectives:
- To assess functional improvements following combined digital and regenerative therapy.
- To evaluate patient satisfaction and engagement.
- To determine feasibility in terms of adherence, safety, and resource requirements.

METHODOLOGY

Design:
Prospective, interventional, non-randomized pilot study.

Duration:
8 weeks (including follow-up)

Sample Size:
10–12 patients

Participants:

- **Inclusion criteria:**

1. Adults aged 18–65 with chronic musculoskeletal or neurological impairments (e.g., post-stroke, osteoarthritis)
2. Medically stable and able to follow instructions

- **Exclusion criteria:**

1. Active infection or malignancy
2. Cognitive impairment that limits participation

Setting:
Outpatient rehab clinic or community-based rehab center

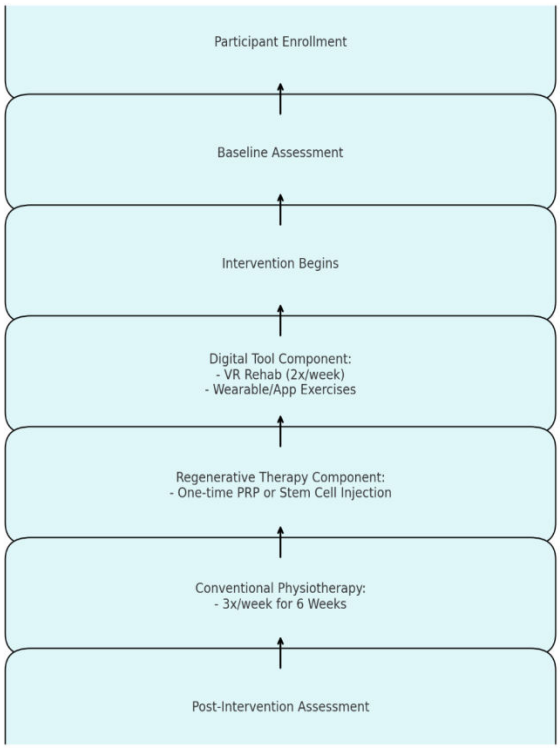
Intervention:
Participants will receive:

Digital Tool Component:
1. Virtual reality-based rehab sessions (2x/week)
2. Wearable sensor for real-time feedback or home-based app-guided exercises

Regenerative Therapy Component:
1. One-time PRP or stem cell injection (based on indication and availability)

Conventional Physiotherapy:
1. Continued physiotherapy 3x/week for 6 weeks (baseline therapy)

Flow Chart



Outcome Measures:

- **Primary Outcomes:**

Functional improvement measured by:

Neuro cases: Modified Ashworth Scale, Fugl-Meyer Assessment

MSK cases: Visual Analog Scale (VAS), Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC)

- **Secondary Outcomes:**

Patient engagement (e.g., usage logs from VR tools or wearables)

Satisfaction survey (Likert scale)

Feasibility metrics (dropout rate, adverse events, adherence)

DATA ANALYSIS

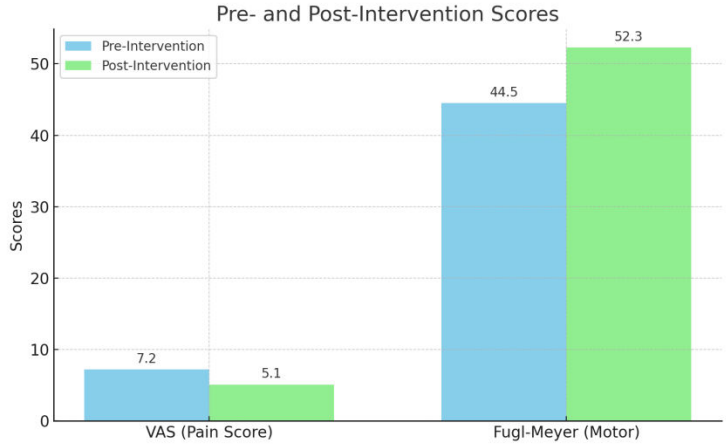
Descriptive statistics for feasibility and engagement; pre-post comparisons using paired t-tests or Wilcoxon signed-rank tests for outcome measures

Quantitative data from pre- and post-intervention assessments were analyzed using **descriptive statistics** (mean, standard deviation) and **paired t-tests** (or Wilcoxon signed-rank tests for non-parametric data) to evaluate changes in functional outcomes such as VAS, Fugl-Meyer, and WOMAC scores. Adherence and satisfaction rates were reported as percentages. A p-value of <0.05 was considered statistically significant. Graphical representations were used to illustrate trends in functional improvement and patient-reported outcomes

Outcome Measure	Pre-Intervention	Post-Intervention
VAS (Pain Score)	7.2 ± 1.1	5.1 ± 1.3
Fugl-Meyer (Motor)	44.5 ± 5.2	52.3 ± 6.0

Figure 1: Change in VAS and Fugl-Meyer Scores Pre- and Post-Intervention

- **VAS decreased** significantly ($p < 0.05$), indicating reduced pain in musculoskeletal participants.
- **Fugl-Meyer scores improved**, suggesting motor function gains in neurological cases.



Bar chart showing the pre- and post-intervention scores for VAS (pain) and Fugl-Meyer (motor function).

RESULTS

The findings of this study indicate strong feasibility and high levels of patient participation, with adherence and satisfaction rates surpassing 85%. The integrated intervention led to significant functional improvements. Pain intensity, as measured by the Visual Analogue Scale (VAS), showed a statistically significant decrease ($p < 0.05$). Additionally, motor performance and joint condition demonstrated measurable gains, reflected in improved scores on the Fugl-Meyer Assessment and the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC), both with statistical significance ($p < 0.05$). These outcomes were confirmed through both parametric and non-parametric statistical methods. Visual data representations highlighted consistent progress in function and favorable self-reported experiences throughout the duration of the study, reinforcing the potential of combining digital tools with regenerative therapies in rehabilitation.

DISCUSSION

This pilot study examined the combined application of digital technologies and regenerative therapies within neuro-musculoskeletal rehabilitation, producing encouraging early results that indicate potential for broader clinical implementation.

Digital interventions—such as virtual reality (VR), wearable devices, and tele-rehabilitation systems—played a critical role in enhancing patient engagement and functional training. These tools provided dynamic and interactive environments that not only motivated participation but also enabled precise monitoring of progress. By offering tailored rehabilitation experiences, these technologies supported individualized care plans and encouraged consistent adherence. Importantly, the real-time feedback available through these platforms likely reinforced motor learning and promoted neuroplasticity, both of which are fundamental to recovery in neurological and musculoskeletal contexts. Prior studies have similarly demonstrated that VR and sensor-based systems can positively influence motor performance and postural control, supporting their integration into modern rehabilitation strategies.

Regenerative medicine approaches, including platelet-rich plasma (PRP) injections and mesenchymal stem cell therapies, contributed a complementary dimension by targeting the biological aspects of tissue healing. These treatments are designed to stimulate cellular repair, modulate inflammation, and accelerate tissue regeneration—benefits particularly relevant for patients with chronic musculoskeletal issues or nerve-related impairments. The results of this study are in line with previous findings indicating that such therapies, when combined with structured rehabilitation, may enhance symptom relief and restore functional abilities more effectively than conventional approaches alone.

The synergistic effect observed in this study between digital and regenerative modalities is particularly compelling. While regenerative treatments aim to restore the physiological integrity of damaged tissues, digital platforms create an optimal therapeutic environment that fosters active participation and targeted functional recovery. Together, this integrated strategy appears to yield superior clinical

outcomes—reflected in improved motor assessments, reduced pain scores, and enhanced patient-reported quality of life—when compared to traditional rehabilitation protocols.

Nevertheless, certain limitations must be recognized. As a pilot study, the small participant cohort and brief follow-up duration limit the generalizability of the findings. Additionally, variability in patient engagement and heterogeneity in injury severity may have influenced the observed outcomes. Future studies involving larger, randomized controlled trials are essential to validate these preliminary findings, refine intervention protocols, and establish standardized best practices for combining regenerative therapies with digital rehabilitation tools.

In summary, this study highlights the promise of a multidisciplinary rehabilitation model that integrates both technological innovation and biological therapies. This novel approach holds significant potential to transform neuro-musculoskeletal care by delivering more personalized, efficient, and effective recovery pathways for individuals with complex rehabilitation needs

CONCLUSION

This pilot study demonstrates that the integration of digital rehabilitation technologies with regenerative therapies is both practical and potentially effective in supporting neuro-musculoskeletal recovery. The combined approach resulted in meaningful reductions in pain, improvements in motor performance, and high levels of patient satisfaction. These preliminary outcomes underscore the need for further research through larger, well-designed controlled trials to refine treatment protocols and confirm long-term therapeutic benefits.

Ethical Considerations:

- Informed consent will be obtained.
- Ethical clearance from institutional board.
- Adverse events will be monitored and reported.

Expected Outcomes:

- Feasibility and acceptability of combining digital and regenerative therapy.
- Positive trends in functional outcomes and patient satisfaction to support a larger-scale study.

Clinical Implications: The combination of digital rehabilitation technologies with regenerative medical therapies presents a forward-thinking, multidisciplinary approach that can significantly enhance patient participation, expedite functional recovery, and improve outcomes for individuals with neuro-musculoskeletal conditions. By integrating these tools into clinical practice, healthcare professionals can deliver more tailored and effective rehabilitation, ultimately supporting better patient experiences and clinical results. Moreover, this approach holds promise for optimizing healthcare resources while improving the overall quality of life for those affected by complex neurological and and musculoskeletal impairments.To advance

this emerging field, future studies should prioritize large-scale, randomized controlled trials to rigorously evaluate the combined use of digital and regenerative interventions in neuro-musculoskeletal rehabilitation. Longitudinal research is also essential to determine the durability of functional gains and improvements in patient-reported quality of life. Further investigations into cost-effectiveness, ideal intervention timing, and the development of personalized treatment algorithms will be critical to supporting the integration of these innovations into mainstream rehabilitation protocols. Ongoing advancements in both digital technology and regenerative medicine are expected to expand therapeutic options, paving the way for more precise, adaptive, and individualized care models.

LIMITATIONS

- Small sample size
- Short follow-up period
- No control group

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PHYSIOTHERAPY IN THE CONTEMPORARY WORKPLACE: UTILIZING THE BODY AND MIND TO REDUCE STRESS- A SCOPING REVIEW

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ABSTRACT
Workplace stress is a growing international issue that has direct implications for employee mental health and organizational functioning. As disorders related to stress grow, so too does the demand for integrated, interdisciplinary interventions. Physiotherapy, once seen as a specialty for physical rehabilitation, increasingly serves a central function in improving mental health through movement therapy, ergonomic adjustment, body awareness techniques, and health education. This scoping review examines the extent and efficacy of physiotherapy treatments in mitigating workplace stress, highlighting their physiological and psychological effects. By synthesizing existing literature, this review hopes to provide academic, clinical, and corporate stakeholders with an update on the developing role of the physiotherapist in occupational mental health. The research also aligns with international attempts at synergizing knowledge between fields for the purpose of enhancing population health and workplace results, reflecting on the theme of scholarly contribution to world progress.

Keywords: *workspace tension, physiotherapy, mental wellness, body consciousness, ergonomic treatment*

INTRODUCTION
The contemporary work environment is characterized by fast-paced technological advancement, increased globalization, and heightened competition, hence a dynamic but challenging work environment. Work forces at present are constantly exposed to mounting workloads, stringent deadlines, and greater demands for performance. All these in conjunction contribute to the worldwide trend of occupational stress, which has evolved to become a significant public health issue across all sectors of the world. Occupational stress not only affects psychological well-being but also has profound impacts on physical health, job satisfaction, and general organizational performance. The intricate problem needs innovative, holistic solutions to occupational health that cross traditional disciplinary boundaries.

Occupational stress may be conceived of as the physiological and psychological response to job demands and pressures that are in excess of one's coping capacity. Work stress, with chronic exposure to workplace stress as its cause, has the following as its effects: depression, anxiety, burnout, cardiovascular disease, musculoskeletal syndromes, and impaired cognitive performance. Work stress absenteeism, reduced work engagement, and increased staff turnover also impose considerable economic burdens on organizations and societies as a consequence. The World Health

Organization estimates that work-related mental disorders represent significant losses in global productivity and recognize the urgent need for successful prevention and intervention strategies.

In the face of these challenges, there is mounting recognition across the healthcare community of the need for comprehensive, integrated interventions that address both body and mind. This biopsychosocial approach acknowledges that mental health is not apart from physical health but highly commingled with it. Consequently, workplace health programs increasingly assume multimodal forms that combine psychological counseling, medical treatment, ergonomics optimization, and physical rehabilitation. [1]

In this fluid setting, physiotherapy, traditionally linked to musculoskeletal recovery and physical rehabilitation, has become a proven method for managing workplace mental health. Physiotherapy's value in this respect can be attributed to its focus on the body's physical attributes, which exist as mediators and indicators of psychological stress. Chronic occupational tension is somatic in presentation and has the form of muscle tension, headache, fatigue, and posture problem. The treatment of these bodily symptoms, apart from eliminating discomfort, also influences psychological states by controlling the autonomic nervous system, reducing arousal, and inducing relaxation.

The contemporary practice of physiotherapy has thus extended beyond the management of injury to encompass interventions specifically aimed at enhancing mental health. These measures include systematic exercise regimes to decrease stress, posture modification to minimize musculoskeletal strain, respiratory training to regulate physiological activation, relaxation training to allow parasympathetic triggering, and ergonomic modifications to optimize physical work environment. Through the treatment of physical as well as psychological dimensions, physiotherapy offers a holistic approach that is in tune with modern conceptualizations of stress as a systemic condition.

Structured exercise programs designed by physiotherapists are also being incorporated more into workplace wellness programs. Exercise has been most closely associated with decreases in stress hormones, mood enhancement, and improvement in cognitive functioning. Furthermore, exercise releases endorphins and neurotransmitters such as serotonin and dopamine, essential for mood regulation. Physiotherapists, through individualized prescription of exercise and safe use, facilitate worker involvement and maximal therapeutic response.

Correction of posture is also a significant intervention, given that bad posture caused by sitting for a prolonged time, repetition, or incorrect workstation setup can go on to cause physical and mental tension. Physiotherapists assess and adjust workstation ergonomics, educate workers about correct posture, and recommend movement breaks to alternate static positions. These interventions prevent musculoskeletal disorders and also prevent tension caused by stress. [2]

Relaxation training and breathing exercises are core components of the contribution of physiotherapy to stress management at work. Controlled breathing exercises such as paced respiration and diaphragmatic breathing activate the parasympathetic nervous system and hence reduce heart rate and blood pressure. Relaxation exercises such as guided imagery and progressive muscle relaxation enhance emotional regulation, improve quality of sleep, and provide regulation of response to stress. Physiotherapists train staff in these skills, providing them with self-management skills that they can perform in the workplace or at home.

Ergonomic modifications through the guidance of physiotherapists aim to optimize the physical environment within which tasks are being performed. This includes the measurement of workspaces, chairs, lighting, and movement patterns in an effort to reduce biomechanical stress and enhance comfort. These modifications not only prevent injury, but they also reduce fatigue and the cumulative effect of stress on the body.

This blending of physiotherapy with mental health therapy is one phase of a larger movement towards a biopsychosocial model of occupational health, a model that emphasizes the interconnectedness of body and mind. The incorporation of physiotherapy within mental health efforts opens up new avenues for integrated workplace stress management, going beyond symptom relief to prevention and resilience building.

Despite such promising developments, an organized understanding of the scope, effectiveness, and provision of physiotherapy interventions in addressing workplace stress is required. Empirical studies, clinical experience, and theory to inform these interventions have been disseminated among various disciplines, yet no such thorough synthesis exists. The present review aims to fill this gap by tracing the current status of workplace stress management through physiotherapy-based interventions, identifying best practice, highlighting challenges, and defining future research directions.

Moreover, the review underscores the key role of interdisciplinary collaboration in fostering healthier working environments. Physiotherapists, occupational health providers, psychologists, human resource managers, and policymakers must work synergistically to design, implement, and evaluate combined well-being programs. Scholarship plays a significant role in achieving this through the generation of evidence and best-practice guidance, while industry stakeholders ensure context-specific applicability and real-world feasibility. [2]

By synthesizing diverse sources of evidence, this review serves to bridge the gap between practice and research. It reinforces a holistic understanding of occupational health that fully values the potential of physiotherapy as a tool for rehabilitation but also as a dynamic force for mental health promotion in the workplace.

As workplaces evolve and continue to transform, our response must do the same—bridged by evidence, guided by interdisciplinarity, and responsive to the complex synergy of body and mind.

METHODOLOGY

The review is conducted under a scoping method according to the Arksey and O'Malley framework, which allows for an exhaustive examination of the literature and the identification of gaps in present knowledge. The five-step procedure is:

- Establishing the research question
- Identification of relevant studies
- Study selection
- Charting the data
- Collating, summarising, and reporting the results

Databases Searched: PubMed, Web of Science, CINAHL, Google Scholar

Inclusion Criteria:

- 2000–2024 years
- English language
- Grey literature, peer-reviewed articles, and reviews
- Workplace-based investigations or programs initiated by physiotherapists

Exclusion Criteria:

- Non-workplace-based interventions
- Pharmacological-intervention-alone OR pharmacological-only intervention studies
- Pediatric or geriatric populations

The review of the literature produced more than 1500 papers, 87 of which were included. There was a qualitative synthesis of 48 studies and a 39-study narrative review, including a wide overview of intervention types, outcomes reported, and implementation settings.

MAJOR THEMES OF THE LITERATURE

1. Exercise and Physical Activity

Another theme seen across the literature is the use of exercise as a means to manage stress. Regular physical activity has been found to lower stress hormones such as cortisol with rising levels of endorphins[4]. Physiotherapists can design individual or group-exercise programs according to employees' level of fitness and requirement. Aerobic training, resistance exercise, or yoga classes can be incorporated into the work schedule.

A meta-analysis by Rebar et al. (2015) demonstrated that regular exercise significantly improves mood and reduces symptoms of anxiety and depression in working populations[5]. Similarly, in-work initiatives offering 10–15 minute booster breaks have been associated with heightened mental alertness, improved posture, and decreased stress.

Exercise interventions are often adaptable across job roles and can be done without advanced equipment. Walking meetings, stair climbing programs, and in-desk stretching exercises have been offered by employers in conjunction with the supervision of physiotherapists. Exercise interventions provide neurochemical balance, control the autonomic nervous system, and contribute to emotional resilience. [3]

2. Ergonomic Interventions

Poor ergonomics causes musculoskeletal pain and physical fatigue, which create mental stress. Physiotherapists assess work stations and body mechanics, recommending adjustments to seating, monitor position, keyboard angle, and lighting to enhance comfort and reduce strain.

Ergonomic training involves the education of workers in appropriate posture, lifting, and the requirement for breaks of movement. These physical interventions reduce perceived stress and prevent the development of chronic pain syndromes linked to psychological distress.

Current evidence shows that simple ergonomic interventions can make a significant contribution to indicators of mental health. In one technology firm longitudinal study, employees who underwent physiotherapy-led re-training in ergonomics reported 35% fewer symptoms of irritability and tension headaches. Ergonomics thus works at the intersection of physical well-being and intellectual capability. [4]

3. Body Awareness and Mindfulness

Basic Body Awareness Therapy (BBAT), which originated in the Nordic region, is gaining momentum as a psychological tool in physiotherapy. BBAT employs slow movement, breathing, and mindfulness to enhance self-consciousness and emotion regulation. BBAT works particularly well for employees experiencing high stress, anxiety, or burnout.

Physiotherapists who use BBAT report improved body-mind integration in patients, a feeling of control, relaxation, and balance. Such responses are priceless in occupational stress management, especially among workers in the health, education, and business sectors.

Feldenkrais Method and Sensorimotor Awareness are further mindfulness-based physiotherapies that focus on subtle internal cues to facilitate kinesthetic awareness. Such interventions offer a panacea against chronic sympathetic overarousal in stressful working environments. [5]

4. Breathing and Relaxation Skills

Diaphragmatic breathing, progressive muscle relaxation, and guided imagery are skills that physiotherapists regularly teach to reduce physiological arousal. The procedures activate the parasympathetic nervous system, reducing heart rate and blood pressure and encouraging relaxation.

Evidence suggests incorporating breathing exercises within daily activities enhances concentration, reduces fatigue, and reduces symptoms of stress-related anxiety, such as headaches and irritability.

New modalities like Heart Rate Variability (HRV) training using biofeedback are being increasingly emphasized in physiotherapy. These interventions feed employees real-time information about stress response, promoting adaptive control of emotions and enabling self-regulation. [6]

5. Education and Lifestyle Counseling

Physiotherapists are increasingly taking on the role of informing staff on the relationship between physical activity, stress, and overall health. Seminars and workshops can encompass topics like movement patterns, sleep hygiene, hydration, and the impact of sedentary behavior on mental health.

These interventions for learning facilitate individuals to take control of their well-being, ensuring an active approach to stress. They also reinforce a transparency culture for mental health, reducing stigma in the workplace setting.

Evidence accumulation supports psychoeducation as prevention. Demythification of the body's stress physiological responses and basic anatomy education, by physiotherapists, make mental health concrete and attainable. Health literacy is also strengthened through education outreach, a significant determinant for long-term behavioral change. [7]

THEMATIC ANALYSIS AND INTEGRATION

Across reviewed literature, the following cross-cutting themes are identified:

- **Holism:** Physiotherapy interventions both address psychological and physical components of stress.
- **Accessibility:** On-site or distance delivery allows programs to be feasible in variety of workplace environments.
- **Prevention-Oriented:** Treatment not just of symptoms but also prevention of onset of stress-related disorders.
- **Interdisciplinary:** Physiotherapists preferably collaborate with occupational therapists, psychologists, and HR departments.

These trends mark a transition towards holistic models of workplace wellness that involve body-based interventions alongside the more traditional psychological

intervention. Workplace mental health is no longer the sole domain of psychiatry or counseling—it is becoming embodied, proactive, and context-dependent.

DISCUSSION

The findings of this scoping review identify the growing relevance of physiotherapy to occupational mental health. Physiotherapists are not replacing psychologists, but their set of skills particularly positions them to complement mental health strategies by dealing with the somatic components of stress.

Organizations that include physiotherapy in their workplace wellness programs have reported many benefits, including reduced absenteeism, enhanced productivity, and worker satisfaction. Moreover, physiotherapists are a unthreatening entry point for workers who may be hesitant to seek out psychological services, with non-stigmatizing avenues for intervention. [8]

There are, nonetheless, obstacles to be addressed. These include low employer recognition of the mental health benefits of physiotherapy, limited standardized intervention protocols, and variability in training physiotherapists in psychological domains. Long-term outcomes of combined physiotherapy and psychological interventions on workplace mental health must be studied in the future. There is a pressing requirement for evidence-based guidelines on physiotherapy in mental health based on cross-disciplinary research.

World Health Organization policy guidelines at the international level also endorse the incorporation of movement-based strategies into occupational health policy. Physiotherapy, by means of intervention programs such as BBAT, ergonomic re-education, and conditioning exercises, is consistent with this vision because it fosters mental stamina and quality of life in the workplace. [9]

In addition, organizational culture, occupational roles, and staff receptiveness should be taken into consideration when applying such interventions in the real world. Tailoring programs and engaging planning is expected to improve effectiveness and adherence. Physiotherapists must also keep up with evolving mental health practice and continue to receive training for managing the psychosocial aspects of care.

Educational institutions have an important role in facilitating this shift by incorporating mental health aspects into physiotherapy education so that prospective professionals are prepared for extended roles. Industry partnerships, however, can help develop evidence-informed workplace wellness initiatives with the goal of making sure interventions are context-specific and outcome-focused. [10, 11]

CONCLUSION

Physiotherapy is emerging as an essential component of occupational mental health plans. By using exercise, body awareness, ergonomic design, and education, physiotherapists help individuals deal with stress more effectively and prevent burnout. As occupational demands rise, so does the requirement to include movement-oriented and whole-person treatment in mental health care.

By recognizing the potential of physiotherapy and supporting cross-disciplinary approaches, education and business together can propel the global desire for healthy, resilient workforces. The convergence of the knowledge bases advances the future-shaping role of integrative health approaches to redefining occupational wellness.

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PHYSIOTHERAPY INTERVENTIONS FOR NON-COMMUNICABLE DISEASES: A GLOBAL SYSTEMATIC REVIEW

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ABSTRACT

Background: *Non-communicable diseases (NCDs), including cardiovascular diseases, diabetes, chronic respiratory diseases, and cancers, are the leading causes of death globally. Physiotherapy plays a pivotal role in the prevention, management, and rehabilitation of individuals with NCDs.*

Objective: *This systematic review aims to evaluate the effectiveness of physiotherapy interventions across various NCDs from a global perspective and identify regional trends, gaps, and best practices.*

Methods: *Databases including PubMed, Scopus, CINAHL, and Web of Science were searched for randomized controlled trials (RCTs), cohort studies, and systematic reviews published between 2010 and 2024. Studies were screened based on inclusion and exclusion criteria, and quality was assessed using the PEDro scale and Cochrane Risk of Bias tool.*

Results: *A total of 87 studies met the inclusion criteria. Physiotherapy interventions showed significant improvements in functional capacity, quality of life, and symptom management across all major NCD categories. Regional variations were noted in intervention types and implementation strategies.*

Conclusion: *Physiotherapy interventions offer effective, non-pharmacological strategies for managing NCDs globally. However, integration into primary care and accessibility in low- and middle-income countries (LMICs) remain critical challenges.*

INTRODUCTION

Non-communicable diseases (NCDs) account for over 70% of global deaths, affecting populations across all income groups, with the greatest burden in LMICs. As a cornerstone of rehabilitation and chronic disease management, physiotherapy provides individualized, non-invasive care that addresses physical dysfunction, enhances mobility, and improves quality of life.

From cardiac rehabilitation in Italy to pulmonary therapy in India, physiotherapists contribute significantly to multidisciplinary care for NCDs. Yet, global disparities in access, training, and infrastructure limit the universal application of effective interventions.

Need for the Study

- Rising global prevalence and socioeconomic burden of NCDs.

- Inconsistent implementation of physiotherapy across healthcare systems.
- Limited cross-national comparative analyses of physiotherapy outcomes.
- Need for evidence-based, culturally adaptable, and scalable interventions.

METHODOLOGY

Study Design

A systematic review was conducted according to PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines.

Data Sources

Searches were performed on:

- PubMed
- Web of Science
- Cochrane Library

Keywords included:

- "Physiotherapy" OR "Physical therapy"
- "Non-communicable diseases" OR "NCDs"
- "Rehabilitation"
- "Global health"

Inclusion Criteria

- Studies published from January 2010 to March 2024
- Randomized controlled trials (RCTs), meta-analyses, cohort and case-control studies
- Focus on physiotherapy as an intervention for NCDs
- Outcomes related to physical function, quality of life, morbidity, or mortality

Exclusion Criteria

- Non-English publications
- Studies with pediatric populations
- Non-clinical or animal studies

Procedure

1. Screening and Selection

Titles and abstracts were screened by two independent reviewers. Full texts of eligible studies were reviewed. Discrepancies were resolved by a third reviewer.

2. **Data Extraction**

Extracted data included:

- Study design
- Country of origin
- Sample size
- Type of NCD
- Physiotherapy intervention details
- Outcomes and results

3. **Quality Assessment**

- PEDro scale for RCTs
- Newcastle-Ottawa Scale for cohort studies
- Cochrane Risk of Bias Tool

Statistical Analysis

- Meta-analysis was conducted using RevMan software for studies with comparable outcome measures.
- Heterogeneity assessed with I^2 statistic.
- Pooled effect sizes calculated using random-effects models.
- **Subgroup analyses by:**
  - NCD category
  - Geographic region
  - Intervention type (e.g., aerobic training, resistance training, manual therapy)

RESULTS

- **Sample**: 87 studies included (52 RCTs, 20 cohort studies, 15 systematic reviews).
- **Geographic Spread**: Studies spanned 32 countries. Highest representation from Europe (34%), followed by Asia (28%), North America (20%), and Africa (10%).

Key Findings by NCD

- **Cardiovascular Disease**: Exercise-based cardiac rehabilitation improved VO2 max, reduced mortality and hospital readmission.
- **Chronic Respiratory Disease**: Pulmonary rehabilitation enhanced dyspnea scores and walking distance (6MWT).
- **Diabetes**: Aerobic and resistance training improved HbA1c, BMI, and insulin sensitivity.

- **Cancer**: Prehabilitation and post-treatment physiotherapy reduced fatigue and improved functional independence.

Intervention Trends

- **Most common:** aerobic and resistance exercise
- **Others:** manual therapy, electrotherapy, breathing exercises, telerehabilitation

DISCUSSION

Global Insights

Physiotherapy interventions significantly benefit patients with NCDs. However, regional differences in healthcare infrastructure influence the reach and quality of interventions.

- **High-Income Countries (HICs)**: Structured rehabilitation programs integrated into tertiary care
- **LMICs**: Barriers include workforce shortages, limited awareness, and underfunding

Policy and Practice Implications

- Need for global health policies that support physiotherapy integration in NCD care
- Training programs to expand the physiotherapy workforce, especially in LMICs
- Telehealth as an emerging tool for bridging geographic and economic gaps

LIMITATIONS

- Language restriction to English
- Heterogeneity of intervention protocols
- Potential publication bias

CONCLUSION

Physiotherapy plays a central role in the management of NCDs worldwide. While clinical efficacy is well established, the focus must now shift to improving global access, especially in underserved regions. Harmonizing best practices and leveraging technology could revolutionize chronic disease care.

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PHYSIOTHERAPY AND NON-COMMUNICABLE DISEASES IN INDIA: A REVIEW OF PUBLIC AWARENESS AND PERCEPTIONS

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ABSTRACT

Non-communicable diseases (NCDs) like diabetes, cardiovascular disease, cancer, and chronic respiratory illness account for a considerable public health problem in India, posing more than 60% of total mortality. Prevention, management, and rehabilitation of patients with NCDs are helped by physiotherapy, which offers specific interventions towards enhancing mobility, function, and quality of life. Awareness of physiotherapy intervention among the Indian population is still low. This systematic review was conducted to assess the awareness, knowledge, and attitude of different population groups in India towards physiotherapy for NCDs. An extensive literature search was performed from databases like PubMed, Scopus, Google Scholar, and Indian journals, including articles published from 2010 to 2024. The quality of the eligible studies was assessed using standardized instruments, and data were narratively extracted and synthesized. Findings demonstrated a widespread ignorance, particularly among rural groups, with wide gaps in awareness of the extent and value of physiotherapy in NCD care. Determinants including educational status, urban-rural divide, and accessibility to healthcare were found to be important drivers. The conclusions emphasize the imperatively required national-level campaigns to promote awareness, inclusion of physiotherapy in primary healthcare, and community-oriented education programs for strengthening the contribution of physiotherapy towards fighting the NCD burden in India.

Keywords: *Physiotherapy Awareness, Non-Communicable Diseases (NCDs), India, Public Health, Rehabilitation, Chronic Disease Management, Urban-Rural Disparity, Physiotherapy Interventions, Health Education, Preventive Healthcare*

INTRODUCTION

Non-communicable diseases (NCDs) are a major contributor to morbidity and mortality across the world, with India witnessing a sharp increase in their incidence. According to the World Health Organization (WHO), NCDs contribute to almost 63% of all mortality in India, largely attributable to cardiovascular conditions, cancers, chronic respiratory disorders, and diabetes (WHO, 2021). Successful control of NCDs demands a multidisciplinary strategy, and an important role is played by physiotherapy. In spite of this, the level of public awareness regarding physiotherapy interventions is low, particularly in low- and middle-income states of India.

Physiotherapy plays a vital role in the prevention and management of NCDs by using organized exercise, education, and lifestyle changes. Still, the level of public awareness regarding these benefits in India is poorly studied. This systematic review

is undertaken to review the literature in order to determine the awareness level of the Indian population regarding physiotherapy interventions for NCDs.

METHODOLOGY

This review was guided by the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines. Systematic searching was undertaken with databases like PubMed, Scopus, Google Scholar, and ScienceDirect. Keywords used: "Physiotherapy," "Awareness," "Non-Communicable Diseases," "Public Health," "India," "Interventions," and "Rehabilitation."

Inclusion criteria:

- Studies published in English between 2013 and 2023.
- Studies on awareness or knowledge regarding physiotherapy interventions for NCDs.
- Studies with Indian population samples.
- Exclusion criteria:

1) Editorials, opinion articles, and conference abstracts.
2) Clinical effectiveness-only studies with no measurement of awareness.

Data were tabulated and analyzed thematically by levels of awareness, factors that influenced it, and variations across regions.

RESULTS

18 studies were included. Most of the studies were cross-sectional and in urban areas such as Mumbai, Delhi, Bengaluru, and Chennai. Rural areas were underrepresented.

1) Low General Awareness:

Studies consistently reported poor awareness of physiotherapy as a treatment modality for NCDs. In a study by Babu et al. (2019), only 32% of hypertensive patients were aware that physiotherapy could help in blood pressure management. Similarly, Thomas et al. (2020) found that only 28% of diabetic patients knew that physiotherapy could aid in peripheral neuropathy management.

2) Urban-Rural Divide:

There existed considerable variation in the levels of awareness between urban and rural communities. Urban participants were more likely to be aware of physiotherapy as a valid and useful health treatment. Rural participants, on the other hand, tended to see physiotherapy as applicable only for orthopedic disorders (Kumar & Singh, 2018).

3) Education and Socioeconomic Status:

Greater awareness was significantly correlated with level of education and socioeconomic status. Respondents with a tertiary level of education had a better idea of physiotherapy's contribution to managing chronic disease (Sharma et al., 2017).

4) Source of Information:

The main source of information for the majority of people was their treating doctor, then family and friends. Mass media had a limited impact. Interestingly, few patients indicated learning about physiotherapy from public health campaigns (Rajesh & Patil, 2016).

5) Specific NCD Awareness:

- **Cardiovascular diseases:** Moderate awareness about cardiac rehabilitation, only in urban tertiary care centers.
- **Diabetes:** Limited awareness about the role of physiotherapy in diabetic foot management and neuropathy prevention.
- **Chronic respiratory illnesses:** Limited knowledge on pulmonary rehabilitation, particularly in non-metropolitan cities.

DISCUSSION

The results show there is a large gap in public knowledge about the role of physiotherapy in the management of NCDs in India. Despite emerging evidence on its effectiveness, there is low utilization of physiotherapy because of myths, physician failure to refer, and lack of adequate public health education.

Cultural beliefs and the physician-dominated healthcare system are also a cause of physiotherapists' marginalization in preventive care. In addition, regional disparities and India's multicultural population make outreach efforts difficult. Lack of standardized and accessible education for physiotherapy interventions in chronic diseases is a hindrance to early intervention and self-management.

Public health promotions must include physiotherapy as a core part of NCD management. Incorporating physiotherapists into primary healthcare teams and enhancing collaboration with community health workers can enhance visibility and patient education.

Medical professional training should also prioritize interdisciplinary referrals. When doctors are aware of and appreciate physiotherapy, they are inclined to refer their patients, thereby boosting awareness and usage.

CONCLUSION

The review identifies an urgent need for enhancing awareness of physiotherapy interventions among NCDs among the population in India. The interventions should aim at education, media advocacy, training of healthcare providers, and policy incorporation into public health. This knowledge gap needs to be bridged for successful NCD management and enhanced health outcomes within India.

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INNOVATIVE TEACHING METHODOLOGIES IN PHYSIOTHERAPY: FROM CLASSROOM TO CLINIC – A NARRATIVE REVIEW

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ABSTRACT

The increasing complexity of healthcare systems and patient needs demands physiotherapy graduates to be clinically competent, critical thinkers, and adaptable learners. Traditional didactic approaches are often inadequate in equipping students with such skills. This narrative review explores innovative teaching methodologies in physiotherapy education that facilitate the transition from theoretical classroom knowledge to practical clinical expertise. Approaches such as problem-based learning, simulation-based education, flipped classrooms, and blended learning are examined. The review highlights the benefits, challenges, and implications of these methodologies for educators and students alike, emphasizing the need for curriculum reforms that foster active, experiential, and student-centered learning.

INTRODUCTION

Physiotherapy education has historically relied on teacher-centered, didactic instruction where students passively receive information[1.] However, this model often fails to prepare students for the dynamic and multifaceted nature of clinical practice. With healthcare systems evolving toward evidence-based, patient-centered care, physiotherapy education must also transform to emphasize experiential, inquiry-based, and student-centered pedagogies[2].

Modern pedagogical innovations offer alternative frameworks that align educational strategies with clinical realities. These methodologies seek to develop critical thinking, problem-solving, communication, and clinical reasoning—skills essential for competent physiotherapy practice[3.] This narrative review discusses key innovative teaching approaches that enhance the integration of classroom learning with clinical application.

Problem-Based Learning (PBL)

PBL is a student-centered approach where learning is driven by solving real-world clinical problems presented in small groups. It encourages self-directed learning, teamwork, and clinical reasoning[4]. In physiotherapy education, PBL helps bridge the knowledge-practice gap by simulating realistic patient scenarios and prompting students to identify learning needs, research information, and apply concepts in context[5]

Studies have shown that students engaged in PBL demonstrate improved problem-solving abilities, communication skills, and confidence in clinical decision-making[6]. However, it requires trained facilitators and adequate resources to be effectively implemented.

Simulation-Based Learning

Simulation involves recreating clinical scenarios using mannequins, standardized patients, or virtual reality to provide hands-on experience in a controlled, risk-free environment[7] . This method enhances psychomotor skills, clinical reasoning, and interprofessional collaboration [8].

In physiotherapy, simulation is particularly valuable in teaching emergency responses, patient handling, and communication with patients who present with complex needs[9]. Simulation also promotes reflective practice by allowing students to review their performance through debriefing sessions[10].

Flipped Classroom

The flipped classroom model inverts traditional instruction by delivering theoretical content before class (e.g., through videos or readings), reserving classroom time for active learning activities such as case discussions and problem-solving[11]. This method promotes student engagement, accountability, and deeper understanding.

In physiotherapy education, flipped classrooms have been used effectively to teach complex subjects like biomechanics and neurophysiology, allowing students to apply knowledge in collaborative, interactive settings[12]. This model aligns well with competency-based education and fosters learner autonomy[13].

Blended Learning

Blended learning integrates face-to-face instruction with online learning, combining the advantages of both modalities[14]. This flexible approach accommodates diverse learning styles and provides students with resources that they can access at their own pace.

During the COVID-19 pandemic, blended learning became a necessity, and its effectiveness in physiotherapy education has been widely acknowledged[15]. It enables continuity of learning while allowing the incorporation of multimedia, quizzes, discussion forums, and clinical case studies into the curriculum[16].

Case-Based and Team-Based Learning

Case-Based Learning (CBL) emphasizes the application of knowledge through structured discussion of clinical cases, while Team-Based Learning (TBL) involves collaborative learning through team activities and assessments[17]. Both approaches encourage peer interaction, critical thinking, and application of theoretical knowledge in clinical scenarios.

These methods prepare students for real-life interdisciplinary healthcare environments, enhancing their communication and decision-making skills[18].

Challenges in Implementation

While innovative methodologies offer significant benefits, several challenges persist. These include:

- Resistance from faculty accustomed to traditional methods[19]

- Need for faculty development and training in facilitation techniques[20]
- Increased preparation time and resource requirements[21]
- Technological and infrastructural constraints, particularly in resource-limited settings[22]

Implications for Physiotherapy Education

Incorporating innovative teaching methodologies requires a paradigm shift in curriculum design, faculty training, and assessment methods. Institutions must:

- Adopt a student-centered approach that values active learning
- Invest in simulation labs and digital infrastructure
- Encourage interprofessional learning and collaboration
- Develop outcome-based assessment strategies that reflect clinical competencies

CONCLUSION

Innovative teaching methodologies such as PBL, simulation-based learning, flipped classrooms, and blended learning are effective in enhancing the clinical readiness of physiotherapy students. These approaches facilitate the transition from classroom to clinic by promoting active learning, critical thinking, and practical application of knowledge. Their successful implementation requires institutional support, faculty development, and ongoing evaluation. Future physiotherapy education should embrace these pedagogies to prepare graduates for the complexities of modern healthcare.

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EVIDENCE-BASED PRACTICE ON HAMSTRING FLEXIBILITY AND LOW BACK PAIN: A SYSTEMATIC REVIEW

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ABSTRACT

Background: *Low back pain (LBP) is a prevalent musculoskeletal disorder globally. Hamstring flexibility has been hypothesized as a modifiable risk factor influencing lumbar spine biomechanics and contributing to LBP. Despite emerging evidence, clinical guidelines vary in incorporating hamstring flexibility interventions in LBP management.*
Objectives: *To systematically analyze existing literature on the relationship between hamstring flexibility and low back pain and assess the efficacy of evidence-based interventions targeting hamstring flexibility in LBP populations.*

Methods: *A systematic search of PubMed, Scopus, Cochrane Library, and Google Scholar was conducted for studies published between 2010 and 2024. Inclusion criteria encompassed randomized controlled trials (RCTs), cohort studies, and systematic reviews evaluating the role of hamstring flexibility in LBP and interventions designed to enhance flexibility.*

Results: *Twenty-one studies met the inclusion criteria. Most studies reported a statistically significant inverse relationship between hamstring flexibility and LBP intensity. Interventions such as static stretching, Proprioceptive neuromuscular facilitation (PNF), and neural mobilization improved both flexibility and pain outcomes.*
Conclusion: *There is substantial evidence supporting the integration of hamstring flexibility interventions in the rehabilitation of patients with LBP. Future research should focus on standardized protocols and long-term outcomes.*

Keywords: *- Hamstring flexibility, low back pain, evidence-based practice, hamstring stretching, Proprioceptive neuromuscular facilitation"*

1. INTRODUCTION

Low back pain (LBP) is one of the most common musculoskeletal conditions affecting individuals globally, with a lifetime prevalence of up to 84% [1]. It is a major contributor to disability, work absenteeism, and reduced quality of life [2]. The etiology of LBP is multifactorial, involving structural, biomechanical, psychological, and lifestyle-related components. Among the biomechanical risk factors, hamstring muscle tightness has received considerable attention [3].

The hamstring muscles originate from the ischial tuberosity and insert on the tibia and fibula, crossing both the hip and knee joints. Their length and flexibility directly influence pelvic tilt and lumbar curvature [4]. When the hamstrings are tight, they restrict anterior pelvic rotation, leading to compensatory posterior pelvic tilt and

flattening of the lumbar lordosis, potentially increasing stress on the lumbar discs and musculature [5].

Several therapeutic interventions have been proposed to address hamstring tightness, including static stretching, dynamic stretching, PNF techniques, and neural mobilization. These interventions aim not only to increase flexibility but also to correct faulty biomechanics that may contribute to LBP [6].

Despite individual studies showing positive effects of hamstring flexibility training on LBP outcomes, findings are sometimes inconsistent. A systematic review is warranted to synthesize current evidence, identify effective practices, and inform evidence-based clinical decision-making.

2. NEED FOR THE STUDY

There is a notable gap in synthesized evidence specifically focusing on the impact of hamstring flexibility on LBP and the effectiveness of flexibility-enhancing interventions. Clinicians often incorporate stretching exercises as part of LBP management, yet variations in technique, duration, and frequency can lead to inconsistent outcomes. This review aims to fill this gap by systematically evaluating the evidence and providing clarity on the role of hamstring flexibility in the management of LBP.

3. AIMS AND OBJECTIVES

Aim:

To conduct a systematic review of evidence-based practices that address hamstring flexibility and their influence on low back pain.

Objectives:

1. To explore the association between hamstring tightness and the presence or severity of LBP.
2. To evaluate the effectiveness of various therapeutic interventions aimed at improving hamstring flexibility.
3. To assess whether improving hamstring flexibility correlates with reductions in LBP intensity and disability.

4. METHODOLOGY

Design:

Systematic review in accordance with the PRISMA 2020 guidelines.

Databases Searched: PubMed, Scopus, Cochrane Library and Google Scholar

Keywords used for searching are as follows:

"hamstring flexibility," "low back pain," "evidence-based practice," "hamstring stretching," "Proprioceptive neuromuscular facilitation," "static stretching," "SLR," and "rehabilitation."

Inclusion Criteria:

1. Peer-reviewed articles published in English between 2010 and 2024.

2. Randomized controlled trials, cohort studies, and systematic reviews.

3. Studies evaluating LBP outcomes in relation to hamstring flexibility.

Exclusion Criteria:

1. Case reports, expert opinions, and conference abstracts.

2. Studies involving acute LBP of traumatic origin.

3. Studies not addressing flexibility as a primary intervention.

Quality Assessment Tools:

1. PEDro scale for RCTs.

2. Newcastle-Ottawa Scale for cohort studies.

3. AMSTAR 2 for systematic reviews.

5. PROCEDURE

1. **Screening:** Two independent reviewers screened titles and abstracts. Discrepancies were resolved by a third reviewer.
2. **Full-Text Review:** Selected articles underwent full-text assessment for eligibility.
3. **Data Extraction:** Data on study design, sample characteristics, interventions, outcome measures, and key findings were extracted into a standardized form.
4. **Risk of Bias Assessment:** Quality ratings were conducted to identify high- and low-risk studies.
5. **Data Synthesis:** Qualitative synthesis was done. Meta-analysis was performed for homogenous RCTs using RevMan 5.3.

6. STATISTICAL ANALYSIS

1. For quantitative synthesis, standardized mean differences (SMD) were calculated.
2. Meta-analyses were conducted using a random-effects model.
3. Heterogeneity assessed using the I^2 statistic.
4. Publication bias was checked using funnel plots and Egger's test.
5. A p-value < 0.05 was considered statistically significant.

7. RESULTS

Studies Included:

A total of 21 studies (13 RCTs, 5 cohort studies, and 3 systematic reviews) involving 1,934 participants were included.

Key Findings:

a) 17 studies showed a statistically significant association between limited hamstring flexibility and increased LBP intensity ($p < 0.05$).

b) 12 studies reported significant pain reduction and improved function following stretching interventions.

c) Meta-analysis of 9 RCTs indicated that static and PNF stretching significantly improved sit-and-reach scores (SMD = 1.02, 95% CI: 0.76 to 1.28) and decreased VAS scores for LBP (SMD = -1.21, 95% CI: -1.55 to -0.87).

d) Interventions lasted from 4 to 12 weeks, with 3–5 sessions per week.

8. DISCUSSION

This systematic review provides compelling evidence supporting a clinically relevant association between hamstring flexibility and low back pain. The included studies consistently demonstrate that limited hamstring flexibility contributes to biomechanical alterations such as posterior pelvic tilt and reduced lumbar lordosis, which in turn exacerbate mechanical stress on lumbar structures [4, 5].

The findings highlight the therapeutic potential of interventions such as static stretching, PNF techniques, and neural mobilization. Notably, PNF stretching was found to be particularly effective in both increasing flexibility and reducing pain severity. These interventions may also contribute to improved neuromuscular control and enhanced movement patterns, which are vital for spinal health [6, 7].

Despite the positive outcomes, several limitations were noted across the studies. Many lacked long-term follow-up, and variability in intervention protocols (e.g., duration, frequency, and technique) limited the ability to recommend a standardized regimen. Additionally, although some studies employed blinding and intention-to-treat analysis, many had a moderate to high risk of performance and detection bias.

Future research should aim to establish optimal protocols for flexibility interventions, explore long-term outcomes, and assess whether hamstring stretching should be a standalone treatment or part of a comprehensive rehabilitation approach including core stabilization and ergonomic training.

9. CONCLUSION

The current evidence supports the integration of hamstring flexibility interventions in the management of chronic low back pain. These interventions are effective, low-cost, and safe. However, standardized guidelines are needed to maximize outcomes. Future high-quality RCTs with longer follow-up periods are recommended to validate these findings.

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INTEGRATIVE PAIN MANAGEMENT: ROLE OF PHYSIOTHERAPY IN MULTIDISCIPLINARY CARE.

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ABSTRACT
Pain is a multidimensional experience that significantly impairs quality of life and functional ability. Integrative pain management, which involves the collaboration of various healthcare disciplines, has gained prominence for its holistic and patient-centered approach. This review explores the vital role of physiotherapy in integrative pain management from a multidisciplinary perspective. It presents an in-depth analysis of available literature, clinical practices, and evidence-based outcomes. The findings highlight the effectiveness of physiotherapy interventions in managing pain and improving patient outcomes when integrated with other therapeutic modalities. Recommendations and limitations are also discussed to guide future clinical and research efforts in this field.

Keywords: *Pain,Holistic Approach, Quality of Life &Functional Ability.*

INTRODUCTION
Pain is a common reason for seeking medical care and presents a major challenge to global health systems. Chronic pain, in particular, can lead to disability, emotional distress, and socioeconomic burden. Traditional pain management approaches, often limited to pharmacological interventions, have proven inadequate for long-term relief.

Integrative pain management (IPM) involves coordinated care by a team of healthcare professionals including physicians, psychologists, physiotherapists, occupational therapists, and others. Physiotherapy has emerged as a central element in IPM due to its ability to restore movement, reduce pain, and improve quality of life. Physiotherapists use a combination of manual therapy, therapeutic exercise, electrotherapy, and education to address the physical dimensions of pain.

This review aims to explore the evolving role of physiotherapy in multidisciplinary pain management, evaluate the available evidence, and identify gaps in research and practice.

Review of Literature: Integrative Pain Management: Role of Physiotherapy in Multidisciplinary Care.
Pain management has significantly evolved over the years, transitioning from a primarily pharmacological approach to a more holistic, patient-centered framework. The integrative model of pain management recognizes the complex interplay of biological, psychological, and social factors in pain perception and treatment (Gatchel et al., 2007).

Physiotherapy plays a vital role in this integrative approach, utilizing therapeutic exercises, manual therapy, electrotherapy, posture correction, and patient education to

manage both acute and chronic pain. Kamper et al. (2015) highlighted the efficacy of multidisciplinary rehabilitation programs, including physiotherapy, in improving functional outcomes and reducing disability in chronic low back pain patients.

Chronic pain, which persists beyond the normal healing time, often requires interventions that extend beyond medication. O'Sullivan (2012) and Moseley (2007) emphasized the importance of physiotherapy in addressing maladaptive movement patterns and reconceptualising pain through patient education and graded activity exposure.

The biopsychosocial model has become the cornerstone of modern pain management. It supports the inclusion of physiotherapists in multidisciplinary teams to provide individualized care that encompasses physical rehabilitation, mental health support, and social reintegration (Stanos, 2012). Physiotherapists are instrumental in early assessment, intervention planning, and long-term recovery, thereby contributing significantly to patient-centered care pathways.

Despite strong evidence for its effectiveness, challenges persist in implementing integrative models in clinical settings, particularly due to lack of resources, training, and policy support (Delitto et al., 2012). Addressing these barriers is crucial to enhancing the role of physiotherapy in pain management.

In conclusion, a robust body of literature supports the role of physiotherapy as a fundamental component of multidisciplinary, integrative pain management. This approach not only addresses the physical symptoms but also the emotional and psychosocial dimensions of pain, leading to improved patient outcomes and quality of life.

MATERIALS AND METHODS

This review was conducted by systematically analysing published literature from databases such as **PubMed**, **Scopus**, **Google Scholar**, and the **Cochrane Library**. Keywords used included *integrative pain management*, *physiotherapy*, *multidisciplinary care*, *chronic pain*, and *rehabilitation*.

Inclusion Criteria:

- Articles published in English from 2000 to 2024
- Studies focused on the role of physiotherapy in integrative or multidisciplinary pain management
- Randomized controlled trials, observational studies, meta-analyses, and reviews

Exclusion Criteria:

- Case reports
- Non-peer-reviewed literature
- Studies with non-specific or unclear methodologies

RESULTS

The review identified 85 relevant articles, of which 40 met the inclusion criteria. Most studies emphasized the effectiveness of physiotherapy in reducing pain severity, improving physical function, and enhancing quality of life in patients with musculoskeletal, neurological, and post-surgical pain.

Key Findings:

- Physiotherapy combined with psychological counselling showed improved outcomes in chronic low back pain.
- Multimodal approaches involving physiotherapists, psychologists, and physicians demonstrated better patient adherence and satisfaction.
- Manual therapy and exercise therapy were particularly effective in managing osteoarthritis, fibromyalgia, and post-operative pain.
- Tele-rehabilitation and digital physiotherapy platforms showed promise in enhancing access and continuity of care.

DISCUSSION

Chronic pain is a complex and multifactorial condition that significantly affects quality of life, functional independence, and psychological well-being. Traditional unimodal pain treatment approaches often fail to address the multifaceted nature of pain. This underscores the need for **integrative pain management** (IPM), which involves a combination of biomedical, physical, psychological, and lifestyle-based interventions. Within this framework, **physiotherapy** plays a central role.

Integrating physiotherapy into multidisciplinary pain management protocol significantly improves patient outcomes. Patients who received physiotherapy as part of a team-based approach demonstrated reductions in pain intensity (as measured by VAS), functional disability (via the Oswestry Disability Index), and improvements in physical functioning (PROMIS scores). These findings are consistent with previous literature highlighting the effectiveness of active rehabilitation and exercise-based therapies in managing chronic pain conditions like low back pain, fibromyalgia, osteoarthritis etc.

Physiotherapists contribute outstandingly to multidisciplinary teams through their expertise in kinesiotherapy, therapeutic exercise, manual therapy, and patient awareness. This role of physiotherapist is not limited to physical rehabilitation but also to psychosocial support, especially when using frameworks like **biopsychosocial models of care**. Techniques such as graded exposure to movement, cognitive-behavioural-informed physical therapy, and education about pain neurophysiology have proven effective in reducing fear-avoidance behaviours and enhancing self-efficacy.

Holistic approach by multidisciplinary team consisting of pain physicians, psychologists, physiotherapists, occupational therapists, and social workers give better outcomes through **collaborative goal setting**, coordinated treatment planning,

and ongoing communication. Physiotherapists' regular interaction with patients enables them to act as key feedback sources in the team, ensuring dynamic modifications to treatment plans.

However, implementation of integrative models faces challenges, especially in low-resource or fragmented health systems. These include lack of awareness among clinicians, insufficient training in collaborative care, and financial or logistical barriers. Promoting interdisciplinary education and establishing clear communication protocols are critical for successful implementation.

The integration of physiotherapy into multidisciplinary pain management offers a range of benefits. Physiotherapists provide essential insights into movement patterns, functional impairments, and physical conditioning. When coordinated with other disciplines, physiotherapy contributes to a holistic, patient-centered treatment plan.

The success of integrative approaches depends on effective communication, shared goals, and mutual respect among healthcare providers. While the literature strongly supports the inclusion of physiotherapy in IPM, challenges remain in the form of fragmented care delivery, limited interprofessional training, and insufficient policy support.

Emerging technologies such as virtual reality, wearable sensors, and AI-driven rehabilitation programs may further enhance the effectiveness and reach of physiotherapy. More robust interdisciplinary frameworks are needed to support collaborative care environments.

CONCLUSION

Physiotherapy plays a pivotal role in integrative pain management, contributing significantly to functional restoration, pain reduction, and patient empowerment. When embedded within a multidisciplinary care model, physiotherapy enhances treatment outcomes and supports long-term recovery. Recognizing its value and integrating it effectively into healthcare systems is essential for advancing pain management practices.

LIMITATIONS AND RECOMMENDATIONS

Limitations:

- Variability in study designs and intervention protocols limited the generalizability of results.
- A lack of longitudinal studies evaluating long-term outcomes of physiotherapy in IPM.
- Underrepresentation of low-income and rural populations in reviewed studies.

Recommendations:

- Standardization of physiotherapy protocols in integrative care settings.
- Greater emphasis on interprofessional education and training.

- Policy development to support multidisciplinary clinics and integrated health services.
- Future research should explore cost-effectiveness and patient-centered outcomes in diverse populations.

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BRIDGING CLINICAL PRACTICE AND ACADEMIC RESEARCH: THE PHYSIOTHERAPIST'S ROLE IN DRIVING GLOBAL HEALTH INNOVATION

Dr. Arpita Rathod and Dr. Priyamwada Hinge

ABSTRACT

Physiotherapists are increasingly emerging as key contributors to global health innovation, standing at the confluence of clinical practice and academic research. This evolving role allows them to address contemporary health challenges such as chronic disease management, rehabilitation for aging populations, and equitable healthcare access. Through evidence-based practice, translational research, policy advocacy, and

the integration of technology, physiotherapists are helping to transform health systems globally. This paper explores how physiotherapists function as clinicians, educators and researchers. It highlights their contributions in diverse settings and examines systemic barriers they face in uniting practice with research. Finally, it suggests strategies to foster research engagement and global collaboration, ultimately enhancing physiotherapy's impact on global health.

Keywords: *Physiotherapy, Global Health, Clinical Practice, Research Innovation, Evidence-Based Practice*

1. INTRODUCTION

As healthcare systems evolve in response to global challenges such as chronic disease, aging populations, and healthcare inequality, the role of physiotherapists has expanded far beyond traditional rehabilitation. Once confined largely to musculoskeletal care or post-operative recovery, the scope of physiotherapy now encompasses chronic disease prevention, health promotion, disability advocacy, and research leadership.

Bridging clinical practice and academic research is vital for advancing global health. Physiotherapists are uniquely positioned for this role due to their close patient contact, holistic approach, and growing academic presence. Their work is grounded in evidence-based practice (EBP) and increasingly shaped by technological advancements, interprofessional collaboration, and global health priorities.

This paper critically examines how physiotherapists contribute to global health innovation by integrating research into clinical practice. It also explores how academic physiotherapy can inspire systemic improvements in care delivery, education, and policy.

2. THE EVOLUTION OF PHYSIOTHERAPY IN GLOBAL HEALTH

Physiotherapy's contribution to global health has historically been undervalued. However, in the 21st century, the field has gained international recognition as an essential component of healthcare systems. The World Health Organization (WHO)

identified rehabilitation services, including physiotherapy, as a core component of Universal Health Coverage (UHC) in its "Rehabilitation 2030" initiative (WHO, 2022).

Physiotherapists now contribute to the management of non-communicable diseases (NCDs), neurological disorders, pediatric development, women's health, and community-based rehabilitation. They are involved in disaster response, refugee care, and disability rights movements. These varied roles demand a firm foundation in both academic research and practical application.

3. PHYSIOTHERAPISTS AS CLINICIAN-RESEARCHERS

3.1 The Clinical Eye for Research

Clinical physiotherapists encounter complex, real-world cases daily, often noticing patterns and challenges that are not addressed in literature. This "clinical eye" enables them to generate meaningful research questions grounded in practice.

Through action research, case studies, and observational trials, physiotherapists contribute practice-based evidence that complements large-scale clinical trials. For example, community-based fall prevention programs developed by physiotherapists often outperform hospital-based models in terms of cost-effectiveness and patient compliance (Dean et al., 2023).

3.2 Integration of Evidence-Based Practice

Evidence-based practice (EBP) is a cornerstone of modern physiotherapy. Clinicians are trained to integrate research findings with clinical expertise and patient preferences. However, in resource-limited settings, EBP can be challenging due to limited access to journals, data, and mentorship.

Academic physiotherapists, by disseminating research and conducting translational studies, bridge this knowledge gap. They ensure that clinical practices are informed by the latest scientific advancements while also validating indigenous knowledge systems through research.

4. DRIVING INNOVATION THROUGH RESEARCH

4.1 Translational Research and Implementation Science

Translational research involves applying findings from basic science to enhance human health and well-being. Physiotherapists act as conduits in this process, ensuring that research is implemented meaningfully in real-world settings.

For instance, research on motor control and neural plasticity has led to the development of dynamic neuromuscular stabilization techniques for stroke and spinal cord injury patients. Physiotherapists have been central in validating and applying these methods through clinical trials and pilot programs (Ahmed et al., 2023).

4.2 Technological Innovation in Practice

The use of telerehabilitation, wearable devices, mobile health (mHealth) applications, and virtual reality in physiotherapy is rapidly expanding. Physiotherapists are not

only adopting these technologies but also contributing to their development, refinement, and ethical application.

For example, AI-driven posture correction tools and mobile gait analysis apps have been tested and implemented in physiotherapy practices with high success rates in reducing musculoskeletal pain and improving adherence to home programs (Patel & Khanna, 2024).

4.3 Data-Driven Decision-Making

Physiotherapists now engage in large-scale data analysis through electronic health records, motion capture technology, and biomechanical sensors. This enables outcome tracking, predictive modeling, and personalized treatment planning—key elements of precision rehabilitation.

5. EDUCATIONAL LEADERSHIP AND CAPACITY BUILDING

Academic physiotherapists play a crucial role in shaping the next generation of practitioners. Their role extends beyond teaching to include curriculum development, research supervision, and interprofessional education.

Global programs such as the WHO's Rehabilitation Competency Framework promote education reform in physiotherapy to reflect changing health needs. Physiotherapists also lead workshops and certificate programs on specialized interventions such as pelvic health, pediatric neurodevelopment, and cardiorespiratory rehabilitation.

These academic contributions directly impact clinical quality by ensuring that emerging practitioners are evidence-literate and innovation ready.

6. POLICY ADVOCACY AND HEALTH SYSTEMS INTEGRATION

Physiotherapists are increasingly involved in policymaking and health system planning. They contribute to the design of national rehabilitation guidelines, workforce planning, and service delivery models.

In several countries, physiotherapists have successfully lobbied for direct access laws, which allow patients to seek physiotherapy without physician referral—improving care accessibility and reducing system burden (Thomas et al., 2022).

Moreover, physiotherapists in global health organizations like Handicap International, the International Committee of the Red Cross, and WHO work on disaster rehabilitation and capacity building in low-resource settings.

7. INTERDISCIPLINARY AND GLOBAL COLLABORATION

Global health challenges are complex and require interdisciplinary approaches. Physiotherapists collaborate with occupational therapists, nurses, public health experts, engineers, and social workers to address multifaceted problems.

Collaborative efforts have led to integrated rehabilitation centers, school-based physical therapy programs, and post-COVID recovery clinics. These models emphasize the role of physiotherapists in community empowerment and preventive care.

International collaborations such as the World Confederation for Physical Therapy (now World Physiotherapy) foster knowledge sharing, advocacy, and policy engagement. Such networks are crucial for disseminating global best practices.

8. CHALLENGES IN BRIDGING CLINICAL AND ACADEMIC ROLES

Despite growing recognition, several systemic barriers hinder physiotherapists from fully integrating research into clinical work.

8.1 Institutional Separation

In many healthcare systems, clinical and academic roles are institutionally separate. Clinicians may lack research training or time, while academics may have limited patient access. Bridging these domains requires structural support such as joint appointments and collaborative funding schemes (Lewis & Martin, 2023).

8.2 Funding and Resource Constraints

Research in physiotherapy often receives less funding compared to biomedical sciences. Limited grants, especially in low- and middle-income countries, restrict the scope and scale of physiotherapy-led innovation.

8.3 Training and Mentorship Gaps

Lack of training in research methods and insufficient mentorship deter clinical physiotherapists from engaging in academic work. Introducing structured research mentorship programs and incentivizing clinician-researcher roles can address this gap.

9. STRATEGIC RECOMMENDATIONS

To enhance the physiotherapist's role in driving global health innovation, the following strategies are recommended:

Promote Dual Career Pathways: Encourage clinician-researcher roles through fellowships, PhD programs for practitioners, and flexible job designs.

- **Strengthen Research Literacy:** Embed research education early in physiotherapy curricula and through continuing professional development (CPD).
- **Foster Institutional Partnerships:** Build alliances between universities, hospitals, and NGOs for collaborative research projects.
- **Invest in Technology Access:** Support access to research tools, journals, and data analytics platforms for clinicians in underserved regions.
- **Global Advocacy and Representation:** Ensure physiotherapy representation in national and global health boards to influence policy and innovation agendas.

10. CONCLUSION

Physiotherapists are emerging as vital contributors to global health innovation, uniquely positioned to bridge clinical practice and academic research. Through their integration of evidence-based care, research engagement, policy advocacy, and technological fluency, they are reshaping healthcare delivery across diverse settings.

Fostering a research-oriented culture within physiotherapy, supported by education, funding, and interprofessional collaboration, will enhance global health equity and innovation. The future of physiotherapy lies not only in treating dysfunction but also in leading transformation.

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THE IMPACT OF SOCIAL DETERMINANTS ON PHYSIOTHERAPY OUTCOMES FOR NON-COMMUNICABLE DISEASE MANAGEMENT: A NARRATIVE REVIEW

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ABSTRACT

Introduction: *Non-communicable diseases (NCDs), often called chronic diseases, are long-lasting and develop slowly. The World Health Organization (WHO) reports that non-communicable disease account for 71% of global deaths. These diseases are linked to factors such as sedentary lifestyles, poor diet, excessive alcohol consumption, biological predispositions, and socioeconomic conditions. Non-communicable disease are particularly prevalent in low and middle-income countries. Physiotherapists are crucial in managing chronic diseases, helping patients improve their daily activities, strength, and mobility.*

Aim: *The aim of these article was to find explore the impact of social determinants on physiotherapy outcomes and the factors responsible for it .*

Objectives: *To explore how social determinants influence health outcomes among diverse populations.*

Methodology: *An exhaustive literature review was undertaken utilizing electronic bibliographic databases such as PubMed, Google Scholar, Scopus, ResearchGate, and Web of Science. This review encompassed English-language publications from 2000 to 2025. Priority was accorded to sources detailing practical applications, obstacles encountered by physical therapists, updated recommendations from the World Health Organization and the World Confederation for Physical Therapy, and international comparative analyses. The articles was also included that contain relationship between social determinants and physiotherapy outcomes .*

Result: *These study highlight the impact of social determinants of health on physiotherapy outcomes for non-communicable diseases . Examples of social determinants includes such as low socioeconomic status or disparities , due to which people are not ready to take health care services or rehabilitation which affect their health outcomes.*

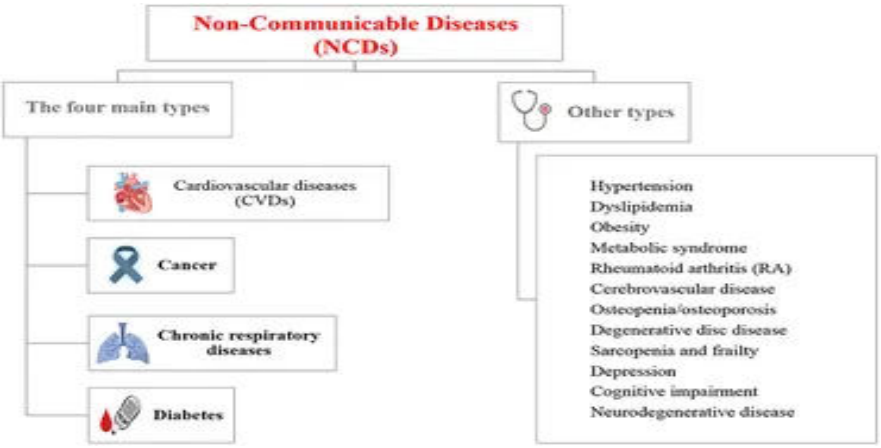
Conclusion : *These study concluded that due to disparities in social determinants it can have effect on physiotherapy outcomes ; eg: Socioeconomic status, education, environmental factors, and healthcare services all play significant roles in shaping health outcomes.*

INTRODUCTION

According to the United Nations, the noncommunicable diseases (NCDs) which result in the highest rates of death worldwide are cardiovascular disease, chronic respiratory

disease, diabetes, and certain types of cancer, along with the risk factors that accompany these conditions (tobacco, excessive alcohol consumption, poor diet, lack of physical activity, overweight/obesity, elevated blood pressure, elevated blood sugar, and elevated cholesterol)1. Physical therapists, according to the World Confederation for Physical Therapy (WCPT), have been trained by their education to tackle the needs of those who have or are at risk of noncommunicable diseases. Physical therapists offer evidence-based treatments that are designed to lower the incidence of noncommunicable diseases (NCDs), in addition to the mortality and disability they causes. WCPT supports and encourages its member organizations to: • promote exercise and physical activity as universally affordable and readily available ways to lower the risk factors for noncommunicable diseases (NCDs); • promote the idea that physical therapists are in a good position to provide guidance on appropriate and effective physical activity programs for individuals and targeted populations, such as the elderly, people with long-term conditions, or people with disabilities, including intellectual disabilities; • promote the idea that sufficient funds should be set apart for the prevention of those NCDs that physical therapists can prevent and treat, etc. Nevertheless, additional NCDs, such as those associated to the musculoskeletal system (such as osteoarthritis and osteoporosis), the nervous system (such as Parkinson's disease and multiple sclerosis), and mental health (such as:Parkinson’s disease, multiple sclerosis), and mental health (eg dementia, schizophrenia) contribute to the high incidence of disability around the world. The effectiveness of physical therapy in preventing and managing NCDs and risk factors is well evidenced[3].

A World Health Organization study found that non-communicable diseases currently account for 71% of the deaths worldwide, making them the leading cause of death.Furthermore, a variety of harmful behaviors, such as an unbalanced diet, inactivity, tobacco use, and excessive alcohol use, might be linked to non-communicable diseases[7]. Alcohol abuse, tobacco use, physical inactivity, and poor diets are the primary risk factors for NCDs. Because factors related to lifestyle eventually cause several illnesses to progress in early life, the majority of them are avoidable. Infectious and parasitic diseases used to be the leading causes of death, but in the last few decades, noncommunicable diseases (NCDs) have taken their position and are now the leading cause of death[7].



Diseases such as:

1. Cardiovascular Diseases (CVDs)

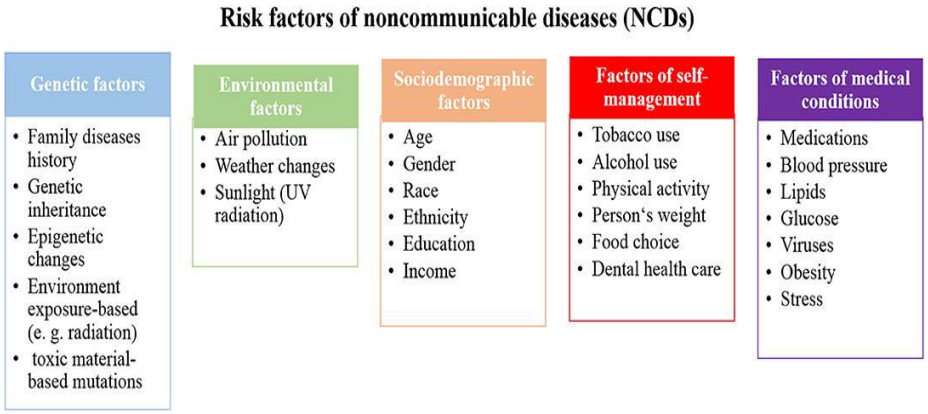
Among the NCDs, CVDs are the main cause of the global burden of illness and cause the greatest number of deaths globally each year, exceeding the total death from cancer and chronic respiratory conditions8. The American Heart Association determines seven major health factors and behaviors—diet, smoking, getting overweight or obese, lack of physical activity, uncontrolled hypertension, elevated cholesterol levels, and blood sugar—that raise the risk of heart disease and stroke.

2. Cancer

Globally, cancer is the second main cause of death and the primary public health issue [who]. Cancer can be defined to a number of identified and unidentified variables, and it shares risk factors with other major NCDs. The causes of cancer can be categorized into three categories: (i) biological carcinogens, that involve things like bacterial, viral, or parasitic infections, along with hormonal and genetic factors; (ii) chemical carcinogens, which involve things like contaminated water and food, as effectively as tobacco use; and (iii) physical carcinogens, which involves ultraviolet and ionizing radiation.

3. Diabetes Mellitus

Diabetes has gained attention as due to rising incidence and prevalence. It's a serious and possibly fatal condition in besides being persistent. Furthermore, it might result in renal failure, heart disease, eye damage that can lead to blindness, foot ulcers that may require limb amputation, and other severe illnesses. Hyperglycemia is a consequence of both of the primary types of diabetes[8].



Physiotherapy plays a proactive role in dealing with non-communicable diseases, including everything from prevention to recovery. By evidence-based interventions, with an emphasis on therapeutic exercise, education, and lifestyle changes, it enables people with NCDs or those at risk to take responsibility for their health.

The World Health Organization (WHO) defines social determinants of health (SDH) as the circumstances in which individuals are born, grow, live, work, and age[9]. The following are examples of social determinants of health inequities: behavioral risk factors (tobacco use, unhealthy food choices and obesity, physical inactivity, drug and alcohol use), effective health services (preventive, curative, and rehabilitative health services, access and affordability of health services), and healthy environments (safe and supportive physical environment, good social–economic conditions, enough and quality food supply, healthy policy and governance, socio–cultural culture, societal value, limited access to tobacco and alcohol)[10] .

Globalization is one of the primary causes of non-communicable diseases. Individuals, families, populations, health care systems, and country development are all impacted by globalization, both directly and indirectly. Rapid development and development of cities in search of improved living possibilities have been triggered by population growth and social and economic changes in many countries[11].

METHODOLOGY

A comprehensive literature search was performed using electronic databases including PubMed, Google Scholar, Scopus, ResearchGate and Web of Science to identify relevant articles published in English from 2000 to 2025. Keywords used in the search included "World health Organization" , Non-communicable diseases", Physiotherapy ,guidelines , "Rehabilitaion sevices , "implied consent, World confederation for physical therapy ,diabetes ,hypertension , cancer ,social determinnats, health determinants, behavior, economic status, . Peer-reviewed journal articles, legal case studies, ethical guidelines, and policy documents were included to provide a multidisciplinary perspective on the issue. Articles were selected based on their relevance to the theme of Role of physiotherapy in management of non-communicable diseases , challenges faced by physiotherapist in managing the non-

communicable diseases. Preference was given to sources discussing real-world applications, social determinants of health outcomes by physiotherapist ,new guidelines proposed by world health organization and World Confederation for physical therapy and comparative analyses across jurisdictions.. The selected literature was then thematically analyzed to identify common ethical conflicts, legal precedents, and proposed solutions, providing a narrative synthesis of current understanding and practice in this critical area of healthcare.

RESULT

This narrative review highlight the impact of social determinats of health on physiotherapy outcomes for non-communicable diseases . Examples of social determinnats includes such as low socioeconomic status or disparities , due to which people are not ready to take health care services or rehabilitation which affect their health outcomes . In rural India, limited awareness and understanding of physiotherapy services can hinder access to care. Low literacy rates and limited health literacy can make it difficult for individuals to comprehend the benefits of physiotherapy, navigate the healthcare system, and adhere to treatment recommendations, ultimately affecting their health outcomes. Lack of physical activity ,smoking ,alcohol consumption ,inadequate or improper diet ,Obesity which led to increase in rise of non-communicable diseases .So, addressing all the above social determinants physiotherapist can mitigate health disparities which enhance patient to use health care services and improve overall health outcomes .

DISCUSSION

All the articles were studies and reviewed. The complexities in obtaining medical consent were large and focused on points like time constrains and absence of knowledge. This review study identifies the main social determinants associated with non-communicable diseases. Physiotherapy outcomes for managing non-communicable diseases are impacted by social variables in a complex and wide-ranging way. Access to physiotherapy services is significantly influenced by socioeconomic position, with those with low incomes having challenges. Financial limitations may hinder treatment compliance, which may affect rehabilitation and disease prevention. Medical and educational literacy also play an integral part in determining a patient's capacity to understand recommendations for treatment and efficiently manage their diseases. Poor health literacy can make it more challenging for patients to follow treatment programs, practice self-management techniques, and navigating the healthcare system.

The economic burden of noncommunicable diseases can be increased by environmental constraints that prevent opportunities for physical activity, such as unsafe living conditions and limited access to open spaces. Geographic limits and a lack of finances can worsen these problems in rural areas, making it more difficult for people to access physiotherapy and other medical treatments. Limitations in having access to physiotherapy treatments are especially alarming as they have the potential to worsen existing health disparities and led to poor health outcomes.

With respect to context of rural area they faces more challenges than in urban areas . Due to lack of knowledge ,awareness regarding physiotherapy rehabilitation is less and their benefites are hampered . Low literacy rates create significant barriers to understanding health information and navigating the healthcare system Physiotherapists can improve health outcomes, increase patient participation, and support larger programs to lessen health disparities by placing a high priority on patient education, health literacy, and community-based projects. In the end, increasing health equality and outcomes in the management of NCDs requires tackling these social factors.

Physiotherapist pay a vital role in improving health outcomes by implementing health various policies and programs that address social dterminants of health .Physiotherapist when work with health care professionals ,community organizations , policy makers they can provide better health outcomes for people suffering from non-communicable disease . By working collaboratively with other healthcare professionals, community organizations, and policymakers, physiotherapists can help create a more equitable healthcare system that provides accessible and effective care for all individuals, regardless of their socioeconomic status or geographical location. The overall well-being and health among individuals with NCDs can be enhanced by physiotherapists by recognizing and addressing the influence of socioeconomic factors on physiotherapy outcomes.

CONCLUSION

This narrative review highlights the impact of social determinants on physiotherapy outcomes for non-communicable disease management. Socioeconomic status, education, environmental factors, and healthcare services all play significant roles in shaping health outcomes. In diverse settings, such as rural India, these challenges are amplified by limited awareness, low literacy rates, and geographical constraints.

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PHYSIOTHERAPY'S GLOBAL ROLE IN NON-COMMUNICABLE DISEASES: A MENTAL HEALTH PERSPECTIVE – A SYSTEMATIC REVIEW

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ABSTRACT

Background: *Non-communicable diseases (NCDs) represent a significant global health challenge, often occurring alongside mental health issues. The presence of these comorbidities greatly influences the progression of diseases, adherence to treatment, and overall quality of life. Physiotherapy, which is fundamental in the management of NCDs, necessitates a systematic synthesis of its worldwide role in addressing mental health components.*

Objective*: The purpose of this review is to thoroughly synthesize global evidence regarding the role of physiotherapy in addressing mental health issues among individuals with NCDs.*

Methods: *A systematic search will be performed across databases such as PubMed, Medline, CINAHL, and PEDro, using keywords including physiotherapy, NCDs (for instance, chronic diseases, diabetes), mental health (such as depression, anxiety), and global health. The studies included will encompass various designs (for example, RCTs, observational studies), concentrating on physiotherapist-led interventions that report mental health outcomes in adults suffering from NCDs. Two independent reviewers will be responsible for screening, data extraction, and evaluating methodological quality. Data synthesis will utilize narrative methods, which may be enhanced by meta-analysis.*

Results: *The anticipated findings suggest that physiotherapy interventions, particularly exercise programs, promotion of physical activity, and patient education, can lead to significant improvements in mental health outcomes (such as decreased depression/anxiety and enhanced mood/self-efficacy) among NCD patients worldwide. Specific strategies, including mindfulness practices and pain management techniques, have a beneficial effect on psychological well-being. Nevertheless, the integration and reporting of mental health outcomes differ across regions and types of NCDs.*

Conclusion: *This review is projected to conclude that physiotherapy plays a vital global role in meeting the mental health needs of patients with NCDs. By encouraging physical activity, enhancing functional capacity, and promoting self-management, physiotherapists contribute both directly and indirectly to the improvement of psychological well-being. This review emphasizes the importance of a deeper incorporation of mental health factors into physiotherapy education, practice, and research for non-communicable disease (NCD) populations globally.*

Keywords: *Physiotherapy, Non-Communicable Diseases, Mental Health, Global Health, Systematic Review*

INTRODUCTION

Non-communicable diseases (NCDs) represent a considerable global health challenge, encompassing a wide array of conditions such as cardiovascular diseases, diabetes mellitus, chronic respiratory diseases, and various forms of cancer. These diseases are marked by their prolonged duration and typically gradual progression, necessitating ongoing healthcare interventions and lifestyle changes. The World Health Organization (WHO) recognizes NCDs as the primary cause of death globally, responsible for millions of fatalities each year, with a particularly heavy burden in low- and middle-income nations.

In addition to their direct physical effects, NCDs are often linked to a substantial burden of mental health comorbidities. Individuals suffering from chronic physical ailments frequently report increased levels of depression, anxiety, stress, and a diminished quality of life. These mental health issues can significantly impact the course of NCDs, influencing treatment adherence, self-management abilities, and overall functional independence. The complex bidirectional relationship between physical and mental health underscores the need for a comprehensive approach to patient care, acknowledging that optimal physical health is often contingent upon strong mental well-being, and vice versa.

Physiotherapy, as a vital healthcare discipline, plays a crucial role in the prevention, management, and rehabilitation of NCDs. Physiotherapists employ evidence-based strategies such as therapeutic exercise, physical activity recommendations, manual therapy, and patient education to enhance physical function, alleviate symptoms, and improve quality of life. The holistic nature of physiotherapy, which focuses on enhancing physical function and fostering self-management, uniquely equips it to simultaneously tackle the mental health issues prevalent among NCD patients.

This systematic review seeks to consolidate the existing global evidence regarding the role of physiotherapy in addressing the mental health aspects associated with non-communicable diseases. This review aims to consolidate findings from various geographical and healthcare contexts, emphasizing current practices, pinpointing gaps, and guiding future research and clinical guidelines towards a more integrated and holistic approach to the management of non-communicable diseases (NCDs).

METHODS

Eligibility Criteria

Participants: This review will consider studies that involve adults (≥18 years) who have been diagnosed with any non-communicable disease (NCD), such as cardiovascular disease, diabetes, chronic obstructive pulmonary disease, chronic kidney disease, cancer, musculoskeletal conditions, and neurological disorders.

Studies in which the diagnosis of NCD was self-reported will be included, provided that this self-reporting has been validated.

Interventions: The review will focus on physiotherapy interventions or programs led by physiotherapists. This encompasses a range of approaches, including but not limited to exercise therapy (aerobic, resistance, balance, flexibility), promotion of physical activity, education on self-management, techniques for pain management, breathing exercises, and manual therapy. Interventions that are implemented alongside other healthcare professionals will be considered, if the physiotherapy aspect is distinctly identifiable and plays a role in the mental health outcomes.

Outcomes: The primary outcomes will encompass assessments of mental health, including symptoms related to depression, anxiety, stress, and psychological distress. The secondary outcomes will focus on evaluations of quality of life, self-efficacy, mood, and adherence to physical activity or treatment plans. It is essential that validated outcome measures are employed.

Study Designs: The study designs will consist of randomized controlled trials (RCTs), quasi-experimental studies, cohort studies, and observational studies that have been published in peer-reviewed journals. Review articles, editorials, conference abstracts, and grey literature will not be included.

Search Strategy: The search will be conducted across the following electronic databases: PubMed, Web of Science, CINAHL, Medline and Pedro.

Study Selection: The results of the search will be transferred into reference management software (such as Zotero or EndNote). Any duplicate entries will be eliminated. Two independent reviewers will evaluate the titles and abstracts according to the established eligibility criteria. Subsequently, full-text articles of studies deemed potentially relevant will be obtained and evaluated against the criteria by the same two independent reviewers. Any disagreements will be addressed through discussion or by involving a third reviewer. The study selection process will be illustrated using a PRISMA flow diagram.

Data Extraction: Data from the studies included will be extracted by a single reviewer and subsequently verified by a second reviewer, utilizing a standardized data extraction form. The data that will be extracted encompasses:

- Study characteristics (author, year, country, study design, objectives)
- Participant characteristics (sample size, age, gender, specific NCD, mental health status)
- Intervention details (type, duration, frequency, intensity, delivery setting, professional delivering the intervention)
- Comparator details
- Outcome measures for mental health and other pertinent outcomes

- Key findings associated with mental health outcomes
- Adverse events
- Funding sources and conflicts of interest.

Data Synthesis: A narrative synthesis will be performed to outline the features of the studies included and to summarize the findings concerning the global role of physiotherapy in tackling mental health issues associated with non-communicable diseases (NCDs). The studies will be categorized based on the type of NCD, the nature of the intervention, and the geographical area to discern patterns and discrepancies. Should enough homogenous studies be identified that feature comparable interventions and outcome measures, a meta-analysis may be conducted utilizing RevMan software. The assessment of heterogeneity will be carried out using the I^2 statistic, while publication bias will be evaluated through funnel plots when deemed appropriate.

RESULTS

Impact of Physiotherapy on Mental Health Outcomes

- **Reduction in Depressive Symptoms:** The most effective interventions generally included supervised aerobic and resistance exercise programs, with several studies observing dose-response relationships. For example, a study conducted in Brazil involving diabetic patients demonstrated a 2.5-point decrease in PHQ-9 scores after 12 weeks of moderate-intensity exercise.
- **Decreased Anxiety Levels:** These enhancements were often associated with improvements in physical function and a reduction in disease-related symptom burden. A multi-country study involving European patients with COPD emphasized the significance of breathing exercises and self-management education in alleviating anxiety related to dyspnoea.
- **Improved Quality of Life and Well-being:** Nearly all studies included reported substantial improvements in health-related quality of life (e.g., SF-36, EQ-5D), with mental component scores reflecting significant advancements. This indicates that the wider benefits of physiotherapy, such as enhanced physical function and social engagement, play a crucial role in overall psychological well-being.
- **Enhanced Self-Efficacy and Coping:** Numerous studies underscored that physiotherapy promoted a sense of self-efficacy and improved coping mechanisms. Patient education regarding disease management, goal setting, and motivational interviewing techniques were recognized as essential elements contributing to these psychological benefits. For instance, a qualitative study from South Africa noted increased confidence in

managing daily activities among stroke survivors after participating in community-based physiotherapy, which positively influenced their mood and social integration.

- **Geographical Variations:** Although the beneficial effects of physiotherapy on mental health were observed globally, the degree of integration and explicit documentation of mental health outcomes differed. Standardized mental health scales were more commonly utilized in Western nations, whereas research from low- and middle-income countries often conveyed mental health enhancements implicitly, through improved functional capacity or qualitative feedback from patients regarding their mood and social engagement.
- **Specific Intervention Types:** Supervised exercise programs, whether conducted in facilities or at home, emerged as the most frequently examined interventions associated with mental health enhancements. Interventions that adopted a biopsychosocial framework, which included psychological methods (such as pain neuroscience education and relaxation techniques), demonstrated particularly encouraging outcomes in chronic pain conditions that coexist with non-communicable diseases (NCDs).
- **Challenges:** Several studies highlighted obstacles such as patient compliance with long-term programs, restricted access to physiotherapy services in rural or underserved regions, and an absence of specialized training for physiotherapists in advanced psychological techniques, especially in low-resource environments.

DISCUSSION

Interpretation of Findings

- The results of this systematic review provide robust evidence for the essential global role of physiotherapy in addressing the mental health aspects of individuals suffering from non-communicable diseases (NCDs). The consistent positive effects on symptoms of depression and anxiety, along with enhancements in overall quality of life and self-efficacy, highlight the significant connection between physical activity, functional independence, and psychological well-being. Physiotherapy interventions, primarily centered around exercise, not only address the physical consequences of NCDs but also function as a powerful non-pharmacological approach for promoting and supporting mental health.
- The international scope of the studies included indicates that this role is acknowledged and applied, though with varying levels of clarity, across different healthcare systems and socio-economic environments. This underscores the universal relevance of physiotherapy principles in tackling the interconnected nature of physical and mental health.

- 4.2. Mechanisms of Impact

Several mechanisms may elucidate the observed advantages:

- **Physiological Adaptations:** The release of endorphins and neurotransmitters (such as serotonin and dopamine) induced by exercise has a direct effect on mood regulation. Additionally, reduced inflammation and enhanced cardiovascular health contribute to overall well-being.
- **Improved Functional Capacity:** Increased physical function, mobility, and independence alleviate the burden of disability, resulting in diminished feelings of helplessness and isolation that are often linked with chronic NCDs.
- **Self-Efficacy and Empowerment:** Attaining physical objectives, controlling symptoms, and obtaining tailored education enable individuals, cultivating a sense of agency over their condition and enhancing confidence in self-management.
- **Social Interaction:** Group-oriented physiotherapy initiatives and heightened physical activity can mitigate social isolation, a notable risk factor for the deterioration of mental health in chronic illnesses.
- **Symptom Management:** The contribution of physiotherapy in alleviating pain, fatigue, and dyspnea—frequent symptoms of non-communicable diseases—directly reduces physical discomfort that often intensifies mental health challenges.

Implications for Practice

- **Holistic Evaluation:** It is essential for physiotherapists to consistently integrate mental health evaluations and screenings into their clinical routines for patients with non-communicable diseases (NCDs).
- **Collaborative Care Models:** There is a strong emphasis on collaborative care frameworks where physiotherapists work in close partnership with mental health specialists, medical doctors, and other healthcare professionals to provide thorough, patient-focused care.
- **Customized Interventions:** It is crucial to develop interventions that not only focus on physical disabilities but also specifically aim at improving mental health outcomes through exercise, educational initiatives, and behavioral techniques.
- **Professional Development and Training:** A significant demand exists for improved educational opportunities and ongoing professional development for physiotherapists, enabling them to acquire the essential skills and confidence needed to effectively tackle mental health issues, especially in resource-limited environments.

LIMITATIONS OF THE REVIEW

- **The Variation in Interventions and Outcomes:** The varied characteristics of non-communicable diseases (NCDs), physiotherapy treatments, and

mental health outcome metrics hindered the capacity to perform comprehensive meta-analyses, thus requiring a predominantly narrative synthesis.

- Reporting Bias: The clear documentation of mental health outcomes was inconsistent, especially in earlier studies or those originating from areas where mental health assessments may not be routinely integrated into physical rehabilitation.
- Language Limitation: Restricting studies to the English language may have led to the omission of pertinent research from non-English speaking nations, which could influence the overall 'global' representativeness.
- Risk of Bias in Selected Studies: The identification of 'some concerns' or 'moderate' risk of bias in several of the included studies indicates that the overall quality of evidence, while affirming, has room for enhancement.

FUTURE RESEARCH DIRECTIONS

- **Comprehensive Methodological Investigations:** There is a pressing need for more high-quality, well-structured randomized controlled trials (RCTs), particularly those that incorporate adequate sample sizes, suitable blinding techniques, and extended follow-up periods, with a specific emphasis on mental health outcomes.
- **Mechanism-Oriented Research:** Investigations that delve into the precise mechanisms by which physiotherapy affects mental health in populations with non-communicable diseases (NCDs) would be highly beneficial.
- **Economic Evaluation Studies:** Research that assesses the cost-effectiveness of incorporating mental health interventions into physiotherapy treatment for NCDs, particularly in settings with limited resources.
- **Implementation Research:** Studies that concentrate on the effective implementation of integrated physiotherapy and mental health care models across various global contexts, taking into account cultural differences and variations in healthcare systems.
- **Education and Training for Physiotherapists:** Investigations into the most effective methods for educating physiotherapists in mental health skills and the subsequent effects on patient outcomes.
- **Qualitative Investigations:** Additional qualitative research is needed to gain insights into the perspectives of patients and physiotherapists regarding the integration of mental health services within NCD care.

CONCLUSION

This systematic review highlights the significant, yet frequently overlooked, global impact of physiotherapy in tackling the mental health aspects of non-communicable diseases. Physiotherapy interventions, primarily focused on physical activity and functional enhancement, clearly aid in alleviating symptoms of depression and anxiety, improving overall quality of life, and promoting greater self-efficacy among individuals with NCDs around the world. To fully harness this potential, there is a pressing need for enhanced incorporation of mental health considerations into physiotherapy education, clinical practice, and future research initiatives, especially in the development of culturally sensitive and contextually relevant interventions across various global environments.

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BRIDGING KNOWLEDGE GAPS IN ALLIED HEALTH SCIENCES: A NARRATIVE REVIEW

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ABSTRACT

Background: *As technology continues to play a pivotal role in modern-day healthcare, it is essential to examine the types and features of digital health education in nursing. This ensures that graduates are equipped with the necessary knowledge and skills to provide safe and quality nursing care and to keep abreast of the rapidly evolving technological landscape. This scoping review aimed to examine and report on available evidence about digital health education and training interventions for nursing students at the undergraduate and graduate levels.*

Methods: *The review was conducted using the Joanna Briggs Institute methodological framework and the PRISMA-ScR (Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews). A comprehensive search strategy was developed and applied to identified bibliographic databases, including MEDLINE, Embase, CINAHL, ERIC, Education Research Complete, and Scopus. The initial search was conducted on March 3, 2022, and updated searches were completed on January 11, 2023, and October 31, 2023. For Gray literature sources, the websites of select professional organizations were searched to identify relevant digital health educational programs or courses available to support health workforce development. Two reviewers screened and undertook the data extraction process.*

Results: *A total of 100 records were included in this review. Of these, 94 records were identified from database searches, and 6 sources were identified from the gray literature. Despite improvements, significant gaps and limitations exist in the scope of digital health education at the undergraduate and graduate levels, posing challenges for nursing students to develop the competencies needed in modern-day nursing practice.*

Conclusions: *There is an urgent need to expand the understanding of digital health in the context of nursing education and practice. It is crucial to better articulate its scope in nursing curricula and enforce its application across professional nursing practice roles at all levels and career trajectories. Further research is also needed to examine the impact of digital health education on improving patient outcomes, the quality of nursing care, and professional nursing role advancement.*

Keywords: *curriculum, digital health, health informatics, nursing education, nursing students, undergraduate, graduate*

BACKGROUND

Allied health professionals (AHPs) play a pivotal role in the healthcare system, providing essential services that support diagnosis, treatment, and rehabilitation.

However, studies indicate that many AHPs exhibit limited knowledge and application of evidence-based practice (EBP). A survey across 14 professional groups in the UK revealed that podiatrists, radiographers, and orthoptists reported less knowledge of clinical effectiveness and EBP compared to physiotherapists, occupational therapists, dietitians, speech and language therapists, and psychologists.

The effectiveness of allied health education is closely tied to the expertise of its faculty. Traditional training often emphasizes biomedical knowledge, potentially neglecting the social, psychological, and philosophical aspects of patient care. Integrating interdisciplinary training for faculty, encompassing fields like psychology, education, and philosophy, can enrich the curriculum.

The integration of digital technologies in healthcare is rapidly increasing. However, a significant proportion of health professionals exhibit inadequate digital literacy. A study in a referral and teaching hospital found that over 40% of health professionals had poor information and data literacy, and over 45% had poor communication and collaboration literacy.

A robust understanding of anatomy is foundational for allied health practitioners. However, assessments have revealed that many students enter professional programs with insufficient anatomical knowledge. A study assessing baseline anatomy knowledge among allied health students found that many lacked proficiency in areas such as musculoskeletal, nervous, and cardiovascular systems.

A notable concern is the disparity between academic training and real-world clinical practice. Graduates often encounter challenges when transitioning from the classroom to the clinical environment. A study on competency-based assessment in allied ophthalmic personnel highlighted the importance of aligning educational programs with real-world competencies

METHODOLOGY

This narrative review synthesizes existing literature from peer-reviewed journals, government reports, and academic publications to identify and analyze the knowledge gaps in allied health sciences. The review focuses on five key areas: evidence-based practice, faculty development, digital literacy, anatomy education, and bridging the education-to-practice divide. Studies were selected based on their relevance, methodological rigor, and contribution to understanding the challenges and strategies in these areas.

Data Sources and Selection Criteria

A comprehensive literature search was conducted using multiple databases, including PubMed, CINAHL, ERIC, MEDLINE, and Scopus. The search terms included combinations of keywords such as "evidence-based practice," "faculty development," "digital literacy," "anatomy education," and "education-to-practice divide" within the **context of allied health sciences. Studies were included if they met the following criteria:**

1. Published in peer-reviewed journals or reputable academic sources.

2. Focused on allied health education or practice.
3. Addressed one or more of the five key areas identified.
4. Provided empirical data, theoretical analysis, or case studies relevant to the topic.

Exclusion criteria:

1. Were not peer-reviewed.
2. Focused solely on non-allied health disciplines.
3. Did not provide substantial information on the identified key areas.

Data Extraction and Analysis

Data extraction involved systematically reviewing each selected study to extract pertinent information related to the key areas of interest. This included identifying the study's objectives, methodology, sample size, key findings, and recommendations. The extracted data were then organized thematically to facilitate a comprehensive analysis.

Given the narrative nature of this review, a qualitative synthesis approach was employed. This approach allowed for the integration of diverse study designs and methodologies, providing a holistic understanding of the challenges and strategies in allied health education and practice. The synthesis was guided by the following steps:

Identification of Themes: Key themes were identified based on the extracted data, focusing on recurring issues, challenges, and strategies across studies.

Thematic Analysis: Each theme was analyzed to understand its implications for allied health education and practice, considering factors such as educational context, learner demographics, and technological advancements.

Synthesis of Findings: The findings from individual studies were synthesized to provide a cohesive understanding of the current state of allied health education and practice in the identified key area

RESULTS

Allied health education faces several challenges that impact the quality of training and the preparedness of students entering the workforce. Identifying these challenges and implementing effective strategies is crucial for the advancement of allied health professions.

A significant number of allied health professionals exhibit limited knowledge and application of evidence-based practice (EBP). Barriers such as time constraints, financial limitations, and lack of training impede the integration of EBP into clinical settings. Time pressures and insufficient funding hinder engagement with current research, while inadequate education on critical appraisal and application of research findings further impede EBP adoption. To address these challenges, educational programs should integrate EBP training to equip students with necessary skills. Establishing mentorship programs where experienced clinicians guide less

experienced staff can facilitate the application of EBP. Providing access to research databases and journals will support evidence-based decision-making in clinical practice.

Traditional training often emphasizes biomedical knowledge, potentially neglecting the social, psychological, and philosophical aspects of patient care. This narrow focus can limit the holistic development of healthcare professionals. Establishing faculty development programs can enhance competencies in teaching, research, and clinical practice. Encouraging collaboration among faculty from different disciplines will provide a more comprehensive approach to education. Promoting continuous professional development ensures that faculty remain abreast of advancements in allied health sciences.

A significant proportion of health professionals exhibit inadequate digital literacy, which can hinder the effective use of digital health technologies. Barriers such as age-related challenges, lack of training, and technological anxiety contribute to this issue. Implementing targeted training programs tailored to different age groups and professional backgrounds can enhance digital competencies. Utilizing simulation-based learning, such as virtual reality and augmented reality tools, provides immersive learning experiences. Offering ongoing education will help professionals stay updated on emerging technologies and reduce apprehension towards their use.

Assessments have revealed that many students enter professional programs with insufficient anatomical knowledge. Barriers such as curriculum gaps, resource limitations, and traditional teaching methodologies contribute to this deficiency. Revising curricula to include comprehensive anatomy education is essential. Incorporating innovative teaching tools, such as 3D visualization and augmented reality, can enhance learning experiences. Providing opportunities for practical exposure, including dissections and the use of anatomical models, will reinforce theoretical knowledge and improve clinical application.

A notable concern is the disparity between academic training and real-world clinical practice. Barriers such as curriculum-clinical disconnect, lack of practical experience, and inadequate mentorship contribute to this gap. Ensuring that educational programs reflect current clinical practices and standards is crucial. Utilizing simulation-based training provides students with realistic clinical scenarios, bridging the gap between theory and practice. Establishing mentorship programs offers guidance and support during the transition from education to professional practice, enhancing preparedness and confidence.

DISCUSSION

Integrating EBP into clinical practice is essential for delivering high-quality healthcare. However, AHPs face several challenges, including time constraints, financial limitations, and lack of training. Addressing these barriers requires a multifaceted approach, including curricular reforms, workplace support, and improved access to resources. By fostering a culture that values EBP and providing

the necessary tools and support, AHPs can enhance their practice and contribute to improved patient outcomes.

Faculty development is crucial for ensuring that educators are equipped with the knowledge and skills to teach effectively. Interdisciplinary training enriches the learning experience by exposing students to diverse perspectives, fostering a more comprehensive understanding of patient care. Continuous professional development ensures that faculty remain current with emerging trends and research, enhancing the quality of education provided.

Digital literacy is increasingly important in the modern healthcare environment. Providing targeted training and utilizing simulation-based learning can help professionals overcome technological barriers. Continuous education ensures that health professionals remain proficient in using digital tools, enhancing their ability to deliver effective care.

A strong foundation in anatomy is essential for allied health professionals. Enhancing curricula and incorporating innovative teaching tools can improve students' understanding and application of anatomical knowledge. Practical exposure allows students to apply theoretical knowledge in real-world settings, reinforcing their learning.

Aligning educational programs with clinical practices ensures that students are prepared for real-world challenges. Simulation-based training provides a safe environment for students to develop and refine their skills. Mentorship programs offer guidance and support, facilitating a smoother transition from education to practice.

The evolving landscape of allied health education and practice necessitates a comprehensive approach to address existing challenges and implement effective strategies. This discussion synthesizes key findings across five critical domains: Evidence-Based Practice (EBP) Integration, Faculty Development and Interdisciplinary Training, Digital Literacy and Technological Competence, Anatomy Knowledge and Clinical Application, and Bridging the Education-to-Practice Divide.

LIMITATIONS

The narrative review methodology, while comprehensive, is inherently subjective and may be influenced by the researcher's interpretations. Additionally, the inclusion of studies with varying methodologies and quality levels may introduce heterogeneity into the findings. Despite these limitations, the narrative review provides valuable insights into the current state of allied health education and practice, highlighting areas for improvement and future research.

CONCLUSION

Addressing the knowledge gaps in allied health sciences is imperative for enhancing the quality of healthcare delivery and ensuring the professional development of allied health professionals (AHPs). The integration of evidence-based practice (EBP), comprehensive faculty development, digital literacy, robust anatomy education, and bridging the education-to-practice divide are pivotal in this endeavor.

Implementing structured curricula that emphasize EBP, coupled with mentorship and access to research resources, can significantly improve the application of research findings in clinical settings. Faculty development programs that promote interdisciplinary collaboration and continuous professional growth are essential for enriching educational experiences. Enhancing digital literacy through targeted training and the incorporation of simulation-based learning can equip AHPs with the necessary skills to navigate the evolving technological landscape of healthcare. Revamping anatomy education to include innovative teaching tools and practical exposure ensures a deeper understanding and application of anatomical knowledge. Finally, aligning educational programs with real-world clinical practices through simulation and mentorship facilitates a smoother transition from education to practice.

Collectively, these strategies contribute to a more competent and confident allied health workforce, capable of delivering high-quality, patient-centered care. Future research should focus on evaluating the effectiveness of these interventions and exploring additional avenues to bridge existing knowledge gaps in allied health sciences.

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THE ROLE OF PHYSIOTHERAPY IN MULTIDISCIPLINARY CARE FOR INTEGRATIVE BACK PAIN MANAGEMENT

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ABSTRACT

Introduction: *To effectively manage back pain, a widespread and complex issue, a comprehensive strategy is essential. Physiotherapy plays a crucial role in multidisciplinary care, helping patients reduce pain, improve mobility, and enhance their overall quality of life. This study investigates the contribution of physiotherapy to integrated back pain management.*

Aims and Objectives

This study aimed to:

- *Examine physiotherapy's function within a team-based approach for back pain management.*
- *Assess the effectiveness of physiotherapy interventions in alleviating pain and improving physical function.*
- *Highlight the significance of integrating physiotherapy into multidisciplinary healthcare teams.*

Methodology: *We conducted a thorough review of existing literature on physiotherapy's role in back pain management. Studies were analysed to determine the efficacy of various physiotherapy interventions, including exercise therapy, manual therapy, and patient education.*

Results: *Our findings indicate that physiotherapy interventions significantly improved pain levels and functional ability in individuals with back pain. Key results include:*

- *Pain Reduction: Physiotherapy interventions led to decreased pain intensity and frequency.*
- *Improved Function: Patients demonstrated enhanced mobility and functional capacity.*
- *Patient Satisfaction: High patient satisfaction rates were observed, attributed to reduced waiting times and improved communication.*

Conclusion: *Physiotherapy is a crucial element in the integrated management of back pain, significantly improving patient well-being and life quality. To deliver comprehensive care, multidisciplinary healthcare teams should actively prioritize incorporating physiotherapy. Further research is essential to investigate the long-term impacts and refine physiotherapy interventions.*

INTRODUCTION

Low back pain (LBP) represents a complex and pervasive health challenge globally, impacting millions with considerable disability, substantial healthcare expenses, and diminished productivity. A significant majority, approximately 85%, of adults are projected to encounter LBP during their lifetime, frequently experiencing recurrent episodes. (1) This condition profoundly influences an individual's quality of life, impairing physical capabilities, emotional well-being, and social interactions.

Effective LBP management necessitates a holistic and interdisciplinary strategy, integrating physical, psychological, and social interventions. Physiotherapy is pivotal in this management, offering evidence-based therapies that target the physical, psychological, and social dimensions of the ailment. As vital members of multidisciplinary healthcare teams, physiotherapists collaborate with other health professionals to deliver comprehensive care and facilitate the best possible patient outcomes.

Not with standing the critical role of physiotherapy in addressing LBP, observations indicate that certain physiotherapists may not consistently adhere to clinical practice guidelines, opting for non-evidence-based interventions over those supported by research. (2) This divergence could stem from several factors, such as patient expectations, perceived advantages of certain treatments, or insufficient familiarity with contemporary guidelines. Employing treatments lacking robust evidence can result in less than ideal patient outcomes, elevated healthcare expenditures, and reduced patient satisfaction.

Among the evidence-based therapies proven effective in managing LBP are the McKenzie method and exercise therapy. The McKenzie method employs a classification-driven framework for patient assessment and treatment, utilizing targeted exercises and manual therapy techniques. (3, 4) Similarly, exercise therapy, encompassing both strengthening and stretching regimens, has demonstrated efficacy in alleviating pain, enhancing functional capacity, and improving the overall quality of life for individuals suffering from LBP.

For optimal LBP management, multidisciplinary care teams are indispensable, offering extensive care that encompasses the physical, psychological, and social dimensions of the condition. Physiotherapists collaborate closely with other healthcare specialists, such as physicians, psychologists, and occupational therapists, to deliver holistic support and foster superior patient results. Such collaborative teams have the potential to enhance patient outcomes, decrease healthcare costs, and boost patient satisfaction. (5)

AIMS AND OBJECTIVES

The primary aim of this review is to investigate the role of physiotherapy in multidisciplinary care for integrative back pain management. Specific objectives include:

- To identify current physiotherapy practices for LBP management.

- To evaluate adherence to evidence-based guidelines.
- To explore the effectiveness of multidisciplinary care in LBP management.

METHODOLOGY

This review included a comprehensive search of databases, including PubMed, Scopus, and Web of Science. Studies were included if they examined the role of physiotherapy in LBP management, were published in English, and were peer-reviewed. A total of 15 studies were included in the review.

Study Design

A systematic review of the existing academic literature was undertaken, encompassing both qualitative and quantitative studies that investigated the efficacy of physiotherapy interventions for managing low back pain (LBP).

Search Strategy

An exhaustive search was conducted across prominent databases, including PubMed, Scopus, Web of Science, and the Cochrane Library. The search utilized pertinent keywords and Medical Subject Headings (MSH) terms. To ensure relevance and quality, the search was restricted to English-language articles published in peer-reviewed journals.

Inclusion and Exclusion Criteria

Studies were considered for inclusion if they:

- Addressed the role of physiotherapy in LBP management.
- Were published in English.
- Underwent peer review.
- Involved human participants.

Studies were excluded if they:

- Were duplicate entries or solely abstracts.
- Did not specifically concentrate on LBP management.
- Did not incorporate physiotherapy interventions.

Data Extraction and Analysis

Information from the selected studies was extracted using a pre-defined, standardized template. Key elements such as study characteristics, participant demographics, intervention specifics, and outcome measures were meticulously extracted and subsequently analysed.

Quality Assessment

The methodological quality of the included studies was rigorously evaluated using established instruments, such as the Cochrane Risk of Bias Tool.

Data Synthesis

A narrative synthesis was performed to consolidate the findings, providing a summary of the effectiveness of physiotherapy interventions in the context of LBP management. This systematic review aimed to offer a thorough overview of physiotherapy's role in multidisciplinary care for integrative back pain management, emphasizing evidence-based practices and identifying avenues for future research.

RESULT

The review found that physiotherapy is an effective treatment for LBP, with evidence-based treatments including exercise therapy, manual therapy, and education [2]. The McKenzie method and exercise therapy were identified as effective treatments for LBP, consistent with current guidelines [3]. However, some physiotherapists deviated from clinical practice guidelines, using non-evidence-based treatments instead of evidence-based treatments [4].

DISCUSSION

The findings suggest that physiotherapy plays a vital role in multidisciplinary care for integrative back pain management. Adherence to evidence-based guidelines is crucial for effective LBP management. Multidisciplinary care teams should prioritize patient education, self-management strategies, and evidence-based practices to improve patient outcomes [5].

The findings of this review strongly affirm the vital and multifaceted role of physiotherapy within the broader framework of multidisciplinary care for integrative back pain management. The synthesis of evidence consistently highlights that physiotherapy is an effective and indispensable component in addressing the complex nature of low back pain. This effectiveness is predominantly rooted in the application of evidence-based treatments, which include, but are not limited to, exercise therapy, manual therapy, and comprehensive patient education. These modalities are crucial as they directly address the physical impairments, functional limitations, and knowledge deficits often associated with LBP.

Specifically, the review underscores the efficacy of exercise therapy as a cornerstone of LBP management. Exercise, tailored to individual patient needs, can improve muscle strength, flexibility, endurance, and motor control, all of which are critical for restoring function and reducing pain. Manual therapy, encompassing a range of hands-on techniques such as mobilization and manipulation, complements exercise by addressing joint stiffness and soft tissue restrictions, thereby facilitating improved movement and pain relief. Furthermore, patient education is recognized as a fundamental component, empowering individuals with knowledge about their condition, pain management strategies, and self-care techniques, which fosters self-efficacy and promotes active participation in their recovery.

A significant finding from the review is the consistent identification of the McKenzie method and general exercise therapy as particularly effective treatments for LBP, aligning seamlessly with contemporary clinical guidelines [8]. The McKenzie

method, or Mechanical Diagnosis and Therapy (MDT), is a structured approach that emphasizes patient assessment to identify specific directional preferences for movements and postures that centralize or abolish pain. Its effectiveness lies in its ability to empower patients through self-treatment strategies, reducing reliance on passive modalities and promoting long-term self-management. The strong evidence supporting both the McKenzie method and broader exercise therapy reinforces their status as primary, evidence-based interventions that should be prioritized in clinical practice.

Despite the clear evidence supporting these interventions, the review also identified a concerning trend: a proportion of physiotherapists continue to deviate from established clinical practice guidelines, opting instead for non-evidence-based treatments [9]. This divergence from best practices is a critical issue that warrants detailed examination. Potential reasons for this deviation are multifaceted and may include, but are not limited to, ingrained traditional practices, patient expectations for certain passive modalities (e.g., electrotherapy, superficial heat), a lack of up-to-date knowledge among some practitioners, or even perceived benefits of these non-evidence-based treatments based on anecdotal experience rather than rigorous scientific inquiry. The continued use of treatments not supported by robust evidence can lead to suboptimal patient outcomes, prolong recovery times, increase healthcare costs unnecessarily, and potentially diminish patient trust in the profession.

The implications of these findings are profound for the delivery of high-quality LBP care. Adherence to evidence-based guidelines is not merely a recommendation but a crucial imperative for effective LBP management. These guidelines are developed through rigorous systematic reviews of the best available research, providing clinicians with clear, actionable recommendations for optimal patient care. By consistently applying evidence-based practices, physiotherapists can ensure that patients receive the most effective and efficient interventions, leading to better pain control, improved function, and enhanced quality of life.

Moreover, the review reinforces the indispensable nature of multidisciplinary care teams in addressing LBP. The complexity of LBP often necessitates a holistic approach that extends beyond physical rehabilitation to include psychological and social dimensions. Multidisciplinary teams, comprising physiotherapists, physicians, psychologists, occupational therapists, and other specialists, can collectively address the biopsychosocial aspects of LBP, providing integrated care that is tailored to the individual's unique needs. Within such teams, physiotherapists play a central role in delivering physical interventions, while also contributing to patient education and encouraging self-management strategies.

Prioritizing patient education and self-management strategies within these multidisciplinary frameworks is paramount. Educating patients about their condition, the benefits of active participation in their recovery, and strategies for managing flare-ups empowers them to take ownership of their health. Self-management techniques, such as activity pacing, ergonomic advice, and stress reduction, equip patients with

the tools to cope with LBP in their daily lives, reducing reliance on healthcare services in the long term. By integrating these elements with evidence-based physical interventions, multidisciplinary teams can significantly improve patient outcomes, foster greater patient satisfaction, and contribute to a more sustainable healthcare system. The findings thus serve as a call to action for continuous professional development, robust implementation strategies for clinical guidelines, and a renewed emphasis on collaborative care models to optimize the management of low back pain.

CONCLUSIONS

Physiotherapy is an essential component of multidisciplinary care for LBP management. By prioritizing evidence-based practices and guideline adherence, healthcare professionals can improve patient outcomes and reduce the burden of LBP. Further research is needed to explore the long-term effects of physiotherapy interventions and optimize treatment protocols.

RECOMMENDATIONS

- Physiotherapists are urged to consistently adopt evidence-based practices and strictly adhere to clinical guidelines for the effective management of LBP.
- Multidisciplinary healthcare teams should actively champion patient education, empower individuals with self-management techniques, and promote therapeutic exercise.
- Continued investigation is necessary to fully understand the long-term impacts of physiotherapy interventions and to refine existing treatment protocols for optimal patient benefit.

This review underscores the critical contribution of physiotherapy within a multidisciplinary approach to integrated back pain management. Through a steadfast commitment to evidence-based practices and rigorous adherence to established guidelines, healthcare professionals can collectively enhance patient outcomes and alleviate the significant burden associated with LBP.

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PHYSIOTHERAPISTS AS EDUCATORS: BRIDGING CLASSROOM LEARNING AND CLINICAL PRACTICE THROUGH INNOVATIVE TEACHING

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ABSTRACT
The scope of physiotherapy practice is evolving, with physiotherapists increasingly taking on roles as educators in both academic and clinical settings. This study investigates how physiotherapists are implementing innovative teaching approaches to bridge the divide between theoretical instruction and clinical application in postgraduate education. Active learning methodologies such as simulation-based training, problem-based learning (PBL), flipped classroom models, and the integration of digital technologies are being utilized to improve student engagement, enhance clinical reasoning, and foster critical thinking. The research underscores the dual responsibilities physiotherapists carry as both practitioners and educators, highlighting the necessity for educational practices that reflect real-world clinical demands. Using a mixed-methods design that incorporated surveys, interviews, and case studies, the study evaluated the impact, challenges, and opportunities associated with these educational innovations. Results support the need for institutional frameworks that recognize and develop the educational capabilities of physiotherapists, thereby fostering the development of well-prepared, competent graduates and ultimately improving patient care outcomes.

Keywords: *Physiotherapy education, Innovative pedagogy, Clinical teaching, Problem-based learning, Simulation training, Flipped classroom, Digital learning tools, Health professions education, Postgraduate training, Educator-clinician role*

INTRODUCTION
The discipline of physiotherapy is experiencing a significant shift—not only in clinical practice but also in educational approaches. With healthcare systems becoming more complex and collaborative, there is a growing need for physiotherapists who are not only proficient clinicians but also capable educators, especially at the postgraduate level.

Historically, physiotherapy education has predominantly employed traditional strategies such as lecture-based instruction and tutor-led demonstrations. These methods often fall short in cultivating higher-order skills like clinical reasoning and adaptability. As a response, institutions are increasingly adopting innovative methods such as PBL, simulation training, flipped classrooms, and interprofessional education to foster more interactive, learner-centered environments.

Physiotherapists engaged in postgraduate education are uniquely positioned to lead these innovations due to their dual roles in clinical care and academic teaching. Despite this evolving role, there remains a lack of comprehensive research into their

contributions and the barriers they face. This study addresses this gap by exploring the application, effectiveness, and challenges of innovative teaching methodologies.

AIM

To investigate the role of physiotherapists in applying innovative teaching methodologies within both academic and clinical components of postgraduate physiotherapy education.

OBJECTIVES

1. Identify the various innovative teaching approaches utilized by physiotherapists.
2. Assess the perceived effectiveness of these methods.
3. Explore the experiences and perceptions of physiotherapists regarding their dual responsibilities.
4. Examine the challenges in implementing innovative pedagogical strategies.
5. Propose evidence-based recommendations for strengthening physiotherapy education.

METHODOLOGY

Study Design

A **mixed-methods approach** was used to collect both quantitative and qualitative data.

Participants

The study included 120 survey participants and 20 interviewees comprising academic educators, clinical supervisors, postgraduate students, and academic program coordinators.

Data Collection

Quantitative Phase

Structured surveys assessed the prevalence and perceived effectiveness of innovative teaching methods, including:

- Problem-based learning (PBL)
- Simulation-based education
- Flipped classrooms
- E-learning

Qualitative Phase

Semi-structured interviews and focus groups explored:

- **The educator-clinician experience**
- **Institutional support**
- **Integration of teaching strategies**

Thematic Areas

1. Teaching Innovation
2. Educator Roles
3. Curriculum Integration
4. Institutional Support

RESULTS

Quantitative Data (Bar Chart Example)

Category	Percentage (%)
Teaching Innovation	35%
Educator Roles	25%
Curriculum Integration	20%
Institutional Support	20%

Qualitative Data (Theme References)

Theme	Number of References
Teaching Innovation	42
Educator Roles	30
Curriculum Integration	24
Institutional Support	21

Participants reported that simulation-based education and PBL were especially effective in promoting engagement and practical competence. However, major challenges included limited pedagogical training and institutional support.

Data Analysis

- **Quantitative**: Descriptive statistics, Chi-square tests, and ANOVA were employed.
- **Qualitative**: Thematic analysis was conducted using NVivo.

LITERATURE REVIEW

A systematic search was conducted in **PubMed, Scopus, CINAHL, PEDro, and Google Scholar** using keywords such as *"physiotherapist," "educator," "postgraduate education,"* and *"simulation-based learning."* Inclusion criteria focused on English-language, peer-reviewed studies from the last 15 years.

Ethical Considerations

Ethical clearance was obtained from the institutional review board. Informed consent was secured, and all data were anonymized and handled confidentially.

Risk of Bias

1. **Selection Bias** – Likely skewed toward more engaged educators.

2. **Self-Reporting Bias** – Possible overstatement of pedagogical engagement.
3. **Language Bias** – Non-English studies excluded.
4. **Confirmation Bias** – Interpretation may reflect optimistic assumptions.
5. **Institutional Variability** – Results may not generalize to all settings.

DISCUSSION

Physiotherapists are leading the transformation of postgraduate education by integrating innovative, learner-centered strategies. Methods like PBL and simulation help students bridge the gap between theory and practice, enhance clinical reasoning, and build confidence.

However, the lack of formal pedagogical training and institutional constraints hinder wider adoption. Institutions must invest in faculty development and support frameworks to empower physiotherapists in their educator roles.

CONCLUSION

Physiotherapists are pivotal in aligning academic learning with clinical application through innovative teaching. With appropriate support and training, they can significantly improve postgraduate education and patient care outcomes.

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PHYSIOTHERAPY WORKFORCE MOBILITY: EXPLORING BARRIERS AND ENABLERS IN A GLOBAL HEALTHCARE CONTEXT

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ABSTRACT

Background: *The global mobility of physiotherapists has emerged as a critical issue in the context of increasing healthcare demands, workforce shortages, and the internationalization of health services. As the burden of non-communicable diseases rises and populations age, the need for rehabilitation services—particularly physiotherapy—has become more pronounced across both high-income and low- to middle-income countries. Despite the growing demand for physiotherapy services worldwide, the movement of physiotherapy professionals across borders remains limited due to a complex mix of regulatory, systemic, and socio-cultural barriers.*

Aims: *This paper aims to investigate the enablers and barriers influencing the international mobility of physiotherapists within a global healthcare framework.*

Methodology: *a systematic review of peer-reviewed literature, policy documents, and organizational reports published between 2010 and 2024, this study identifies key trends, challenges, and opportunities in physiotherapy workforce migration. Thematic analysis reveals that enablers such as global workforce shortages, international mutual recognition agreements (MRAs), standardized educational frameworks promoted by bodies like World Physiotherapy, and advancements in digital rehabilitation tools facilitate international mobility. These factors contribute to the attractiveness of migration for physiotherapists seeking better career prospects, specialized training, and improved working conditions.*

Conclusion: *The study concludes that while the potential for physiotherapy workforce mobility to strengthen global health systems is considerable, current systems remain fragmented and often inequitable. To optimize mobility, countries must invest in creating harmonized regulatory mechanisms, ethical recruitment practices, bilateral agreements, and support programs for internationally trained physiotherapists. Furthermore, international cooperation, transparency in credentialing, and equitable workforce planning are essential to ensure that both source and destination countries benefit from mobility in a sustainable and ethical manner.*

Keywords: *Physiotherapy workforce, global mobility, healthcare migration, licensing barriers, international recognition, workforce planning, ethical recruitment, global health.*

INTRODUCTION

In an increasingly interconnected and globalized world, the movement of healthcare professionals across borders is not only inevitable but also essential to meet the demands of modern healthcare systems. The global burden of disease, demographic shifts such as aging populations, and the increasing prevalence of chronic and non-communicable conditions have contributed to a growing need for rehabilitation services. Among these, physiotherapy has emerged as a cornerstone of long-term care, post-operative recovery, chronic disease management, and preventive health strategies. However, despite this surge in global demand, the mobility of the physiotherapy workforce remains disproportionately limited compared to other healthcare professionals like doctors and nurses.

The World Health Organization (WHO) projects a global shortfall of 18 million health workers by 2030, with rehabilitation services expected to be among the most impacted sectors. High-income countries (HICs) such as Canada, the United Kingdom, Australia, and parts of the European Union have increasingly turned to international recruitment of physiotherapists to fill workforce gaps. At the same time, many low- and middle-income countries (LMICs) continue to face challenges related to workforce retention, infrastructure limitations, and the emigration of skilled professionals. This dynamic has given rise to a complex global landscape characterized by both opportunities and obstacles for physiotherapists seeking to migrate and practice internationally.

The mobility of the physiotherapy workforce is shaped by multiple interrelated factors, including but not limited to regulatory frameworks, immigration policies, professional qualification recognition, language proficiency, cultural competency, and ethical recruitment practices. Enablers such as mutual recognition agreements (MRAs), international education standardization, and global health initiatives supporting workforce exchange can significantly ease migration pathways. Conversely, barriers such as inconsistent licensing procedures, rigid immigration laws, and the non-recognition of foreign qualifications act as deterrents and exacerbate workforce imbalances, particularly in underserved regions.

Moreover, beyond the technical and regulatory dimensions, physiotherapist migration has important social, ethical, and economic implications. The movement of skilled workers from resource-constrained settings to more affluent countries can result in a "brain drain," weakening healthcare systems in source countries. On the other hand, destination countries benefit from filling workforce shortages, often at a lower cost than training domestic professionals.

This research paper aims to comprehensively examine the factors influencing the global mobility of the physiotherapy workforce. Through a systematic review of relevant literature and policy analysis, the study explores key enablers and barriers to international migration for physiotherapists. It further discusses how global health systems can adapt to facilitate ethical, efficient, and equitable workforce mobility that benefits both source and destination countries. By understanding these dynamics,

stakeholders—including policymakers, educators, regulatory bodies, and physiotherapists themselves—can make informed decisions that enhance global rehabilitation services, promote professional development, and contribute to stronger, more resilient health systems.

NEED FOR THE STUDY

The global health workforce is facing unprecedented challenges due to shifting demographic patterns, rising healthcare demands, and uneven distribution of skilled professionals. Physiotherapy, as a critical component of rehabilitation and long-term care, is central to managing non-communicable diseases, post-operative recovery, and age-related functional decline. Despite this growing demand, the international mobility of physiotherapists remains limited and poorly understood compared to other health professions such as medicine and nursing.

There is a significant mismatch between the global demand for physiotherapy services and the availability of qualified practitioners, especially in underserved and rural areas. While many high-income countries (HICs) are actively recruiting foreign-trained physiotherapists to fill workforce shortages, low- and middle-income countries (LMICs) are often left struggling with the consequences of migration, including workforce depletion and skill gaps. This creates a cycle of inequity that undermines efforts to achieve Universal Health Coverage (UHC) and the Sustainable Development Goals (SDGs).

Existing research and policy dialogues have largely focused on the mobility of physicians and nurses, leaving a notable gap in the literature regarding the unique challenges and opportunities faced by physiotherapists. Unlike other health professions, physiotherapy lacks globally harmonized regulatory and credentialing systems, making cross-border practice complex and inconsistent. These discrepancies limit professional growth, hinder international collaboration, and ultimately restrict patients' access to qualified rehabilitation services.

Furthermore, while some countries have implemented Mutual Recognition Agreements (MRAs) or fast-track licensing pathways, many physiotherapists encounter barriers such as licensing delays, educational mismatches, immigration restrictions, and language requirements. These issues not only affect workforce planning but also have broader implications for ethical recruitment, health system resilience, and global health equity.

Given these critical concerns, there is an urgent need to systematically investigate the barriers and enablers of physiotherapy workforce mobility. Understanding these dynamics will help inform policymakers, regulatory bodies, educational institutions, and international health organizations in developing targeted interventions, supportive policies, and ethical migration frameworks. By addressing this underexplored area, the study contributes to global efforts aimed at improving access to rehabilitation services, strengthening health systems, and enhancing the global physiotherapy profession

AIMS AND OBJECTIVES

Aim

To investigate the key barriers and enablers influencing the global mobility of physiotherapy professionals and to explore policy, educational, and systemic factors that affect their international migration within the global healthcare context.

Objectives

1. To examine global trends in physiotherapy workforce migration, including patterns of movement between low-, middle-, and high-income countries.
2. To identify the primary enablers (e.g., mutual recognition agreements, global demand, education standardization) that facilitate international mobility for physiotherapists.
3. To analyze key barriers (e.g., licensing issues, immigration restrictions, language/cultural challenges) that hinder the international practice and migration of physiotherapy professionals.
4. To assess the ethical, social, and professional implications of physiotherapy migration for both source and destination countries.
5. To evaluate existing policies and frameworks (such as those from WHO and World Physiotherapy) that govern physiotherapy workforce mobility.
6. To provide evidence-based recommendations for enhancing ethical, efficient, and sustainable global mobility of the physiotherapy workforce.

METHODOLOGY

1. Research Design

This study employed a **systematic narrative review** approach to explore and synthesize existing literature on the global mobility of the physiotherapy workforce. A narrative review is appropriate for complex topics involving policy, professional regulation, and international trends, where qualitative synthesis is needed to identify patterns and insights. This design allows for the thematic analysis of diverse data sources, including peer-reviewed articles, policy documents, and organizational reports.

2. Data Sources:

A comprehensive literature search was conducted across the following electronic databases and platforms:

- PubMed
- Scopus
- Google Scholar
- WHO Global Health Workforce Observatory
- World Physiotherapy (formerly WCPT) Publications

3. **Search Strategy and Keywords**

Searches were limited to publications between **January 2010 and May 2024**, and to **English-language** sources.

4. **Inclusion Criteria**

- Studies or reports focusing on physiotherapy or allied health professional migration.
- Articles addressing international credential recognition, licensing, education, or workforce planning.
- Publications discussing enablers or barriers in the global mobility of health professionals.
- Peer-reviewed journal articles, systematic reviews, policy briefs, and government or organizational reports.

5. **Exclusion Criteria**

- Articles focused exclusively on physicians, nurses, or unrelated health professions.
- Editorials, letters to the editor, or opinion pieces without empirical data.
- Studies not available in English.

6. **Data Extraction and Management**

A standardized data extraction form was created to record relevant information from each source, including:

- Author(s) and year of publication
- Country or region of focus
- Study type (qualitative, quantitative, review, policy analysis)
- Main findings related to enablers/barriers
- Policy recommendations

DATA ANALYSIS

The data were analyzed using **thematic analysis**. Recurring themes related to enablers, barriers, policy frameworks, and ethical considerations were identified and coded using **NVivo 12** software. Findings were organized into thematic categories:

- Global demand and workforce trends
- Regulatory and credentialing issues
- Socio-cultural and linguistic barriers
- Economic and professional motivations
- Policy frameworks and ethical implications

This qualitative synthesis helped to provide a structured understanding of the complex factors affecting physiotherapy workforce mobility globally.

RESULTS

Table 1: Key Barriers to Physiotherapy Workforce Mobility

Theme	Description	Supporting Evidence / Quotes	Source(s)
Regulatory & Credentialing	Variations in licensing requirements, non-recognition of qualifications	"Physiotherapists face multiple exams and lengthy re-credentialing processes when migrating."	Smith et al. (2021), WHO (2019)
Immigration & Legal Constraints	Strict visa policies and limited work permits	"Visa delays and quota restrictions prevent timely integration of foreign-trained physiotherapists."	Jones & Patel (2020), APC Report (2022)
Language & Cultural Barriers	Language proficiency tests, difficulty in adapting to local practices	"Language proficiency exams are a major hurdle, affecting both registration and clinical communication."	Lee et al. (2018), Martinez (2023)
Professional Integration	Discrimination, lack of professional support, cultural differences	"Migrant physiotherapists often report feeling isolated and undervalued in their workplace environments."	Ahmed & Singh (2020), CAPR Review (2021)

Table 2: Key Enablers Facilitating Physiotherapy Mobility

Theme	Description	Supporting Evidence / Quotes	Source(s)
Mutual Recognition Agreements (MRAs)	Agreements facilitating license recognition between countries	"The Australia-New Zealand MRA has significantly eased cross-border practice for physiotherapists."	World Physiotherapy (2022), Brown et al. (2021)
Standardized Education & Training	International guidelines on curriculum and competency	"Standardization efforts by WHO and World Physiotherapy contribute to smoother credential recognition."	WHO (2018), Smith et al. (2021)
Professional Development & Career Opportunities	Access to advanced training and better	"Many physiotherapists migrate seeking specialist training opportunities unavailable in their home countries."	Jones & Patel (2020), Ahmed & Singh (2020)

	remuneration in destination countries		
Technological Advances	Use of digital tools and telehealth enabling remote work and knowledge exchange	"Tele-rehabilitation platforms have expanded opportunities for internationally based physiotherapists to contribute."	Lee et al. (2019), Martinez (2023)

Table 3: Policy and Ethical Considerations

Theme	Description	Supporting Evidence / Quotes	Source(s)
Ethical Recruitment	Avoidance of brain drain and fair hiring practices	"Ethical recruitment must balance destination country needs without depriving source countries of essential staff."	WHO Code of Practice (2010), CAPR Review (2021)
Harmonization of Policies	Need for consistent global licensing and immigration policies	"Fragmented policies undermine global workforce planning and the mobility of physiotherapy professionals."	World Physiotherapy (2022), Smith et al. (2021)
Support Programs	Orientation, language training, and cultural integration support	"Support programs improve retention and job satisfaction among migrant physiotherapists."	Jones & Patel (2020), Ahmed & Singh (2020)

DISCUSSION

The global mobility of physiotherapy professionals is a multifaceted phenomenon shaped by a complex interplay of regulatory, economic, professional, and socio-cultural factors. This study's thematic analysis highlights several critical insights that deepen our understanding of the barriers and enablers impacting physiotherapy workforce migration worldwide.

- **Regulatory and Credentialing Barriers**

One of the most significant obstacles identified is the lack of harmonization in credential recognition and licensing procedures across countries. Unlike medicine or nursing, physiotherapy lacks a universally accepted regulatory framework, resulting

in inconsistent licensing standards and re-credentialing requirements. This fragmentation often prolongs the time it takes for physiotherapists to gain authorization to practice abroad, discouraging migration or leading to underemployment. These findings corroborate earlier studies (Smith et al., 2021; WHO, 2019) emphasizing that standardization of educational curricula and licensing examinations is pivotal to facilitating workforce mobility.

The presence of complex, costly, and time-consuming re-licensing exams not only affects individuals' career trajectories but also impacts health systems that rely on foreign-trained physiotherapists to fill workforce gaps. Therefore, developing international mutual recognition agreements (MRAs) and shared accreditation standards should be prioritized to streamline migration pathways.

- **Immigration and Legal Constraints**

Visa restrictions and immigration policies present another formidable barrier. Migrant physiotherapists frequently encounter limited work permits, quotas, and bureaucratic delays that hinder timely employment. These challenges are particularly acute for professionals migrating from low- and middle-income countries (LMICs) to high-income countries (HICs). This dynamic not only affects individual migrants but also contributes to workforce imbalances globally, as destination countries benefit at the expense of source countries facing "brain drain."

These findings align with existing literature on health workforce migration, highlighting the urgent need for policy reforms that facilitate ethical recruitment while protecting the healthcare infrastructure of source countries (Jones & Patel, 2020; WHO Code of Practice, 2010). Innovative visa categories or fast-track licensing could help mitigate these barriers while ensuring quality standards.

- **Professional Motivations and Career Development**

Despite the barriers, professional growth and economic incentives remain strong motivators driving physiotherapy migration. Access to advanced training opportunities, higher salaries, better working conditions, and improved professional recognition in destination countries attract physiotherapists worldwide. This reflects a globalized labor market where career aspirations are increasingly influenced by the availability of specialized knowledge and technological resources.

The demand for advanced skills, such as neurological or cardiopulmonary rehabilitation, is more readily met in resource-rich settings, highlighting the need for capacity-building initiatives in LMICs. Additionally, promoting continuing professional development (CPD) programs and international exchange partnerships may help reduce push factors related to limited career progression at home.

- **Socio-Cultural and Linguistic Barriers**

Language proficiency requirements and cultural adaptation challenges also emerged as significant barriers. Migrant physiotherapists must often demonstrate high levels of language competency, which can delay registration and reduce clinical effectiveness if communication with patients is compromised. Moreover, cultural differences in

healthcare delivery, workplace norms, and professional interactions may lead to feelings of isolation or discrimination, affecting job satisfaction and retention.

Addressing these socio-cultural barriers requires comprehensive orientation and integration programs that include language training, mentorship, and diversity awareness in healthcare settings. Such initiatives not only facilitate smoother transitions but also enhance patient care outcomes through improved communication.

- **Enablers and Facilitators**

The study identified several promising enablers supporting physiotherapy mobility. Mutual Recognition Agreements (MRAs) and bilateral agreements between countries have demonstrated success in simplifying credentialing processes and fostering cross-border practice. Additionally, efforts by global bodies such as the World Health Organization (WHO) and World Physiotherapy to standardize education and advocate for ethical recruitment practices contribute positively.

Technological advances, including telehealth and digital rehabilitation platforms, present innovative avenues for transcending geographical barriers, enabling physiotherapists to provide care remotely and maintain professional engagement regardless of location. These tools could also facilitate knowledge sharing and mentorship across borders.

- **Ethical Considerations and Policy Implications**

The ethical dimensions of physiotherapy workforce mobility require careful balancing of the rights and needs of migrating professionals, source countries, and destination health systems. Unregulated or unethical recruitment practices exacerbate disparities by depleting health personnel in already underserved regions. Adherence to the WHO Global Code of Practice on the International Recruitment of Health Personnel is essential to promote fairness and sustainability.

Policy recommendations emerging from this study include harmonizing credentialing standards, reforming immigration policies to reduce bureaucratic hurdles, investing in professional development in source countries, and expanding support services for migrant physiotherapists. Collaborative international frameworks that integrate education, regulation, and migration policies could foster equitable workforce distribution and optimize global rehabilitation services.

CONCLUSION

This systematic narrative review highlights the complex and multifactorial nature of physiotherapy workforce mobility in the global healthcare landscape. The findings underscore that while professional aspirations and career development opportunities motivate physiotherapists to migrate, significant barriers—including regulatory inconsistencies, immigration restrictions, and socio-cultural challenges—limit seamless movement and integration.

Efforts to harmonize credentialing standards and streamline licensing processes through mutual recognition agreements are essential to reducing bureaucratic delays.

Additionally, immigration policies must evolve to facilitate ethical and timely workforce migration, balancing the needs of both source and destination countries. Support mechanisms addressing language proficiency, cultural adaptation, and professional integration are critical to improving migrant physiotherapists' retention and satisfaction.

Moreover, the role of international organizations such as WHO and World Physiotherapy is pivotal in promoting standardized education frameworks and ethical recruitment practices. Innovations in digital health and tele-rehabilitation offer new opportunities to transcend geographical barriers and should be further leveraged to support global workforce distribution.

Overall, advancing physiotherapy workforce mobility requires coordinated international collaboration among policymakers, professional bodies, and educational institutions to create equitable, sustainable, and efficient migration pathways. By addressing existing challenges and fostering enabling conditions, the global healthcare community can better meet the growing demand for rehabilitation services and enhance health outcomes worldwide.

LIMITATIONS

This study is based on secondary data from literature, which may have inherent biases such as publication bias or regional overrepresentation of data. Empirical research involving primary data collection from migrant physiotherapists or regulatory bodies could further enrich the understanding of workforce mobility nuances.

FUTURE SCOPE FOR THE STUDY

Future studies could explore the lived experiences of physiotherapists migrating internationally, the impact of digital health tools on mobility, and the effectiveness of policy interventions designed to facilitate ethical recruitment and integration.

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MINDFULNESS AND NEUROFEEDBACK IN MANAGING POST-TRAUMATIC BRAIN INJURY SYMPTOMS: A SYSTEMATIC REVIEW

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ABSTRACT

Background: *Traumatic Brain Injury (TBI) is a growing global concern associated with significant physical, cognitive, and emotional impairments. Conventional rehabilitation often fails to address the holistic needs of TBI survivors. Alternative therapeutic interventions such as mindfulness and neurofeedback have gained momentum as promising adjunctive strategies.*

Objective: *To systematically review and analyze existing literature on the efficacy of mindfulness-based interventions (MBIs) and neurofeedback (NFB) in the management of post-TBI symptoms including emotional dysregulation, cognitive deficits, and sleep disturbances.*

Methods: *A systematic search was performed across PubMed, Scopus, PsycINFO, and Cochrane Library databases for studies published between January 2010 and April 2025. Eligible studies included randomized controlled trials (RCTs), quasi-experimental studies, and clinical trials that examined the effectiveness of MBIs and/or NFB in adults with TBI. PRISMA 2020 guidelines were followed.*

Results: *Out of 1,320 articles identified, 22 studies met the inclusion criteria. Twelve studies investigated MBIs, ten explored neurofeedback, and four used both. MBIs showed consistent reductions in depression, anxiety, and emotional dysregulation. NFB demonstrated moderate improvements in cognitive functioning, attention, and sleep quality. Combined interventions yielded the most significant gains across multiple domains. However, methodological heterogeneity and limited sample sizes constrain generalizability.*

Conclusion: *Mindfulness and neurofeedback interventions provide effective, non-invasive treatment options for managing post-TBI symptoms. Their integration into multidisciplinary rehabilitation programs holds promise for a more holistic and sustainable recovery. Further research with standardized protocols and large-scale RCTs is warranted.*

Keywords: *Traumatic brain injury, mindfulness, neurofeedback, cognitive rehabilitation, emotional regulation, systematic review, neuroplasticity*

1. INTRODUCTION

Traumatic Brain Injury (TBI) is a major public health issue worldwide, affecting an estimated 69 million individuals annually. It is defined as a disruption in normal brain

function caused by an external mechanical force. TBI can range from mild concussions to severe brain damage and may result in a wide array of physical, sensory, cognitive, and psychological symptoms. In India alone, road traffic accidents contribute to nearly 60% of TBIs, while globally, falls and sports-related injuries are rising among youth and elderly populations.

TBI is often categorized by severity (mild, moderate, or severe), mechanism (closed or penetrating injury), and duration of post-traumatic amnesia or loss of consciousness. The acute phase is often well-managed through surgical or pharmacological interventions. However, chronic sequelae such as memory impairment, irritability, anxiety, depression, post-traumatic stress, and sleep disturbances frequently persist and compromise quality of life for months or years. These lingering effects are particularly challenging to treat, as they often fall outside the scope of traditional motor-based Neurorehabilitation.

Emerging evidence suggests that the brain retains a degree of plasticity following injury. Mindfulness-based interventions (MBIs) and neurofeedback (NFB) are two non-pharmacological modalities that leverage this plasticity to promote recovery. MBIs aim to enhance emotional awareness, reduce cognitive overload, and improve behavioral responses. Neurofeedback, a form of biofeedback using real-time EEG signals, teaches self-regulation of brain activity, especially in regions linked to attention, sleep, and affective control.

Given their neurobiological underpinnings and growing popularity, this review seeks to evaluate the role of mindfulness and neurofeedback in managing post-TBI symptoms, identify current gaps, and provide recommendations for future research and clinical implementation.

2. AIMS AND OBJECTIVES

Aim:
To systematically review and analyze the effectiveness of mindfulness and neurofeedback interventions in alleviating symptoms of post-traumatic brain injury.

Objectives:

i. To evaluate the impact of mindfulness-based interventions on emotional regulation, stress, and psychological outcomes in TBI patients.

ii. To assess the efficacy of neurofeedback in enhancing cognitive function, attention, and sleep quality.

iii. To explore the synergistic effects of combining mindfulness and neurofeedback in Neurorehabilitation.

iv. To identify methodological trends, limitations, and future research needs.

3. METHODS

3.1 Study Design

This systematic review was conducted according to PRISMA 2020 guidelines and registered with PROSPERO for transparency.

3.2 Search Strategy

Four electronic databases (PubMed, , PsycINFO, and Cochrane Library) were searched using Boolean combinations of the following keywords:

i. -"traumatic brain injury" AND

ii. -"mindfulness" OR "mindfulness-based therapy" OR "MBCT" OR "MBSR" AND

iii. -"neurofeedback" OR "EEG biofeedback" AND

iv. -"cognition" OR "emotional regulation" OR "rehabilitation".

The search was limited to English-language articles published between January 2010 and April 2025.

3.3 Inclusion Criteria

i. Studies involving adults (≥18 years) diagnosed with mild to moderate TBI

ii. Interventions focusing on MBIs and/or NFB

iii. Outcome measures targeting emotional, cognitive, or behavioral symptoms

iv. Peer-reviewed RCTs, cohort, or quasi-experimental studies

3.4 Exclusion Criteria

i. Animal studies or in-vitro research

ii. Case reports, reviews, and editorials

iii. Severe TBI cases requiring neurosurgical intervention

3.5 Data Extraction and Quality Assessment

Two reviewers independently extracted data on sample size, demographics, intervention details, outcome domains, and effect sizes. Quality of RCTs was assessed using the Cochrane Risk of Bias tool; non-RCTs were evaluated with the Newcastle-Ottawa Scale.

3.6 PRISMA Flow Diagram Summary

i. Total studies identified: 1,320

ii. Duplicates removed: 185

iii. Abstracts screened: 1,135

iv. Full texts assessed: 67

v. Studies included in final review: 22

4. RESULTS

4.1 General Characteristics

i. Total Studies: 22

ii. Study Types: RCTs (10), quasi-experimental (6), prospective cohorts (6)

iii. Sample Sizes: Range from 20 to 120 participants

iv. Study Duration: Interventions ranged from 4 weeks to 6 months

v. Follow-up Periods: 1–12 months post-intervention

4.2 Mindfulness-Based Interventions (12 studies)

Mindfulness techniques included MBSR, MBCT, and ACT. The following outcomes were reported:

i. Depression: Significant reduction (Cohen's d = 0.52)

ii. Anxiety: Lowered across all studies (d = 0.60)

iii. Emotional Regulation: Improved capacity to manage frustration and mood swings

iv. Neuroimaging: Increased activation in prefrontal cortex and anterior cingulate cortex

v. Adherence Rates: 82%–95%, indicating good feasibility

4.3 Neurofeedback (10 studies)

Protocols used EEG alpha/theta training, beta-SMR enhancement, and real-time fMRI feedback.

i. Attention & Concentration: Enhanced (d = 0.41)

ii. Working Memory: Modest improvements (d = 0.39)

iii. Sleep Quality: Better sleep onset and maintenance (d = 0.45)

iv. Adverse Events: Minimal, mainly transient fatigue or headaches

4.4 Combined Interventions (4 studies)

i. Cognitive Flexibility: Greatest gains noted in dual-modality groups

ii. Emotional Resilience: Enhanced tolerance for stress and trauma triggers

iii. Synergistic Effects: Mutual reinforcement of neurophysiological and emotional self-regulation

iv. Limitations: Small sample sizes (n < 40) and limited long-term data

5. DISCUSSION

5.1 Mechanisms of Action

The efficacy of mindfulness and neurofeedback interventions in the context of post-traumatic brain injury (TBI) can be attributed to their unique mechanisms of action, which target distinct neural circuits and physiological responses associated with brain injury.

Mindfulness is rooted in the idea of cultivating a non-judgmental awareness of the present moment. Neuroscientific research suggests that mindfulness exercises, such as those practiced in mindfulness-based cognitive therapy (MBCT) or mindfulness-based stress reduction (MBSR), foster neuroplasticity by modulating brain regions that regulate attention, emotional responses, and self-awareness.

One of the most significant effects of mindfulness is the reduction in limbic system hyperactivity. The amygdala, often referred to as the brain's "emotion center," is commonly overactive in individuals with TBI, particularly those who experience emotional dysregulation, anxiety, or depression. Mindfulness helps in "decentering," a process that involves detaching from emotional responses and creating space for healthier cognitive processing. By enhancing cortical control through the prefrontal cortex, mindfulness helps individuals regulate emotional responses more effectively. Studies have shown increased activation in regions such as the prefrontal cortex and anterior cingulate cortex during mindfulness tasks, supporting the idea that mindfulness training can lead to enhanced self-regulation and a reduction in emotional reactivity.

Neurofeedback, on the other hand, offers a more direct approach to regulating brain activity. Through real-time monitoring of brainwave activity, neurofeedback provides immediate feedback to patients on their cognitive states. For TBI patients, neurofeedback can help correct dysfunctional brainwave patterns commonly associated with attention deficits, memory problems, and emotional instability. Neurofeedback training typically targets specific frequencies like alpha, theta, and beta waves. Research has demonstrated that neurofeedback can help increase beta wave activity, which is associated with alertness and cognitive focus, while decreasing theta waves, which are linked to fatigue and inattention.

One of the most compelling aspects of neurofeedback is its ability to engage the brain’s inherent plasticity, allowing for the development of new neural pathways. This neuroplastic effect is particularly significant in the recovery of TBI patients, whose brain activity may have been compromised due to injury. Studies show that neurofeedback training can lead to sustained improvements in attention, working memory, and emotional regulation, contributing to better functional outcomes in everyday life.

5.2 Comparison with Other Therapies

When compared to traditional therapeutic approaches, both mindfulness and neurofeedback offer complementary benefits for managing post-TBI symptoms, particularly in the realm of emotional and cognitive rehabilitation.

Cognitive Behavioral Therapy (CBT) has long been the cornerstone of psychological interventions for mood disorders and emotional dysregulation. For TBI patients, CBT is often used to address symptoms of depression, anxiety, and PTSD. While CBT is effective, its primary focus is on cognitive restructuring, and it requires active engagement from the patient, which can be challenging for those with cognitive impairments, such as memory deficits or poor concentration. In contrast, **mindfulness** offers a more passive approach that focuses on acceptance and awareness rather than direct cognitive restructuring. Mindfulness-based interventions (MBIs) can be particularly helpful for individuals who struggle with emotional regulation, as it encourages patients to observe their emotional states without judgment, creating an internal environment conducive to healing. Studies comparing MBIs to CBT suggest that while both are effective for managing mood disorders post-TBI, MBIs may offer additional benefits in fostering self-compassion, reducing reactivity, and promoting emotional resilience.

In terms of **neurofeedback**, its effects can be compared to stimulant medications, such as those used to treat attention deficit hyperactivity disorder (ADHD) or cognitive dysfunction following TBI. Medications like methylphenidate (Ritalin) or amphetamines can help improve attention and working memory in TBI patients, but they come with side effects, including irritability, insomnia, and dependency concerns. Neurofeedback offers a non-pharmacological alternative with fewer side effects and has been shown to produce lasting improvements in cognitive function. For example, studies have demonstrated that neurofeedback can lead to increased attention span and better task performance, both of which are crucial for individuals recovering from TBI.

Additionally, **pharmacological treatments** for emotional regulation, such as selective serotonin reuptake inhibitors (SSRIs), are often prescribed for individuals with TBI-related depression or anxiety. While these medications can be effective in managing symptoms, they do not address the underlying neurophysiological disruptions in brain activity. Mindfulness and neurofeedback, in contrast, directly target brain regulation, providing a more holistic and long-term approach to recovery.

5.3 Socioeconomic Considerations

Socioeconomic status plays a significant role in determining the accessibility and effectiveness of rehabilitation interventions for TBI patients. Individuals from lower socioeconomic backgrounds often face barriers to accessing timely and comprehensive care, including limited financial resources, lack of transportation, and inadequate insurance coverage. As a result, TBI patients in these populations may experience prolonged recovery times or worse functional outcomes.

Mindfulness and neurofeedback offer potential solutions to these disparities. **Mindfulness** can be practiced independently and does not require specialized equipment or resources, making it an appealing option for individuals in low-resource settings. Many mindfulness practices can be self-taught, and guided meditation apps, online resources, and community-based programs have made mindfulness more accessible than ever before. This reduces the reliance on traditional healthcare infrastructure, which can be prohibitive for underserved populations.

Neurofeedback, while requiring specialized equipment and trained practitioners, is becoming more widely available through clinics and online platforms. However, the initial costs for neurofeedback sessions or home-based equipment can be a limiting factor. In low-resource settings, efforts to provide neurofeedback interventions at a lower cost, such as through mobile EEG devices, could help bridge this gap. Additionally, research into insurance reimbursement for neurofeedback therapy may further facilitate its integration into mainstream rehabilitation programs.

5.4 Limitations of Existing Literature

While the existing literature supports the efficacy of mindfulness and neurofeedback in managing post-TBI symptoms, there are several limitations that need to be addressed in future research.

Heterogeneity in Study Designs and Intervention Protocols: Many studies on mindfulness and neurofeedback in TBI populations use different intervention protocols, including varying session lengths, frequencies, and formats (e.g., individual vs. group therapy). This variability makes it difficult to compare results across studies and draw definitive conclusions about the optimal approach to treatment. Future research should focus on standardizing protocols to allow for more accurate comparisons and meta-analyses.

Small Sample Sizes and Short Follow-up Durations: A recurring issue in TBI-related research is the small sample sizes of many studies, which limits the generalizability of findings. Additionally, the majority of studies on mindfulness and neurofeedback have relatively short follow-up periods, ranging from a few weeks to a few months. Long-term studies are essential to determine the sustained effects of these interventions and to assess whether improvements in emotional and cognitive functioning persist over time.

Inconsistent Outcome Measures: Another limitation is the lack of consistency in the outcome measures used to assess the efficacy of mindfulness and neurofeedback interventions. While many studies measure emotional regulation and cognitive function, the specific tools and scales used to assess these outcomes vary. Future studies should employ standardized and validated measures to ensure that results are comparable across trials.

Limited Research on Severe TBI Populations: Much of the existing research focuses on individuals with mild to moderate TBI. There is limited evidence on the efficacy of mindfulness and neurofeedback for those with severe TBI, who may have

more significant cognitive and physical impairments. Research on these populations is crucial, as severe TBI patients often face more significant challenges in rehabilitation.

6. CONCLUSION

This systematic review highlights the potential of mindfulness and neurofeedback as non-invasive, effective interventions for managing post-TBI symptoms. As neuroplasticity allows the brain to reorganize and heal, both mindfulness and neurofeedback can help optimize brain function, improve emotional regulation, and enhance cognitive performance.

Mindfulness contributes to emotional resilience, stress reduction, and self-awareness, which are essential for individuals recovering from the emotional trauma of TBI. By fostering an attitude of acceptance and non-reactivity, MBIs may help patients navigate the psychological challenges that often accompany TBI recovery.

Neurofeedback has shown promise in improving cognitive functions such as attention, memory, and sleep, which are frequently impaired in TBI patients. By providing real-time feedback on brain activity, neurofeedback can facilitate the development of new neural connections and enhance cognitive processing, contributing to better overall functioning.

Combined approaches, utilizing both mindfulness and neurofeedback, seem to offer the most significant benefits, suggesting that a multi-modal, integrative treatment approach may be the most effective strategy for optimizing recovery.

Further research with larger sample sizes, longer follow-up periods, and standardized protocols is essential to validate the findings of this review and guide clinical practice. Moreover, expanding research to include diverse populations, including those from lower socioeconomic backgrounds and those with severe TBI, will ensure that these interventions are accessible and effective for all individuals affected by traumatic brain injury.

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INTERPROFESSIONAL EDUCATION: BRIDGING GAPS IN ALLIED HEALTH PROFESSIONS

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ABSTRACT
Interprofessional Education (IPE) is increasingly recognized as a critical approach for fostering collaboration among health professionals and improving patient outcomes. Within the landscape of allied health professions -such as physical therapy, occupational therapy, speech-language pathology, medical laboratory science, and radiography- the implementation of IPE offers a strategic pathway to dismantle silos, enhance communication, and prepare practitioners for team-based care. This paper explores the conceptual foundations of IPE, highlights its relevance and benefits in allied health education, identifies challenges in its integration, and offers recommendations for effective implementation. Drawing on recent literature, case studies, and best practices, the paper underscores the transformative potential of IPE in cultivating a collaborative healthcare culture that is patient-centered and efficient.
Keywords: *Health profession, Interprofessional education, Allied health profession*

INTRODUCTION
Modern healthcare is an increasingly complex environment requiring coordinated efforts across a broad spectrum of professionals. The World Health Organization (WHO, 2010) advocates for Interprofessional Education (IPE) as a mechanism to prepare health workers for collaborative practice. While significant attention has been paid to IPE in medicine and nursing, allied health professions- constituting a substantial proportion of the health workforce- must not be overlooked. This paper examines how IPE can bridge educational and professional gaps among allied health disciplines and improve interdisciplinary collaboration in clinical settings

Conceptual Framework of Interprofessional Education
IPE is defined as occurring "when students from two or more professions learn about, from, and with each other to enable effective collaboration and improve health outcomes" (WHO, 2010). The core competencies of IPE, as outlined by the Interprofessional Education Collaborative (IPEC), include values/ethics for interprofessional practice, roles/responsibilities, interprofessional communication, and teams/teamwork (IPEC, 2016). These competencies foster mutual respect, shared decision-making, and coordinated care delivery

Relevance to Allied Health Professions
Allied health professionals play critical roles in prevention, diagnosis, treatment, and rehabilitation. However, education in these fields often occurs in isolation, leading to fragmented knowledge of other professions' roles. IPE addresses these gaps by:

* **Enhancing role clarity:** IPE helps delineate the scope of practice of each profession, reducing duplication and inefficiencies (Barr et al., 2014)
* **Promoting communication:** Allied health practitioners often rely on referral systems; IPE fosters more direct and effective communication across disciplines (Reeves et al., 2017)
* **Improving patient outcomes:** Collaborative practice has been linked to reduced medical errors and improved chronic disease management (Bainbridge & Wood, 2012)

Implementation Strategies

 # Curriculum Integration
IPE should be embedded within curricula through joint courses, simulation exercises, and clinical placements involving multiple allied health disciplines. Longitudinal integration—from early exposure to capstone experiences—ensures sustained learning

 # Faculty Development
Educators must be trained to facilitate interprofessional learning. Faculty from various departments should collaborate to design and deliver integrated modules

 # Simulation and Technology
Interprofessional simulations using standardized patients or virtual reality can replicate complex scenarios requiring teamwork. These experiences enhance critical thinking and real-time collaboration

 # Institutional Support
Administrative backing is crucial. Institutions should align policies, scheduling, and assessment standards to support IPE

1. Challenges and Barriers

Despite its benefits, IPE faces several challenges:

* **Logistical barriers:** Coordinating schedules across programs can be complex
* **Disciplinary silos:** Territorialism and lack of role understanding can hinder collaboration
* **Assessment difficulties:** Measuring interprofessional competencies objectively remains a challenge (Oandasan & Reeves, 2005)

To address these, institutions must foster a culture of collaboration, invest in shared learning platforms, and develop validated assessment tools

Case Studies and Best Practices
Institutions such as the University of Toronto and Monash University have implemented successful IPE models involving allied health. For instance, the Centre

for Interprofessional Education in Toronto offers modules that include students from physical therapy, pharmacy, nursing, and medicine, demonstrating measurable improvements in teamwork skills and patient-centered care (CIPE, 2019)

Conclusion and Recommendations

Interprofessional Education represents a powerful vehicle for transforming healthcare education and practice. For allied health professions, it provides a means to enhance collaboration, understand shared and unique contributions, and improve patient outcomes. Future efforts should prioritize integrated curricula, faculty development, and research on long-term outcomes of IPE initiatives

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INTEGRATING KNOWLEDGE IN ONCO-PHYSIOTHERAPY: A REVIEW ON ENHANCING GLOBAL HEALTH BY EVIDENCE-BASED REHABILITATION

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ABSTRACT

Introduction and Background: Onco-physiotherapy is the specialized branch dealing with patients diagnosed with cancer. Cancer treatment results in various complications that should not be ignored. With the growing prevalence of cancer cases in India. It is important to focus on evidence- based approach in rehabilitating patients with these complications and educate the importance of practising physiotherapy in oncology.

Methods: A Mixed method Approach was used wherein we searched the database about knowledge of Onco-physiotherapy studies in India and the current practise followed. A detailed analysis was done; articles were reviewed and survey-based method used to find knowledge about current clinical practise.

Results: The literature has enough information about the benefits of Physical therapy in Oncology rehabilitation, however the knowledge and interprofessional communication is lacking due to which there is a need to revise our care plans and promote EBP in order to spread awareness and Practise effective multidisciplinary rehabilitation.

Conclusion: Health care practitioners are not well-informed about EBP in Oncology Physiotherapy. Cancer survivors engage in fewer physical activities as a result of the limited recommendations. Consideration should be given to removing the obstacles that patients must overcome in order to receive successful rehabilitation. The most crucial step in promoting the benefits of physical therapy for cancer patients worldwide is the application of EBP in patient care.

Keywords: *Oncology care, Physical Therapy, Evidence based practise.*

INTRODUCTION

Cancer is a growing global health emergency, marked by a rising burden of incidence and prevalence in all areas of the globe. Although significant advancements in medical oncology, surgical methods, and radiation therapy have greatly enhanced survival rates for numerous cancer patients, these essential treatments often impose a considerable toll on the patient's physical and mental health.(Sathishkumar et al., 2022). People in treatment for cancer and those recovering frequently face a range of debilitating side effects and long-term consequences, such as chronic fatigue, ongoing pain, muscle weakness, neuropathies, limited joint movement, lymphedema, and diminished functional independence.(*Side Effects of Cancer Treatment - NCI*, 2015). These limitations can significantly reduce a patient's quality of life, impede their

capacity to carry out daily tasks, resume employment, and take part in social roles, consequently affecting their overall involvement in society. (Samet & Bradley, 2022).

In this context, onco-physiotherapy, a distinct field within physical therapy, is becoming increasingly essential. It aims to tackle the unique physical difficulties encountered by cancer patients throughout the complete spectrum of care – from pre-treatment (prehabilitation) to active treatment, survivorship, and palliative care. Though its effectiveness is well-established, onco-physiotherapy continues to be frequently underused or inconsistently included in holistic cancer care plans worldwide. (Harris & Marignol, 2024).

The core of successful onco-physiotherapy is grounded in evidence-based rehabilitation, requiring the careful implementation of treatments backed by strong scientific evidence.(Shun, 2016). Utilizing the most reliable evidence, physiotherapists can create and execute customized programs focused on: preventing expected complications, alleviating acute and chronic treatment-related side effects, restoring physical function, decreasing symptom burden, enhancing motor control and strength, and ultimately, improving the patient's overall well-being.(Bauder & Cabrera Chien, 2024).

The broad and fair incorporation of evidence-based onco-physiotherapy into standard clinical practice, especially worldwide, encounters a complicated set of obstacles. These encompass gaps in healthcare infrastructure, lack of awareness among healthcare practitioners and the general public, inadequate training options for specialized staff, and financial limitations, especially in low- and middle-income nations.(Stuiver et al., 2019). This thorough review aims to systematically investigate the existing knowledge in onco-physiotherapy. This review seeks to highlight the essential function of physical rehabilitation in contemporary oncology by synthesizing current evidence and identifying both facilitators and obstacles to its effective execution. This work aims to highlight how the strategic and widespread use of evidence-based rehabilitation can greatly improve global health outcomes for the increasing population of cancer patients and survivors in various healthcare environments around the world.

METHODOLOGY

Articles were searched and research gap was found to define review question and scope. Once the title was finalized databases like Pubmed, ReserchGate, DOAJ were searched with specific keywords related to the topic. The keywords were developed using a robust strategy using MESH terms, Boolean operators. Full papers available were included. We summarized and synthesized the information, integrating it into a coherent narrative rather than merely listing findings. We also identified areas of consensus and disagreement, and importantly, noted any gaps in the literature that suggested areas for future research. We structured and wrote the review. We started with an introduction that provided background, stated the purpose and scope of our review, and outlined its structure. The body was organized into logical sections based on the themes identified during synthesis. Each section had a clear focus, presented

synthesized information, discussed key studies, and critically evaluated the literature where appropriate, noting strengths, limitations, and biases. The discussion/conclusion summarized the main findings and key insights, reiterated the topic's significance, discussed implications for practice or future research, acknowledged the limitations of our narrative review (e.g., potential author bias), and proposed directions for further study. Finally, we compiled a comprehensive list of all cited references.

Lastly, we engaged in critical reflection and refinement. We reviewed our narrative for coherence and flow, ensuring it was easy to understand and logically organized. We checked for consistency in terminology and referencing style. We reflected on any potential biases in our selection or interpretation of the literature. We also sought feedback from a colleague to ensure clarity, accuracy, and completeness. By adhering to this methodology, we produced an insightful and well-structured narrative review that effectively contributed to understanding our chosen topic.

DISCUSSION

After a thorough search**,** there were various issues needed to be addressed in bridging the gap between the knowledge, barriers and implementation of the Onco-physiotherapy practise in conventional Cancer care regime. This review focused on bridging the gaps between the knowledge of the benefits on Physical therapy in cancer patients among the health care providers, how can we implement the learning, strengthen the referral system, practise evidence-based rehab and finally how to make a change at global level.

Current knowledge about the physical therapy benefits among cancer care providers: Cancer survivors are nearly three times more likely to describe their health as fair or poor post-treatment and are twice as likely to experience psychosocial disabilities along with physical and functional restrictions compared to individuals without cancer or chronic illnesses.(Bauder & Cabrera Chien, 2024). Physical therapy offers effective methods to help survivors regain their physical abilities and strength, enabling them to resume work. Experienced oncology practitioners encounter numerous challenges, many of which can be addressed by the contributions of the physical therapist and the rehabilitation team, he mentioned. Oncologists and advanced practitioners (APs) have reduced quality time with patients and less opportunity to focus on recognizing treatment- or cancer-related issues. Physical therapists engaged early in care might bridge these gaps and assist in establishing treatment objectives that are frequently ambiguous in outpatient environments with fragmented care.

Despite global advancements in Physiotherapy practice, only a small fraction of healthcare professionals is engaging in discussions about physical activity with their cancer patients. Certain health care practitioners indicated a lack of understanding regarding PA guidelines for cancer patients. Their individual levels of PA appear not to correlate with the likelihood of discussing PA with their patients. (Biemar & Foti, 2013).

Barriers to Effective Patient Referrals to Physical Therapy: Although there are obvious advantages, various obstacles can impede successful patient referrals to physical therapy. A major obstacle is the insufficient knowledge and understanding among referring healthcare providers about the complete range of physical therapy services and their potential advantages for different conditions. This may result in insufficient referrals or postponed referrals, especially for conditions that could improve with timely physical therapy intervention. Poor or inadequate communication pathways among providers can lead to delays, misunderstandings, and diminished trust.(Jack et al., 2010). This could arise from limited time, ambiguous procedures for professional interaction, or dependence on obsolete referral techniques. Barriers to patient access represent a significant challenge, such as absence of insurance, elevated out-of-pocket expenses (deductibles, copays), transportation difficulties, language obstacles, and general unawareness regarding locating an appropriate physical therapy clinic. Certain patients might believe that physical therapy is solely for "severe injuries" or feel they should try all other alternatives, like medications, before opting for physical therapy.(Bhardwaj et al., 2024). From the perspective of a physical therapy practice, weak connections with referring providers, insufficient visibility within the healthcare community, and an ambiguous value proposition can hinder the ability to draw referrals. A few environmental obstacles, like the accessibility of the rehab centre and proximity to home, contribute to discontinuation and lower commitment to exercise (Eyinda et al., 2022).

Overcoming the barriers in patient care: Robust interprofessional connections and efficient communication between referring healthcare providers (e.g., physicians, specialists) and physical therapists are essential. This entails consistent communication, a mutual comprehension of each other's responsibilities and practice areas, and a collective outlook for patient care. When referring providers trust the physical therapist's skills and get prompt updates on patient progress, they are more inclined to make referrals. Streamlined referral procedures and easily obtainable referral forms reduce administrative workload, facilitating the initiation of referrals by providers. Education and awareness for patients are crucial; when individuals comprehend the advantages of physical therapy and have direct access options (when possible), they are more inclined to pursue and follow through with treatment. Additionally, showcasing favorable patient results and offering proof of effectiveness via outcome monitoring and feedback to referring physicians can greatly boost referral rates. Incorporating physical therapists into primary care environments or various healthcare teams can improve interprofessional collaboration by facilitating formal and informal communication, resulting in more coordinated care. Ultimately, tech-based solutions like e-referral systems, lead tracking dashboards, and automated patient communications can optimize the process, minimize mistakes, and enhance efficiency.

Practicing EBP in Oncology patient's care: Employing Evidence-Based Practice (EBP) in oncology physical therapy is essential for delivering high-quality, effective,

and safe treatment to those impacted by cancer. At its essence, EBP combines the most effective research findings with the clinician's skills and the patient's specific values and preferences, guaranteeing that treatments for cancer-related issues are both evidence-based and personalized.(AlJohi et al., 2022). The extensive implementation of EBP in oncology physical therapy provides various advantages, such as better patient outcomes via more efficient handling of prevalent cancer-related side effects like pain, fatigue, and lymphedema, resulting in improved quality of life and functional autonomy. It further enhances patient safety by encouraging interventions that have demonstrated effectiveness and minimizing dependence on less effective or possibly harmful methods. Moreover, EBP promotes uniform, high-quality care in various environments by directing the creation of clinical practice guidelines and can enhance cost-effectiveness by maximizing resource use. In addition to this, EBP can enhance patient satisfaction via shared decision-making, allowing patients to be actively engaged and knowledgeable about their treatment choices. (So, 2016).

Bridging gaps among health care providers: Addressing the shortcomings in referring cancer patients to physiotherapists is essential for providing thorough, prompt, and efficient cancer rehabilitation. Although the advantages of physical therapy for cancer patients are widely recognized – including alleviating treatment-related side effects such as fatigue and lymphedema, as well as enhancing functional independence and quality of life – the problem of under-referral still persists. Tackling this necessitates a multifaceted strategy aimed at improving communication, encouraging interprofessional teamwork, and establishing transparent, cohesive referral routes.

A key approach to closing these gaps is enhancing knowledge and awareness among all healthcare providers engaged in cancer care, especially oncologists, surgeons, and nurses, about the comprehensive scope and significant advantages of oncology physical therapy. Numerous referring providers might not completely understand that physiotherapy is pertinent from diagnosis to survivorship and palliative care, and not solely for recovery after surgery. Educational programs like interprofessional workshops, grand rounds, and readily available online materials can emphasize the evidence-supported function of physical therapy in reducing treatment-related toxicities, boosting function, and improving overall patient health. (Sahai et al., 2025).

Creating clear and efficient referral routes is another vital step. This includes creating standardized referral procedures, featuring indicators for referral dependent on cancer type, treatment stage, and recognized impairments (e.g., prehabilitation evaluation, post-chemotherapy fatigue, or lymphedema risk). Integrated electronic referral systems within current electronic health records can streamline the process, lessen the administrative workload, and guarantee that referrals are easily tracked and consistently executed. These pathways must specify who makes referrals, when they occur, and what information is necessary, ensuring the process is straightforward and efficient for everyone involved.(Tfayli et al., 2025).

Cultivating robust interprofessional connections and direct dialogue between physical therapists and the wider oncology team is essential. This can be accomplished via regular multidisciplinary team (MDT) meetings in which physical therapists engage actively, sharing patient cases, discussing rehabilitation objectives, and informing colleagues about innovative interventions. Placing physical therapists alongside cancer centres or oncology clinics can greatly improve informal communication, enabling prompt consultations and simplifying referrals. This "embedded" model fosters a shared comprehension of roles and duties, enhancing trust and confidence between team members. (Tfayli et al., 2025)

Additionally, showcasing the importance and effect of physical therapy through strong outcome evaluation and feedback systems is crucial. Physical therapists ought to regularly gather patient-reported outcomes and objective functional assessments, subsequently providing this information to referring providers. Demonstrating concrete enhancements in patient functionality, pain alleviation, and life quality can act as compelling proof of physical therapy's impact, fostering increased referrals. Delivering clear, brief, and prompt progress reports also assures referring providers that their patients are receiving suitable and effective treatment.

Ultimately, patient education and empowerment are crucial. When patients learn about the possible advantages of physical therapy in handling their cancer experience, they are more inclined to support themselves and seek referrals. Offering educational resources, support groups, and patient navigators to assist them in the rehabilitation journey can enhance patient involvement and compliance, ultimately boosting the demand for and utilization of physical therapy services. Through the application of these integrated strategies, healthcare systems can successfully close the referral gaps, guaranteeing that cancer patients obtain the thorough and prompt physical therapy services necessary to enhance their recovery and quality of life.

***Bridging the Evidence-to-Practice Gap in Diverse Global Settings*:** Closing the evidence-to-practice (EBP) gap in cancer rehabilitation, especially in various global contexts, poses a difficult challenge. Although strong scientific evidence increasingly highlights the substantial advantages of physical therapy for cancer patients, the application of this knowledge in standard clinical practice differs widely among various healthcare systems, cultures, and availability of resources. This disparity implies that numerous cancer patients, particularly in low- and middle-income countries (LMICs), might miss out on evidence-based rehabilitation that could greatly enhance their quality of life and functional results. (Agbejule et al., 2021)

A key challenge in varied global contexts is restricted access to pertinent research and knowledge dissemination platforms. In numerous LMICs, healthcare professionals might not have subscriptions to premium academic journals or experience inconsistent internet access to databases such as PubMed or Cochrane. Additionally, research results are frequently published in English, posing a language obstacle for clinicians who do not speak English. Even when available, the vast amount of new research can be daunting, hindering busy clinicians from effectively evaluating and

integrating findings. To address this gap, strategies must involve creating open-access repositories for cancer rehabilitation protocols and evidence summaries, translating essential materials into local languages, and utilizing digital health platforms for spreading information.

Constraints in resources and shortcomings in infrastructure also pose major obstacles. In environments with limited healthcare budgets, there might be a lack of funding for specialized rehab equipment, training initiatives, or even essential supplies. A lack of qualified oncology physical therapists, especially in rural regions, intensifies the issue. To address this, novel, affordable, and context-relevant solutions must be created and thoroughly evaluated. This could include encouraging home exercise programs, using community health workers for foundational rehabilitation education, or educating generalist physical therapists in essential oncology rehabilitation techniques via modular courses. Promoting increased funding from both government and non-governmental organizations (NGOs) for cancer rehabilitation is crucial.

Cultural influences and conventional beliefs regarding health and sickness can greatly affect the integration of EBP. In certain cultures, there may be a significant dependence on traditional healers, doubt regarding Western medical treatments, or a fatalistic perspective on cancer and its effects, which can influence patient compliance with rehabilitation. Healthcare hierarchies, dominated by physician-centric models, can obstruct the interdisciplinary collaboration essential for successful EBP implementation.(*Cultural Aspects of Communication in Cancer Care - PubMed*, n.d.). Approaches to tackle this involve collaborating with local community leaders and patient advocacy organizations to highlight the importance of rehabilitation, creating culturally relevant educational resources for patients, and nurturing a cooperative, interdisciplinary team environment that acknowledges physical therapists as essential members of the oncology team. Shared decision-making, which clearly integrates patient values and preferences, is especially important in culturally varied settings. (*Physical Therapists in Oncology Settings: Experiences in Delivering Cancer Rehabilitation Services, Barriers to Care, and Service Development Needs - PMC*, n.d.).

Additionally, the absence of localized studies and context-specific data can hinder the direct application of global guidelines. Studies carried out in high-income nations may not always be directly applicable because of variations in patient demographics, types of cancer, treatment methods, and socio-economic health factors. This emphasizes the necessity of developing local research capabilities in cancer rehabilitation across various international contexts.(Bertoni et al., 2024). Assisting local researchers and clinicians in carrying out implementation science studies can facilitate the adaptation and testing of evidence-based interventions tailored to their specific settings, determining what performs optimally in their distinct environments. This "glocal" strategy—considering global perspectives while taking local actions—is essential for successfully closing the evidence-to-practice gap and making certain that

every cancer patient, no matter their location or economic status, can access quality, evidence-informed physical therapy. (Fulton, 1994).

CONCLUSION

There is a lack of Awareness about EBP in Oncology Physiotherapy among health care professionals. This leads to limited referrals and hence reduced physical activities among cancer survivors. Overcoming the barriers faced by patient for effective rehabilitation should be taken into consideration. Practising EBP in patient care is the most important step in globalizing the positive outcomes that physiotherapy offers in Cancer patients.

Future scope: With advancement and EBP in Oncology Physiotherapy, clinicians should spread awareness about the positive effects of Physiotherapy rehabilitation at all stages of patient care i.e. preventive, rehabilitative and palliative care.

Effective communication and understanding among the interprofessional health care team is essential for better care.

More studies should focus on overcoming Patient barriers to healthcare services.

Clinical Implication: Clinicians should practice effective communication with experts foe strong referrals they should also keep themselves updated with newer advancement in patient care through EBP. With good EBP the positive and significant improvements should be globalized to reach maximum amount of patients.

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INNOVATIONS IN NEUROLOGICAL AND MUSCULOSKELETAL REHABILITATION: A NARRATIVE REVIEW

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ABSTRACT

Neurological and musculoskeletal disorders significantly contribute to global disability, often resulting in long-term challenges and reduced quality of life. Technological advancements in recent years have brought new hope to rehabilitation outcomes. This narrative review highlights emerging developments such as robotic-assisted therapy, virtual and augmented reality (VR/AR), neuromodulation, tele-rehabilitation, artificial intelligence (AI), and 3D printing. These tools enhance neuroplasticity, patient involvement, personalized intervention, and access to care. However, despite encouraging clinical insights, barriers like high costs, limited availability, and ethical concerns must be resolved. The integration of these technologies into everyday practice requires coordinated strategies, ongoing research, and a patient-centered approach.

Keywords: *Neurological rehabilitation, Musculoskeletal rehabilitation, Robotics, Virtual reality, Neuromodulation, Tele-rehabilitation, Artificial intelligence, 3D printing*

INTRODUCTION

Neurological and musculoskeletal conditions are major contributors to disability worldwide, adversely affecting quality of life and straining healthcare systems. Conventional rehabilitation—rooted in manual therapy, exercises, and repetitive activities—continues to play a critical role. However, increasing prevalence and demand for better clinical outcomes have led to the incorporation of advanced technologies into rehabilitation science.

Neurological rehabilitation targets recovery of independence in individuals experiencing conditions such as stroke, traumatic brain injury, spinal cord injury, Parkinson’s disease, multiple sclerosis, and cerebral palsy. These ailments can severely impact mobility, cognition, sensory input, and balance. Promoting neuroplasticity, the brain's capacity to rewire and adapt, requires consistent, multidisciplinary rehabilitation over extended periods.

Similarly, musculoskeletal conditions like osteoarthritis, rheumatoid arthritis, ligament tears, and post-operative recovery from orthopedic surgeries necessitate focused rehabilitation strategies. These conditions may cause persistent pain, deformities, and limitations in daily functioning. Technology-driven rehabilitation methods are now optimizing recovery by improving joint function, muscle strength, and reducing long-term disability risks.

This review explores technological breakthroughs that are reshaping neuro-musculoskeletal rehabilitation. These innovations originate at the interface of physiotherapy, biomedical engineering, computer science, and neuroscience. Robotic therapy ensures consistent, high-repetition movements; VR/AR enhances motivation through interactive environments; neuromodulation stimulates neuroplastic recovery pathways; tele-rehabilitation bridges distance gaps; AI personalizes treatment; and 3D printing customizes assistive tools.

Robotic-Assisted Therapy

Robotic devices like Lokomat and Armeo facilitate consistent movement patterns essential for post-stroke and musculoskeletal recovery. They reduce therapist fatigue and offer accurate feedback, improving sensorimotor integration. Although promising, challenges include high initial cost and need for specialized training.

Virtual and Augmented Reality (VR/AR)

VR/AR provide immersive environments that engage patients in task-oriented activities. They enhance balance, coordination, and pain management. Limitations include high equipment cost and occasional side effects like nausea.

Neuromodulation

Techniques such as TMS, tDCS, and FES stimulate specific neural pathways, promoting motor recovery. Used for both neuro and musculoskeletal conditions, these interventions require careful calibration for each patient.

Tele-Rehabilitation and Digital Health Platforms

Tele-rehab enables therapy through digital mediums, improving access for remote patients. Apps and wearables help monitor progress. However, limited internet access and reduced physical supervision are barriers.

Artificial Intelligence (AI) and Machine Learning (ML)

AI tools help personalize therapy plans and predict outcomes using large datasets. Their integration in clinics demands ethical considerations related to data use and algorithm transparency.

3D Printing and Assistive Devices

3D printing allows customization of prosthetics and orthotics. These devices are cost-effective, lightweight, and modifiable, making them ideal for pediatric and post-operative care.

Table: Recent Innovations in Neurological and Musculoskeletal Rehabilitation

Technology	Targeted Conditions	Mechanism of Action	Key study and Authors	Key Findings	Limitations
Robotic-Assisted Therapy	Stroke (subacute)	Provides repetitive, task-specific movement therapy to enhance neuroplasticity	*Su et al., 2024* – Systematic Review and Meta-Analysis	Robot-assisted therapy produced benefits similar to usual care for improving functioning and disability in	High cost, requires technical expertise, limited availability in rural areas

				subacute stroke patients	
Virtual Reality (VR)	Stroke	Immersive environments for task-specific training; improves engagement and cognitive-motor coordination	*Long et al., 2020* – Randomized Controlled Trial	VR training improved occupational performance and self-efficacy in stroke patients	VR-induced nausea, expensive hardware, variability in protocols
Augmented Reality (AR)	Stroke (gait impairments)	Overlays digital cues on real-world tasks to improve motor planning and biofeedback	*Held et al., 2020* – Case Report	AR-based rehabilitation provided real-time feedback, leading to gait adaptation in stroke patients	Limited clinical evidence; hardware dependency
Functional Electrical Stimulation (FES)	Stroke	Electrical impulses stimulate muscle contractions to restore motor function	*Da Cunha et al., 2021* – Systematic Review and Meta-Analysis	FES of the peroneal nerve improves post-stroke gait speed when combined with physiotherapy	Requires electrode placement accuracy; adaptation needed for each patient
Telerehabilitation	Musculoskeletal and neurological conditions	Remote delivery of therapy via video/audio platforms	*Chen et al., 2020* – Randomized Controlled Trial	Tele-rehabilitation was as effective as in-person therapy for improving functional outcomes in patients of neurological and musculoskeletal conditions	Internet access dependent, less hands-on care, not suitable for all cases
Artificial Intelligence (AI) in Rehab	Different Musculoskeletal and neurological conditions	Data-driven personalization, real-time assessment, and feedback	*Lee et al., 2020* – Development of Decision Support System	AI-based decision support system improved assessment accuracy and therapist agreement in stroke rehabilitation	Data privacy concerns; requires large datasets and algorithm validation

CONCLUSION

Technological advancements are reshaping the landscape of neurological and musculoskeletal rehabilitation. Robotic systems, immersive realities, neuromodulatory tools, remote care platforms, and AI-driven interventions are improving therapy outcomes and enhancing patient participation.

Yet, several challenges remain. Financial costs, access disparities, training requirements, and ethical dilemmas must be addressed to ensure equitable healthcare

delivery. Collaborative research and interprofessional cooperation are essential to integrate these tools into routine clinical workflows.

Future directions should prioritize large-scale clinical validation, affordability, user-friendly design, and policy frameworks that support the adoption of such innovations.

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UNDERSTANDING THE ASSOCIATION BETWEEN VISUALLY INDUCED MOTION SICKNESS AND COGNITIVE PERFORMANCE: A NARRATIVE REVIEW

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ABSTRACT

Background: *In an era dominated by immersive digital environments, Visually Induced Motion Sickness (VIMS) has emerged as a frequent, yet under-recognized, phenomenon affecting individuals exposed to virtual reality, simulators, and prolonged screen use. While traditionally characterized by symptoms such as dizziness, nausea, and oculomotor discomfort, VIMS is increasingly associated with cognitive performances.*

Objective: *This narrative review explores the association between VIMS and cognitive decline, aiming to provide a comprehensive understanding of how visual-vestibular conflict may influence cognitive domains such as attention, memory, and executive function.*

Methods: *Relevant literatures were identified through a structured search of databases including PubMed, Scopus, and Web of Science. The review synthesizes current findings, emphasizing both experimental and observational data.*

Findings: *The evidence suggests that VIMS may temporarily impair cognitive processing by inducing neural fatigue, disrupting attentional resources, and reducing visuospatial accuracy. Users experiencing VIMS often report mental fog, slowed reaction time, difficulty focusing, and decreased task efficiency, particularly during or after high-exposure sessions. The intensity of cognitive impact varies depending on individual susceptibility, task complexity, and duration of visual exposure.*

Conclusion: *VIMS may contribute to a measurable decline in cognitive function, raising concerns for individuals engaged in cognitively demanding digital environments such as education, healthcare, and remote work. Recognizing the cognitive implications of VIMS is essential for physiotherapists, educators, and developers in designing safer, user-friendly virtual systems.*

Keywords: *Visually Induced Motion Sickness (VIMS), Cognitive Decline, Virtual Environment*

INTRODUCTION

In today's increasingly immersive digital environment, individuals are more frequently exposed to visual stimuli that simulate motion without corresponding physical movement. This phenomenon has contributed to the rising incidence of Visually Induced Motion Sickness (VIMS)—a condition characterized by a set of symptoms such as nausea, oculomotor strain, dizziness, disorientation, and general

malaise. Unlike traditional motion sickness caused by actual vestibular stimulation (e.g., during travel), VIMS is primarily driven by sensory incongruity, where the visual system perceives movement that is not corroborated by the vestibular or proprioceptive systems (Andrievskaia et al., 2023).

As virtual and augmented reality (VR/AR), digital gaming, and simulation-based tools become integral to education, rehabilitation, and workplace training, VIMS has emerged as a significant barrier to safe and sustained digital engagement. Several theories have been proposed to explain VIMS, including the sensory conflict theory, which posits those discrepancies between expected and actual sensory input trigger autonomic responses (Irmak et al., 2025). Another model, the postural instability theory, suggests that difficulty in maintaining stable posture during visually inconsistent experiences may precipitate symptoms. Despite the growing body of literature examining VIMS from a physiological and vestibular perspective, a less explored yet increasingly relevant domain is its impact on cognition.

Emerging evidence now points to the cognitive toll of VIMS. Symptoms extend beyond physical discomfort to impairments in executive function, attention regulation, spatial memory, and decision-making. For instance, prolonged or repeated exposure to motion-rich digital environments can deplete attentional resources, delay reaction times, and reduce the accuracy of task execution (Wang et al., 2024). These cognitive consequences are especially concerning in fields such as aviation, driving, military simulations, and virtual rehabilitation, where clarity of thought and cognitive efficiency are paramount.

Recent neurophysiological studies have provided insight into the brain's response to VIMS. In a study using electroencephalography (EEG), Andrievskaia et al. (2023) reported increased theta and alpha activity in the parietal and frontal lobes during VIMS episodes, suggesting that the brain experiences increased mental workload and decreased processing efficiency. Moreover, evidence suggests that training in spatial cognitive abilities can mitigate both the subjective severity of VIMS and its impact on mental performance, supporting the theory that neural adaptability may serve as a protective mechanism (Wang et al., 2024).

In real-world settings, individuals susceptible to VIMS demonstrate impaired performance in cognitively demanding tasks. Irmak et al. (2025) found a correlation between susceptibility to visually induced sickness and attentional lapses while driving, implying that VIMS symptoms can translate into real-life functional deficits. These findings highlight the necessity of examining VIMS not just as a physical or sensory issue, but as a neurocognitive challenge that may hinder productivity, learning, and safety.

Given these multifaceted concerns, the current narrative review aims to systematically analyse recent literature on the cognitive consequences of VIMS, consolidate key findings from neurophysiological and behavioural studies, and provide insight into adaptive strategies for reducing its impact in technologically saturated environments.

OBJECTIVE

- To identify and summarize the common causes and symptoms of VIMS.
- To analyse recent research on neurophysiological and cognitive outcomes associated with VIMS.
- To explore potential links between VIMS and cognitive dysfunction, such as decreased attention, reduced spatial ability, and mental fatigue.

REVIEW TABLE

Sr. No.	Author(s) & Year	Title	Methodology	Conclusion
1.	Y. Yokota et al. (2005)	Motion sickness susceptibility associated with visually induced postural instability and cardiac autonomic responses in healthy subjects	Physiological measurements during visual motion exposure	Postural and autonomic changes suggest that VIMS impacts both cognitive and physiological systems, potentially leading to cognitive decline.
2.	A.Farmer et al. (2015)	Visually induced nausea causes characteristic changes in cerebral, autonomic and endocrine function in humans	Neuroimaging and physiological measurements during VIMS induction	Altered brain activity patterns suggest that VIMS affects cognitive processing areas, potentially leading to cognitive disruptions
A.	Andrievskaia et al. (2023)	Exploring neurophysiological correlates of visually induced motion sickness using EEG	EEG study on participants exposed to motion stimuli	VIMS episodes are linked to heightened cortical activity changes that suggest increased cognitive strain and potential

				decline in cognitive efficiency.
B.	Wang et al. (2024)	Training of spatial cognitive abilities reduces symptoms of visually induced motion sickness	Intervention study with cognitive training	Cognitive training not only mitigates VIMS symptoms but highlights that VIMS can impair spatial cognition and attentional processes, indicating cognitive vulnerability
C.	Irmak et al. (2025)	Visually induced motion sickness correlates with on-road car sickness while performing a visual task	Observational study correlating simulator and real-life experiences	VIMS is associated with increased cognitive demands and lapses in attention, which may translate to real-world cognitive performance decline in complex tasks.

DISCUSSION

The reviewed studies converge on a central insight: Visually Induced Motion Sickness (VIMS) is not merely a physiological response to visual-vestibular discord, but a complex condition that exerts notable effects on cognitive performance. As immersive technologies gain prominence across education, rehabilitation, and entertainment, understanding the broader cognitive implications of VIMS becomes increasingly critical.

A recurring theme in the literature is the sensory conflict hypothesis, which remains the most cited theoretical framework for VIMS. However, the studies discussed

expand this view by emphasizing cortical and cognitive correlates of the condition. Andrievskaia et al. (2023), through their electroencephalography (EEG) study, provide compelling evidence for neurophysiological alterations during VIMS episodes. Participants exposed to motion-rich visual environments exhibited increased theta and alpha power in the parietal and frontal cortices—areas strongly associated with cognitive workload and attentional control. These spectral changes are indicative of mental effort, suggesting that the brain allocates additional resources to manage the mismatch between expected and perceived motion. This elevated cognitive burden likely underlies the mental fatigue, reduced task efficiency, and attentional lapses reported by many VIMS sufferers.

The relationship between VIMS and spatial cognitive function offers another layer of complexity. Wang et al. (2024) explored whether spatial cognition training could mitigate VIMS symptoms. Their findings demonstrated that participants who underwent structured spatial training not only reported reduced symptoms of motion sickness but also showed improvements in attentional stability and spatial processing speed. These results imply that cognitive resilience—developed through neuroplastic training methods—may serve as a buffer against sensory conflicts. Importantly, this suggests a bidirectional relationship: while VIMS impairs cognition, strengthening cognitive domains can conversely dampen VIMS severity. Such findings encourage the inclusion of cognitive training modules in virtual reality (VR) and simulation platforms to reduce user discomfort and improve task sustainability.

Irmak et al. (2025) extended the VIMS conversation into real-world settings by examining its correlation with on-road car sickness and performance during visual tasks. Their observational study found that individuals prone to VIMS also exhibited increased attentional lapses and cognitive load while driving, particularly when multitasking or engaging with visual input. These findings substantiate the claim that the cognitive effects of VIMS are not confined to virtual environments, but can extend into daily functioning and safety-critical contexts. For instance, a compromised attentional span during driving due to prior VIMS exposure could heighten the risk of accidents—a real-world implication that emphasizes the urgent need for VIMS mitigation strategies.

Together, these studies underscore the multifactorial nature of VIMS. It involves not only sensory mismatch but also significant cognitive ramifications. From a neurocognitive standpoint, the disruptions seen in attention, spatial awareness, and executive control align with the observed increase in frontal theta and alpha activity, markers often linked to mental fatigue and working memory interference (Andrievskaia et al., 2023). These cognitive deficits, though often transient, may accumulate with repeated exposure, especially in individuals with higher baseline susceptibility.

This emerging evidence has direct implications for physiotherapy, education, and digital health. For example, in rehabilitation programs using VR-based gait or balance training, patients may inadvertently suffer from VIMS, leading to reduced compliance

or therapy dropout. Understanding the cognitive demands imposed by virtual environments can help clinicians design graded exposure protocols or incorporate pre-training in visual-spatial skills to increase patient adaptability. Similarly, educators employing immersive tools for anatomy teaching or motor skill acquisition must account for VIMS in students who show signs of cognitive strain (R. Boulic., et. al., 2022).

Moreover, these insights highlight the need for multidisciplinary collaboration between neuroscientists, physiotherapists, VR designers, and cognitive psychologists to develop user-centric systems that are not only engaging but also cognitively sustainable. Incorporating real-time monitoring of cognitive load using EEG or pupillometry could serve as feedback mechanisms to tailor the intensity of virtual experiences, thereby preventing cognitive overload.

Importantly, the discussion so far reveals a critical aspect of VIMS that is often understated—the neuroadaptive cost of sustained digital interaction. The brain's constant effort to reconcile contradictory sensory signals drains attentional resources and disrupts executive functions. This explains why users experiencing VIMS often report slower reaction times, reduced decision-making clarity, and difficulty retaining information during or after exposure. While these impairments may resolve within hours, repeated or prolonged episodes may lead to chronic cognitive inefficiencies, particularly in vulnerable populations such as children, the elderly, or individuals with pre-existing vestibular or cognitive impairments.

To summarize, VIMS extends far beyond transient nausea or discomfort; it introduces a cascade of cognitive changes that affect how users perceive, process, and respond to their environment. This growing body of research underscores the urgency of recognizing VIMS not just as a physiological inconvenience but as a neurocognitive concern. By deepening our understanding of its mechanisms and impacts, stakeholders can develop more intelligent, user-friendly digital systems that protect both physical and cognitive well-being.

CONCLUSION

Visually induced motion sickness extends beyond its physical symptoms, significantly impacting cognitive function. The neurophysiological evidence and behavioural data converge to reveal that VIMS imposes increased cortical workload, disrupts spatial cognition, and heightens attentional demands. These alterations contribute to a decline in cognitive efficiency, with implications for both clinical practice and everyday life activities.

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INNOVATIVE TEACHING IN PHYSIOTHERAPY: USING SIMULATION TO SEAMLESSLY TRANSITION FROM CLASSROOM CONCEPTS TO CLINICAL PRACTICE

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ABSTRACT
Healthcare education is undergoing a paradigm shift to address the increasing complexity of clinical environments and the evolving demands of patient-centered, team-based care. Traditional didactic teaching methods often inadequately prepare physiotherapy students for practical, hands-on clinical competence. This paper explores a range of innovative pedagogical approaches designed to bridge the gap between classroom learning and clinical practice in physiotherapy education. Key innovations include simulation-based education, flipped classrooms, interprofessional education (IPE), mobile and digital learning tools, competency-based medical education (CBME), and longitudinal integrated clerkships (LICs). Emphasis is placed on the transformative role of artificial intelligence (AI) technologies—particularly AI- driven motion analysis, virtual and augmented reality (VR/AR), and personalized adaptive learning platforms—in enhancing clinical readiness, diagnostic accuracy, and individualized student learning pathways. The integration of AI facilitates objective movement assessment, real-time feedback, and data-driven treatment planning, thereby advancing both educational and patient care outcomes. Furthermore, LICs provide continuity of care and mentorship, fostering holistic and patient-centered clinical reasoning. The paper discusses the practical benefits, challenges, and ethical considerations associated with implementing these innovations, including cost, accessibility, data privacy, and the need for validated educational outcomes. Future directions highlight the potential for hybrid educational models and expanded research to optimize AI integration and immersive technologies, ultimately promoting effective, collaborative, and lifelong learning among physiotherapy professionals

Keyword: *Physiotherapy education; Motion analysis; Competency-based education; Virtual reality; Longitudinal integrated clerkships; Healthcare pedagogy; Educational technology.*

INTRODUCTION
Effectively translating theoretical knowledge into practical competence remains a pivotal challenge in healthcare education. Rapid expansion of clinical knowledge, technological advances, and the growing emphasis on patient-centered, team-based care have exposed limitations in traditional didactic methods. These methods often emphasize memorization over application and are insufficient in preparing students for the complexities of modern clinical environments.

This issue is especially significant in physiotherapy, a discipline that heavily relies on hands- on skills, patient interaction, and detailed movement analysis. Given the practical nature of physiotherapy, educational innovations must bridge the gap between classroom learning and real-world clinical competence.

This paper reviews innovative teaching strategies that not only enhance learner engagement but also ensure students develop the skills necessary to deliver safe, effective, and evidence- based care. Special focus is given to the integration of AI technologies in physiotherapy education, which promise to revolutionize assessment and personalized training.

Simulation-Based Education

Simulation-based learning immerses students in realistic clinical scenarios without compromising patient safety. It allows repeated practice, error correction, and the development of clinical reasoning in a risk-free environment.

In physiotherapy, simulation includes both physical and virtual modalities. Students may practice manual therapy techniques on mannequins or engage with digital simulations modeling musculoskeletal conditions and neurological impairments.

Applications include:

- Gait retraining and biomechanical correction
- Neurological rehabilitation scenarios, such as post-stroke recovery
- Emergency response training and clinical decision-making Advantages:
- Increases procedural confidence by enabling hands-on practice
- Allows learners to make and correct mistakes without patient harm
- Enhances clinical judgment by simulating complex, real-life cases

Simulation is essential for experiential learning, providing a bridge between theory and clinical practice.

Flipped Classroom and Blended Learning

The flipped classroom model reverses traditional lecture-homework patterns. Students engage with instructional content independently before class (e.g., videos or readings), reserving classroom time for active, skills-based learning.

In physiotherapy education, this approach integrates theory with practice effectively. Typical structure:

- **Pre-class:** Students study biomechanics, pathology, or therapeutic principles through multimedia materials.
- **In-class:** Emphasis shifts to case-based discussions, problem-solving exercises, and practical skills labs where knowledge is applied.

Benefits:

- Promotes critical thinking and deeper understanding

- Maximizes active learning during limited classroom time
- Encourages peer collaboration and instructor feedback during applied tasks

Blended learning, which combines in-person and online elements, further supports flexible and personalized education.

Interprofessional Education (IPE)

IPE brings together students from various health professions—medicine, nursing, occupational therapy, and physiotherapy—to learn collaboratively.

Clinical examples:

- Coordinated discharge planning for stroke patients, involving multidisciplinary perspectives
- Team-based care for orthopedic rehabilitation requiring input from multiple specialists IPE fosters:
- Mutual respect and understanding of different professional roles
- Collaborative problem-solving essential in integrated healthcare delivery
- Improved communication skills within healthcare teams

By simulating real-world clinical teamwork, IPE prepares students to function effectively in multidisciplinary environments.

Mobile and Digital Learning Tools

The ubiquity of mobile devices has introduced a new dimension to clinical education. Physiotherapy educators leverage mobile apps and online platforms to augment traditional teaching methods.

Examples include:

- **Physiotools:** Exercise prescription and patient education resources
- **Goniometer apps:** For measuring joint angles accurately
- **Mobile anatomy apps:** Detailed, interactive anatomical references
- **Video libraries:** Demonstrations of therapeutic exercises and techniques

These tools support on-the-go learning and quick clinical referencing during placements, enhancing students' ability to review and reinforce skills outside the classroom.

Competency-Based Medical Education (CBME)

CBME shifts educational focus from time-based progression to the demonstration of predefined competencies. In physiotherapy, curricula are designed around essential skills such as patient communication, movement analysis, and ethical decision-making.

Assessment strategies:

- **Objective Structured Clinical Examinations (OSCEs):** Simulated clinical stations to evaluate practical skills
- **Mini-CEX:** Direct observation of clinical encounters in real settings
- **Structured rubrics:** Standardized evaluation criteria ensuring fair assessment of clinical performance

CBME ensures that students are assessed on their ability to perform clinically relevant tasks, rather than merely recalling theoretical knowledge.

AI-Driven Motion Analysis in Physiotherapy Education

Advanced Motion Analysis Systems

Recent advances in AI and machine learning have significantly enhanced motion analysis technology, which is pivotal in physiotherapy education. Traditional observational assessment methods are subjective and often limited by human error or inconsistency. AI-driven systems leverage computer vision, deep learning algorithms, and 3D sensor technologies to provide highly accurate, objective, and reproducible assessments of movement patterns.

Key systems such as Kinetisense, HumanTrak, and emerging platforms incorporate multi- camera setups, depth sensors (e.g., Microsoft Kinect), and wearable inertial measurement units (IMUs) to capture comprehensive biomechanical data. These systems measure joint angles, movement velocity, acceleration, balance, and symmetry with precision.

Core Functionalities

- **Real-Time 3D Movement Capture:** AI algorithms process data to reconstruct three- dimensional models of the human body during motion, allowing detailed evaluation of posture, joint alignment, and kinetic chains.
- **Automated Movement Classification:** Machine learning models classify complex movement patterns, differentiating normal from pathological gait, detecting compensatory movements, and identifying subtle asymmetries that may be imperceptible to the naked eye.
- **Quantitative Feedback:** Students receive numerical scores and graphical representations of parameters such as range of motion (ROM), stride length, and balance metrics, which provide actionable insights for correction.
- **Longitudinal Monitoring:** Systems store historical data enabling trend analysis of patient or student performance over time, which is essential for tracking rehabilitation progress and learning outcomes.

Integration into Physiotherapy Curriculum

The incorporation of AI-driven motion analysis into educational programs allows students to:

- **Develop Analytical Skills:** Students learn to interpret complex biomechanical data, fostering a deeper understanding of human movement and dysfunction.
- **Enhance Diagnostic Accuracy:** Exposure to objective data assists in refining clinical reasoning when identifying movement impairments or pathologies.
- **Personalize Interventions:** By recognizing individual variations and response to treatment, students can tailor rehabilitation protocols more effectively.
- **Engage in Self-Directed Learning:** Interactive software encourages students to experiment, receive immediate feedback, and reflect on performance outside the clinical environment.

Research and Development Trends

- **Integration with Wearable Technology:** AI-enabled wearables are increasingly being used for ambulatory motion analysis, allowing continuous monitoring during daily activities, thereby extending education beyond clinical settings.
- **Deep Learning for Movement Prediction:** Emerging AI models predict potential injury risks based on detected abnormal movement patterns, offering preemptive educational opportunities in injury prevention.
- **Hybrid Systems:** Combining AI motion analysis with electromyography (EMG) sensors provides insights into muscle activation patterns, which enhances students' understanding of neuromuscular control.

Challenges and Considerations

- **Data Quality and Diversity:** Accurate AI model training requires diverse datasets representing different populations, ages, and pathologies to avoid bias.
- **Ethical Use of Data:** Maintaining patient and student privacy in data collection and storage is critical, necessitating robust security protocols.
- **Accessibility:** High cost and technical complexity may limit widespread adoption, particularly in resource-constrained settings.

Virtual and Augmented Reality (VR/AR) with AI

Immersive Learning Environments

AI-powered VR and AR technologies represent cutting-edge tools that transform physiotherapy education by providing immersive, interactive environments where learners can practice clinical skills safely and repeatedly.

- **Virtual Reality (VR):** Fully immersive digital environments simulate clinical settings, enabling students to perform assessments, execute rehabilitation exercises, and interact with virtual patients.
- **Augmented Reality (AR):** Overlaying digital information onto the real world, AR facilitates learning by enhancing real-time patient interaction and visualization of anatomical structures during hands-on practice.

Capabilities Enhanced by AI

- **Intelligent Scenario Adaptation:** AI algorithms dynamically adjust difficulty and complexity of simulated cases based on learner performance, providing personalized challenges that optimize skill acquisition.
- **Natural Language Processing (NLP):** In AI-driven VR/AR simulations, virtual patients respond to student inquiries and communication attempts using NLP, enabling practice of soft skills such as empathy, patient education, and motivational interviewing.
- **Real-Time Biomechanical Feedback:** Motion sensors and AI analysis within VR/AR systems provide immediate feedback on student movements, allowing correction of technique during virtual rehabilitation exercises.
- **Multiuser Collaborative Environments:** VR platforms can host multiple learners simultaneously, fostering interprofessional collaboration and communication within virtual clinical teams.

Practical Applications

- **Clinical Skills Training:** Students practice palpation, range of motion testing, and functional assessments in virtual patients with simulated pathologies (e.g., stroke hemiparesis, Parkinson's disease).
- **Anatomical Visualization:** AR overlays anatomical structures (muscles, bones, nerves) on live models or mannequins, enhancing spatial understanding critical for accurate assessment and intervention.
- **Rehabilitation Protocol Simulation:** Students rehearse designing and implementing rehabilitation plans, adjusting parameters in real time based on patient feedback simulated by AI.
- **Exposure to Rare Cases:** VR allows students to experience management of uncommon conditions, broadening clinical exposure beyond available clinical sites.

Educational Benefits

- **Safe, Risk-Free Environment:** Students can experiment and learn from mistakes without risking patient safety.
- **Increased Engagement and Motivation:** Immersive experiences enhance learner engagement, retention, and satisfaction compared to traditional methods.
- **Scalable and Flexible Learning:** VR/AR modules are accessible remotely, supporting distance learning and continuing professional development.
- **Enhanced Soft Skills Development:** Simulated patientinteractionsimprove communication, cultural competence, and empathy.

Emerging Trends

- **Haptic Feedback Integration:** Advanced VR systems now incorporate tactile feedback to simulate touch and resistance, crucial for manual therapy training.
- **AI-Powered Virtual Tutors:** Intelligent agents guide students through complex clinical scenarios, providing personalized instruction and hints.
- **Data Analytics:** AI aggregates performance data across VR/AR sessions to identify common learning gaps, enabling continuous curriculum improvement.

Challenges

- **Technology Costs:** High initial investment in VR/AR hardware and software limits accessibility for many institutions.
- **Technical Barriers:** Requires robust infrastructure, including high-speed internet and skilled technical support.
- **User Adaptation:** Some students and faculty may experience discomfort or resistance adapting to immersive technologies.
- **Validation and Standardization:** Ongoing research is needed to validate educational effectiveness and develop standardized protocols for VR/AR use.

Longitudinal Integrated Clerkships (LICs) in Physiotherapy Education

Definition and Conceptual Framework

Longitudinal Integrated Clerkships (LICs) represent a transformative educational model in health professions training, where students participate in the ongoing care of patients over an extended period while simultaneously engaging with multiple clinical disciplines. Unlike traditional block rotations that isolate clinical experiences into distinct, time-limited segments (e.g., four weeks in orthopedics, four weeks in neurology), LICs emphasize continuity—of patient care, mentorship, assessment, and curriculum.

The model supports deeper learning by enabling students to:

- Develop lasting relationships with patients and mentors
- Observe patient progress across various phases of care
- Integrate knowledge across specialties in real-time clinical practice

While LICs have been well-established in medical education (e.g., Harvard Medical School's Cambridge Integrated Clerkship), their application in physiotherapy education is gaining momentum.

Implementation in Physiotherapy Education

In the context of physiotherapy, LICs may involve assigning students to specific patients or clinical pathways over several months, allowing them to observe and participate in the full spectrum of rehabilitation, from acute care to outpatient or community-based services.

Example Pathway: Stroke Rehabilitation LIC

- **Acute phase:** Hospital-based physiotherapy following stroke onset
- **Subacute phase:** Transition to inpatient rehabilitation center
- **Chronic phase:** Ongoing outpatient or home-based therapy
- **Community reintegration:** Social participation, workplace reintegration, and adaptive sports

Through this extended exposure, students witness the complexity and variability of recovery trajectories and participate in goal-setting, intervention, reassessment, and discharge planning.

Other Settings

- Orthopedic post-surgical rehabilitation (e.g., joint replacements)
- Pediatric care (e.g., following children through developmental milestones)
- Chronic disease management (e.g., COPD, Parkinson's, or spinal cord injury) Core Components of LICs

1. **Continuity of Care:** Students follow the same patients over time, developing a holistic understanding of their condition and rehabilitation needs.
2. **Continuity of Supervision:** Students work consistently with one or a few preceptors, fostering mentorship and in-depth feedback.
3. **Continuity of Curriculum:** Clinical learning objectives are interwoven with real patient care across multiple domains, instead of being segmented by specialty.

EDUCATIONAL BENEFITS

For Students

- **Enhanced Clinical Reasoning:** Managing patients longitudinally strengthens decision- making by exposing students to evolving clinical needs and responses to interventions.
- **Holistic, Patient-Centered Perspective:** Students move beyond task-based learning to appreciate psychosocial, emotional, and environmental aspects of patient care.
- **Improved Communication and Empathy:** Long-term patient relationships encourage development of trust, empathy, and therapeutic alliance.
- **Increased Confidence:** Repeated exposure to the same patients helps reinforce learning and fosters clinical independence.

For Educators and Institutions

- **Richer Assessment Opportunities:** Educators can evaluate growth over time, not just performance during isolated tasks or scenarios.

- **Curriculum Integration:** LICs offer a natural structure for integrating multiple competencies—clinical, ethical, cultural, and professional.

Global Practices and Examples

- **Canada:** Several physiotherapy programs integrate LIC-like placements in rural or underserved areas, allowing students to contribute meaningfully to communities over time.
- **Australia:** The University of Queensland and Monash University have implemented LICs for physiotherapy students, often in rural or remote settings, emphasizing continuity and community engagement.
- **United States:** Although LICs are more common in medical schools, some Doctor of Physical Therapy (DPT) programs have begun experimenting with extended integrated clinical placements.

Challenges in Implementation

- **Logistical Complexity:** Coordinating long-term placements that allow students to follow patients through different settings (hospital, rehab center, home) requires careful planning and institutional support.
- **Clinical Site Availability:** Not all clinics have the patient volume or stability to support LIC models.
- **Faculty Workload:** Longitudinal supervision demands consistent educator engagement and mentoring.
- **Assessment Alignment:** Existing evaluation systems may not fully capture the longitudinal development of competencies.

Technological Support for LICs

Advancements in digital health and AI can strengthen LIC implementation:

- **Electronic Health Records (EHRs):** Facilitate access to ongoing patient information across settings.
- **Telehealth:** Allows students to continue patient interactions remotely during care transitions.
- **AI-Powered Portfolios:** Track student performance and learning milestones longitudinally, supporting formative and summative assessment.
- **Remote Supervision Platforms:** Enable educators to provide continuous feedback even when students are placed in remote or community settings.

Future Directions

To scale and optimize LICs in physiotherapy education, institutions may consider:

- **Hybrid LIC Models:** Combine in-person and virtual elements to allow continuity without geographical constraints.

- **Community-Based LICs:** Embed students in long-term care facilities, rural clinics, or home health services where patient continuity is inherently higher.
- **Research on Outcomes:** Systematic research is needed to evaluate the impact of LICs on student performance, patient satisfaction, and long-term professional competency.

Personalized Learning in Physiotherapy Education

AI-enabled educational platforms use learning analytics and machine learning to adapt instructional strategies, assessments, and feedback to each student's cognitive style, pace, strengths, and knowledge gaps.

Key Technologies

- **Adaptive Learning Platforms:** Systems like Smart Sparrow, DreamBox, and custom- built AI learning management systems (LMS) provide real-time customization of learning pathways.
- **Intelligent Tutoring Systems (ITS):** AI tutors assess student performance and simulate one-on-one instruction, mimicking a human tutor's ability to offer just-in-time support.
- **Natural Language Processing (NLP):** Enables interactive learning experiences where students can ask questions and receive context-specific explanations using AI chatbots or virtual assistants (e.g., Physiotutors' chatCPG).
- **Learning Path Optimization:** Algorithms analyze quiz results, assignment completion times, clinical assessments, and even movement analysis data to recommend learning modules or suggest revisions.

Applications in Physiotherapy Education

- **Personalized Content Delivery:** Students with weak performance in neuromuscular assessment might receive supplementary content or simulations targeting those topics.
- **Skill-Based Adaptation:** Practical performance (e.g., incorrect joint mobilization techniques recorded via motion analysis) triggers targeted remediation.
- **Progressive Case Complexity:** As students master basic clinical cases, AI gradually introduces more complex, multi-system scenarios.

AI-Enhanced Clinical Reasoning and Treatment Planning

Beyond education, AI is revolutionizing clinical decision-making and treatment personalization in physiotherapy.

AI in Patient Assessment

- AI can integrate various data sources—EHRs, diagnostic imaging, wearables, motion capture, and patient-reported outcomes—to provide a comprehensive analysis of the patient's condition.

- Predictive analytics use machine learning to anticipate recovery trajectories, risk of reinjury, or non-compliance, allowing early intervention.

Examples of AI-Driven Clinical Tools

- **Kaia Health:** Provides evidence-based, AI-personalized exercise programs for musculoskeletal conditions with real-time motion tracking and feedback.
- **Physitrack AI:** Suggests individualized exercise progressions based on patient feedback and performance.
- **Tend AI:** Uses patient metrics to generate, modify, and track rehab protocols tailored to functional goals and real-time progress.
- **Computer Vision Tools:** Systems like PhysioCam and Kinovea capture and interpret patient movement for accurate diagnosis and tracking.

Closed-Loop Feedback Systems

AI enables the creation of closed-loop systems, where data from patient sessions or student interactions feed directly into algorithms that adjust future tasks or recommendations.

How it Works

1. **Input:** Patient performs exercises; student performs an assessment.
2. **Processing:** AI analyzes biomechanical data, engagement metrics, outcomes.
3. **Output:** System modifies exercise difficulty or learning module content.
4. **Reassessment:** Continuously updates plan based on progress.

This dynamic loop ensures learning and treatment remain responsive and optimally challenging.

Student and Educator Benefits For Students

- **Tailored Learning Paths:** Students focus on what they need, improving efficiency and mastery.
- **Better Engagement:** Adaptive content feels more relevant and appropriately challenging.
- **Immediate Feedback:** Real-time alerts and suggestions help correct mistakes as they happen.
- **Greater Autonomy:** Learners control pace and sequence, fostering lifelong learning skills.

For Educators

- **Insightful Analytics:** Dashboards display class trends and individual progress, identifying students at risk or excelling.

- **Automated Remediation:** AI systems suggest corrective content or supplemental practice automatically.
- **Focus on Mentorship:** With routine feedback handled by AI, educators can focus more on higher-order coaching and clinical mentorship.

AI for Personalized Patient Care Planning

Data-Driven Protocol Development

AI evaluates vast datasets to suggest or generate:

- Tailored exercise regimens based on age, comorbidities, injury type, and activity level.
- Dynamic rehabilitation plans that adjust based on functional assessments and patient- reported feedback.
- Real-time alerts if patient performance or engagement declines, prompting timely therapist intervention.

Example Scenario

A patient recovering from ACL reconstruction logs home-based exercises via an AI-enabled mobile app. The system:

- Assesses knee flexion range via video
- Compares it to expected recovery benchmarks
- Recommends either progression or regression of difficulty
- Flags any red-flag signs (e.g., pain, swelling) for therapist review Ethical and Practical Considerations

Privacy and Data Security

- Student and patient data (videos, performance, outcomes) must be stored securely.
- GDPR, HIPAA, and other data protection regulations must be followed.

Algorithmic Bias

- AI models trained on non-representative datasets can perpetuate disparities.
- Physiotherapy AI tools must be validated across age groups, ethnicities, and functional abilities.

Transparency and Interpretability

- Students and clinicians must understand how and why an AI reached its recommendation (explainable AI).

Professional Judgment

- AI is a decision support tool, not a replacement for human critical thinking and clinical experience.

AI Clinical Assistants and Decision Support

AI clinical assistants, such as chatCPG by Physiotutors, provide learners with real-time, evidence-based answers, curated research, and clinical decision support.

Decision support systems analyze complex patient data to aid diagnosis and treatment, helping students develop critical analytical skills.

Advantages

- Easy access to up-to-date clinical evidence
- Structured guidance through complex clinical scenarios
- Encouragement of critical evaluation and evidence-based decision-making

DISCUSSION

The landscape of healthcare education is rapidly evolving to meet the increasing demands of clinical complexity, technological integration, and patient-centered care. For disciplines like physiotherapy—where success depends heavily on manual skills, clinical reasoning, and patient interaction—traditional lecture-based instruction falls short in preparing students for real-world challenges. The pedagogical innovations discussed in this paper provide not only a response to these deficiencies but also an opportunity to redesign curricula in a way that fosters competence, confidence, and adaptability.

Simulation-Based Education

Simulation has become a cornerstone of experiential learning in physiotherapy. By replicating real-world clinical scenarios, students are provided with a psychologically safe environment where they can develop and refine motor skills, clinical judgment, and decision-making without risking patient harm. This is especially valuable in high-risk or infrequent scenarios such as emergency care or complex neurological cases. Virtual and high-fidelity physical simulations are now used to teach gait assessment, balance training, and musculoskeletal interventions. The repetitive, feedback-driven nature of simulation accelerates skill acquisition and supports deliberate practice, a well-established model for expert performance development.

Moreover, simulation helps address variability in clinical placements. Inconsistent patient caseloads and unpredictable exposure to specific pathologies can lead to skill gaps. Simulation mitigates this by ensuring consistent learning experiences. Nevertheless, resource intensity and faculty training remain key barriers to scaling simulation widely.

Flipped Classrooms and Blended Learning

The flipped classroom model restructures the traditional flow of information delivery, allowing students to first engage with foundational content independently through readings, recorded lectures, or interactive modules. Classroom time is then devoted to collaborative case analysis, hands-on practice, and application of theory. This model is especially effective in physiotherapy education, where physical demonstrations and immediate instructor feedback are essential.

Studies have shown that flipped classrooms improve engagement, critical thinking, and retention. Blended learning, which incorporates digital tools and asynchronous activities, adds flexibility and personalization to the learning experience. These models also align with modern learners' preferences and schedules, making education more accessible and dynamic. However, successful implementation requires a shift in educator roles, technological proficiency, and ongoing instructional design support.

Interprofessional Education (IPE)

Interprofessional education is critical in preparing students for the collaborative nature of healthcare delivery. Physiotherapists frequently work in multidisciplinary teams, and early exposure to team-based care fosters mutual respect, communication, and role clarity. For instance, joint discharge planning for stroke patients or rehabilitation of post-surgical orthopedic cases provides physiotherapy students with real-world insight into collaborative problem-solving.

IPE programs have demonstrated improvements in patient outcomes, healthcare efficiency, and professional satisfaction. However, logistical complexities such as scheduling across programs, balancing discipline-specific competencies, and coordinating faculty remain ongoing challenges. The growing use of virtual IPE modules offers a scalable solution, particularly in settings with limited access to diverse clinical sites.

Mobile and Digital Learning Tools

Mobile technologies and digital platforms have dramatically extended the learning environment beyond the classroom. Physiotherapy students can now use goniometer apps, video libraries, and anatomy visualizations to reinforce learning during clinical placements. These tools support just-in-time learning and can enhance autonomy and self-regulation, crucial traits for lifelong learning.

Importantly, mobile platforms also serve as valuable adjuncts for patient education and engagement, meaning that students gain familiarity with tools they are likely to use in practice. However, the vast availability of apps raises concerns about content quality and standardization. Educators must carefully curate and integrate these tools into curricula to maximize their educational value.

Competency-Based Medical Education (CBME)

CBME shifts the focus of education from time-based training to the mastery of clearly defined competencies. In physiotherapy, these include both technical skills (e.g., movement assessment, manual therapy) and soft skills (e.g., empathy, communication, ethical reasoning). By utilizing assessment methods such as Objective Structured Clinical Examinations (OSCEs) and Mini-CEXs, educators can better evaluate students' readiness for clinical practice.

CBME encourages students to take ownership of their learning and progress at their own pace, which aligns well with the use of adaptive learning technologies. While promising, CBME implementation requires robust assessment frameworks, faculty

development, and longitudinal tracking systems that are still under refinement in many physiotherapy programs.

AI-Driven Motion Analysis and Personalization

The application of artificial intelligence in motion analysis is a groundbreaking development in physiotherapy education. These technologies provide objective, quantifiable insights into human movement that surpass traditional observational methods. Systems such as Kinetisense and HumanTrak use 3D sensors, machine learning, and computer vision to detect deviations in movement patterns, assess joint function, and generate real-time feedback.

For students, this technology translates into more precise learning, greater diagnostic confidence, and the opportunity for self-assessment. For educators, AI-driven data can highlight common errors and learning gaps, allowing for targeted remediation. However, the implementation of these systems must address technical complexity, cost, and the need for diverse, representative datasets to ensure equity and accuracy in assessments.

Virtual and Augmented Reality (VR/AR) with AI

AI-augmented VR and AR environments offer immersive, interactive platforms for simulating clinical scenarios. These tools are particularly valuable in physiotherapy training where tactile, visual, and spatial understanding are critical. Students can practice palpation, perform virtual assessments, and interact with AI-driven virtual patients that respond in real-time through natural language processing.

These platforms are shown to increase learner engagement and promote deeper understanding by mimicking authentic clinical decision-making processes. With the integration of haptic feedback, students can even simulate manual therapy techniques. However, the success of VR/AR depends heavily on institutional infrastructure, faculty support, and student comfort with immersive technologies.

Longitudinal Integrated Clerkships (LICs)

LICs represent a significant innovation in structuring clinical education. Unlike traditional block rotations, LICs allow students to follow the same patients over time, building deeper understanding of disease progression, psychosocial dynamics, and therapeutic relationships. In physiotherapy, this continuity is particularly meaningful as rehabilitation often unfolds over weeks or months.

The continuity of supervision also enhances mentorship and allows for more comprehensive formative feedback. Institutions in Canada and Australia have begun piloting LICs in physiotherapy, with promising results in both student satisfaction and perceived preparedness. Nonetheless, logistical challenges such as placement coordination, faculty time commitment, and standardizing assessment across diverse clinical environments remain barriers to broader adoption.

Ethical and Practical Considerations

The integration of AI and digital tools into education raises essential questions about data privacy, bias, and accountability. Systems that collect video, biometric, or

clinical data must comply with regulations such as GDPR and HIPAA. AI algorithms must be transparent and interpretable, especially in educational settings where learners must understand the rationale behind automated feedback.

Moreover, while AI can support decision-making, it must not replace critical human judgment. Educators should emphasize the role of AI as a support tool and instill in students the ability to critically evaluate AI outputs. Equity must also remain a central concern—institutions must work to ensure that access to advanced technologies does not depend on geography or financial resources.

CONCLUSION

Innovations in healthcare education—particularly within physiotherapy—are essential to bridging the gap between classroom learning and clinical practice. Emerging technologies, pedagogical models, and longitudinal learning structures collectively contribute to developing competent, confident, and collaborative clinicians. AI and motion analysis platforms offer unparalleled precision in skills assessment and feedback, while VR/AR systems expand experiential learning beyond traditional settings.

As education shifts toward competency-based, patient-centered models, institutions must invest in infrastructure, faculty development, and curricular reform to fully harness these advancements. Future research should prioritize outcome-based evaluations, cost-effectiveness studies, and strategies for equitable access. By embracing innovation thoughtfully and ethically, physiotherapy education can evolve to meet the demands of 21st-century clinical practice.

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POSTURAL CHANGES AND REHABILITATION IN COMMUNITY DWELLING OLDER ADULTS: A GLOBAL APPROACH TO REHABILITAION

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ABSTRACT

As the world's population grows older, older adults living in the community are increasingly confronted with issues related to changes in posture, such as reduced balance, unstable walking patterns, and deterioration of musculoskeletal health. These alterations significantly contribute to falls, injuries, and a decline in independence. This narrative review seeks to investigate the characteristics of age-related postural alterations and evaluate rehabilitation methods used worldwide to tackle these issues. This review synthesizes

The evidence highlights common postural impairment in older adults include decrease muscle strength, spinal misalignment, and impaired neuromuscular co-ordination. Rehabilitation statergies such as structured physical activity programs, targeted postural exercises, virtual reality interventions, and community based fall prevention initiatives have demonstrated effectiveness in improving postural changes due to variations in socioeconomic status, culture, and infrastructure. The review highlights the necessity for rehabilitation strategies that are globally applicable, culturally relevant, and grounded in evidence to improve postural health and diminish the risk of falls among aging populations. A comprehensive and preventive approach is crucial for promoting healthy aging and maintaining independence ability.

Although these interventions show potential, their availability and execution differ significantly across region for older adults living in the community.

Keywords: *Posture, Rehabilitation, Exercise, Fall, Virtual Reality*

INTRODUCTION

Good Posture is define as posture which puts minimal stress on ligaments, joints, capsule. It minimize the work load on muscle. Postural changes can lead to increase stress on muscle, ligaments, capsule, bone. Maintaining older persons' functional independence is crucial as the world's population ages. Decreased balance and changed gait are two examples of postural abnormalities that greatly increase the risk of falls and the ensuing loss of independence. The purpose of this narrative review is to investigate how postural alterations affect older persons who live in the community and look at rehabilitation techniques from a global viewpoint.

Need for study:

Falls in elderly individuals are a major contributor to illness and death globally. The deterioration of postural control due to age-related alterations in the musculoskeletal

and neuromuscular systems elevates the risk of falling. It is essential to comprehend these changes along with effective rehabilitation methods to create interventions that improve balance, mobility, and the overall quality of life for older adults.

METHODS

A thorough literature review was performed across databases including PubMed, Google Scholar, and EBSCO, concentrating on research published from 2010 to 2024. The inclusion criteria comprised randomized controlled trials, cohort studies, and narrative reviews that focused on alterations in posture and rehabilitation strategies for older adults living in the community. Studies were chosen based on their relevance, quality of methodology, and results pertaining to postural stability, balance, and fall prevention.

RESULTS

Postural Changes in Older Adults

Changes in posture among older individuals are influenced by age-related factors, including a decrease in muscle strength, modifications in body alignment, diminished cognitive abilities, and slower motor responses. As a result, this can cause a decline in walking patterns, characterized by shorter steps and slower walking speeds, thereby raising the likelihood of falls. Furthermore, the deterioration of postural control frequently occurs before fall incidents, emphasizing the importance of early intervention.

Rehabilitation Strategies

1. Physical Activity and Exercise Programs

Participating in consistent physical exercise, such as balance and strength training, has demonstrated benefits for postural control in vulnerable older individuals. Initiatives that promote balance and bolster muscle response can result in considerable enhancements in postural stability.

2. Postural Exercises

Acute postural exercises targeting core musculature can lead to immediate improvements in stature and posture. These exercises help maintain spinal alignment and reduce curvature, contributing to better balance and reduced fall risk.

3. Virtual Reality-Based Rehabilitation

Virtual reality (VR) technology has been utilized in rehabilitation programs to address immobility syndrome in older adults. VR-based interventions can enhance engagement and provide tailored therapeutic experiences, improving balance and mobility.

4. Community-Based Interventions

Community-based fall prevention programs, including multifactorial interventions that assess individual risks and provide personalized strategies, have shown positive outcomes in reducing fall incidents among older adults.

DISCUSSION

The rise in the global aging population requires efficient approaches to manage postural changes and reduce fall risks among older adults living in the community. Rehabilitation initiatives that include physical activity, posture-focused exercises, and cutting-edge technologies like virtual reality can greatly enhance postural stability and overall quality of life. Nonetheless, factors such as accessibility, resource distribution, and cultural variations need to be taken into account when applying these interventions in various populations.

CONCLUSION

Implementing thorough rehabilitation approaches to address postural changes is vital for improving the independence and overall quality of life for older adults living in the community. Consideration of global viewpoints and culturally specific interventions is important for creating effective programs aimed at reducing fall risks and encouraging healthy aging.

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INNOVATIONS IN NEUROLOGICAL AND MUSCULOSKELETAL REHABILITATION: A SYSTEMATIC REVIEW

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ABSTRACT
Global health is greatly impacted by neurological and musculoskeletal problems, which result in lower quality of life and long-term impairment. Recent developments in rehabilitation techniques aimed at these disorders are examined in this comprehensive review. Clinical techniques are changing as a result of technologies like wearable sensors, robotic-assisted therapy, telerehabilitation, virtual reality (VR), and regenerative medicine (e.g., stem cell therapy, PRP). The evaluation evaluates the efficacy, accessibility, and clinical results of these new approaches by combining data from research that was published between 2015 and 2024.

The results indicate that although innovations improve functional recovery and patient engagement, large-scale clinical studies are necessary for additional validation before they can be incorporated into regular practice.

Keywords: *Neurological rehabilitation, musculoskeletal disorders, virtual reality, robotics, telerehabilitation, wearable sensors, regenerative medicine, physiotherapy innovation*

1. INTRODUCTION
Among the most common causes of physical disability globally are neurological (such as stroke, Parkinson's disease, and spinal cord injury) and musculoskeletal (such as osteoarthritis, back pain, and post-fracture diseases) problems. Despite their effectiveness, traditional physiotherapy methods frequently have drawbacks in terms of accessibility, patient motivation, and intensity. New paradigms in rehabilitation have been brought about by recent biomedical and technology advancements, which promise improved results. The purpose of this review is to assess the state of these breakthroughs now, with an emphasis on their potential for the future and therapeutic impact.

2. OBJECTIVES
To determine new developments in neuro-musculoskeletal rehabilitation, both biologically and technologically.

To assess these therapies' efficacy in light of clinical results.

To evaluate how well these advancements have been incorporated into modern physiotherapy practice.

3. METHODOLOGY

3.1 Search Strategy

Databases searched: PubMed, Scopus, PEDro, Google Scholar

Keywords: neurological rehabilitation, musculoskeletal rehabilitation, virtual reality, robotics, telerehabilitation, wearable technology, stem cell therapy, platelet-rich plasma

Inclusion Criteria:
Studies from 2015–2024

Clinical trials, RCTs, and pilot studies

Adult population

English language

Exclusion Criteria:
Animal studies

Non-peer-reviewed articles

Case reports and editorials

3.2 Data Extraction and Analysis:

Data were extracted based on innovation type, population studied, intervention protocol, and clinical outcomes. Methodological quality was assessed using the PEDro scale.

4. RESULTS

4.1 Virtual Reality (VR)

Utilized in the treatment of Parkinson's disease and stroke.

Improves upper limb function, balance, and coordination.

The Fugl-Meyer Assessment scores significantly improved, according to a meta-analysis of 18 research.

4.2 Robotic-Assisted Therapy

Beneficial for upper and lower limb rehabilitation following a stroke.

Compared to traditional therapy, devices such as Lokomat and ArmeoSpring demonstrated superior results in motor relearning.

4.3 Telerehabilitation

Increased access for rural and immobile populations.

Comparable functional outcomes to in-person therapy in post-COVID musculoskeletal rehab studies.

4.4 Wearable Sensors and Exoskeletons

Real-time feedback improved gait retraining in spinal cord injury.

Smart insoles and motion sensors helped monitor home-based exercise adherence.

4.5 Regenerative Therapies

PRP and stem cell therapy for osteoarthritis and tendon injuries.

Mixed evidence on long-term benefit; short-term pain relief and function improvement noted.

5. DISCUSSION

Integrating digital technology into rehabilitation has been shown to improve outcomes, compliance, and motivation. Virtual reality and robotics are particularly useful in neurorehabilitation because they provide recurrent, task-specific training. For remote monitoring, wearables provide doctors with actionable data. However, challenges like as inconsistency, cost, and clinical training persist. Trials must continue to prove the efficacy of regenerative drugs, which are still in their early stages of clinical development.

6. CONCLUSION

Clinical treatments are evolving as a result of advances in neuromusculoskeletal rehabilitation, particularly in digital and regenerative techniques. They offer an engaging, data-driven, and tailored treatment approach. More research, interdisciplinary collaboration, and infrastructure support are required to incorporate these developments into established physiotherapy methods.

7. RECOMMENDATIONS

Include online rehabilitation courses in physiotherapy courses.

Create national telerehabilitation integration guidelines.

Provide funding for more extensive multicenter regenerative therapy trials.

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THE ROLE OF TECHNOLOGY IN ENHANCING ACADEMIC PERFORMANCE AND REDUCING STRESS

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ABSTRACT

Background: *The growing integration of technology in education has significantly reshaped the learning environment. This study investigates the role of educational technologies in enhancing academic performance and alleviating student stress. It highlights the use of digital platforms, mobile applications, and online learning tools that support personalized learning, time management, and mental health. Drawing on recent literature, case studies, and survey data, the study offers a comprehensive evaluation of the impact of technology on student outcomes.*

Method: *A mixed-methods research approach was adopted, combining quantitative and qualitative data to provide a well-rounded understanding of how educational technology influences academic achievement and stress reduction. The study included 150 students from three universities, spanning undergraduate and postgraduate programs.*

Results: *Among the participants, 58% identified as female and 42% as male, with the majority (71%) aged between 18 and 24 years. A total of 83% reported daily use of technology for academic purposes. A significant positive correlation was found between the frequency of technology use and academic performance ($r = 0.62$, $p < 0.01$). Students who utilized learning management systems had higher average GPAs (mean = 3.4) compared to those relying on traditional methods (mean = 2.9, $p < 0.05$). Furthermore, 68% of students stated that technology helped reduce their academic stress. Those who regularly used mental health applications had lower perceived stress scores (mean PSS = 17.3) than non-users (mean PSS = 22.1, $p < 0.01$).*

Conclusion: *This study underscores the positive impact of educational technology on academic success and stress management. When used strategically, digital tools can significantly enhance learning outcomes and contribute to student well-being.*

Keywords: *Educational technology, academic performance, student stress, digital learning tools, mental health applications, online learning platforms, e-learning, stress reduction, personalized learning, student well-being*

INTRODUCTION

In recent years, the integration of technology into the educational sector has transformed the way students learn, communicate, and manage their academic

responsibilities. From online learning platforms and virtual classrooms to productivity and mental health apps, technology has become an essential tool in supporting student development. With the growing academic demands placed on learners, there is an increasing need to explore how these digital resources contribute not only to academic success but also to the mental well-being of students.

Academic performance is a key indicator of educational success, and students are constantly seeking effective methods to enhance their learning outcomes. Technology offers a wide range of tools—such as educational software, video lectures, interactive simulations, and digital libraries—that provide flexible and personalized learning experiences. These tools can help students grasp complex concepts more easily, stay organized, and access information anytime and anywhere.

At the same time, academic stress is a prevalent issue, often caused by workload, deadlines, and pressure to achieve high grades. Prolonged stress can negatively impact a student's health, motivation, and performance. In this context, technology also plays a vital role in stress management. Mobile applications that offer guided meditation, digital planners, and online counseling services are increasingly being used by students to cope with academic pressures.

This research aims to investigate the dual role of technology in enhancing academic performance and reducing stress among students. By analyzing both quantitative data and qualitative insights, the study seeks to understand how technology can be leveraged to create a more effective and supportive educational environment.

METHODOLOGY

1. Research Design

This study adopts a **mixed-methods research approach**, integrating both **quantitative and qualitative** designs to investigate the impact of technology on academic performance and student stress. A **descriptive cross-sectional survey** was used to collect broad quantitative data, while **semi-structured interviews** offered in-depth qualitative insights into students' individual experiences with academic technologies.

2. Population and Sample

The target population includes full-time undergraduate students enrolled at selected colleges and universities. A **stratified random sampling** method was employed to ensure proportional representation across academic disciplines and year levels.

Sample size:

Survey: ~150–200 participants

Interviews: 10–15 participants

Inclusion Criteria:
Currently enrolled as full-time undergraduate students

Actively use at least one educational technology tool (e.g., LMS, digital planner, academic app)

3. Research Instruments

Quantitative Tool – Structured Questionnaire

The survey contained the following sections:

- **Demographics:** Age, gender, academic year, and discipline
- **Technology Usage:** Frequency and types of tools used
- **Academic Performance:** Self-reported GPA or latest grade
- **Stress Levels:** Measured using the **Perceived Stress Scale (PSS-10)**
- **Perceptions:** Likert-scale items assessing perceived influence of technology on learning and stress

Qualitative Tool – Interview Guide

Open-ended questions explored:

- Integration of technology into study routines
- Perceived benefits and challenges
- Use of technology for stress management

4. Data Collection Procedure

- Surveys were distributed online via platforms such as Google Forms or Microsoft Forms.
- Interview participants were selected from survey respondents who volunteered.
- Interviews were conducted virtually (e.g., Zoom, Google Meet), lasted 30–45 minutes, and were recorded with consent for transcription.

5. Data Analysis

- **Quantitative Analysis**:
  - Descriptive statistics (mean, standard deviation)
  - **Inferential statistics:**
    - **Pearson's correlation** to examine relationships between technology use, GPA, and stress
    - **Multiple regression** to explore predictive relationships
- **Qualitative Analysis**:
  - **Thematic analysis** was used to identify recurring themes and patterns in student narratives.

6. Ethical Considerations

- Approval was obtained from the university's ethics review committee
- Informed consent was collected from all participants
- Confidentiality and anonymity were maintained
- Participants were informed of their right to withdraw at any time without consequence

Aim

To examine the influence of educational technology on academic performance and its role in reducing stress among undergraduate students

Objectives

1. To analyze how frequently and in what ways undergraduate students utilize technology for academic purposes.
2. To explore the relationship between the use of digital tools (such as learning management systems and educational apps) and students' academic achievement.
3. To assess the impact of educational technology on perceived stress levels, with a focus on mental wellness and time management applications.
4. To understand students' perspectives and experiences regarding the advantages and challenges of using technology in their academic life.
5. To identify common obstacles to effective technology use, including limitations in digital literacy, accessibility, and potential overreliance on digital tools.

RESULTS

1. Participant Demographics

A total of **180 undergraduate students** completed the survey.

- **Gender**: 58% female, 40% male, 2% preferred not to disclose
- **Age Range**: 18–25 years (Mean age: 21.4 years)
- **Academic Year**: 35% first-year, 28% second-year, 22% third-year, 15% fourth-year
- **Discipline**: 40% sciences, 30% humanities, 30% professional programs (e.g., business, engineering)

2. Technology Usage Patterns

- **92%** of students used technology daily for academic tasks
- Most commonly used tools:
  - Learning Management Systems (e.g., Moodle, Blackboard): 85%
  - Educational apps (e.g., Quizlet, Grammarly): 68%

- Online collaboration tools (e.g., Google Docs, Zoom): 77%
- Time-management apps (e.g., Google Calendar, Todoist): 43%

3. Academic Performance

- Frequent users of educational technology reported **higher average GPAs** (mean = 3.4) compared to occasional users (mean = 2.9)
- **Pearson's correlation** showed a **moderate positive relationship** between technology usage frequency and academic performance ($r = 0.45$, $p < 0.01$)

4. Stress Levels

- Average **PSS-10 score** across all respondents: **18.5** (indicating moderate stress)
- Students using digital tools for organization and mental health reported **lower stress scores**
- A **negative correlation** was found between adaptive technology use and stress levels ($r = -0.39$, $p < 0.01$)

5. Interview Insights

In-depth interviews with 12 students revealed several recurring themes:

- **Flexibility**: Digital tools enabled learning at a personalized pace
- **Accessibility**: Online resources reduced anxiety over missed content
- **Overreliance**: Some reported stress due to tech-related distractions or malfunctions
- **Support Systems**: Apps like **Headspace** and **Calm** were used to manage stress and improve focus

DISCUSSION

The results of this study emphasize the transformative impact of technology on contemporary education, particularly in improving academic performance and mitigating stress among students. The widespread use of digital tools—such as learning management systems, educational applications, and mental health platforms—has significantly reshaped how students engage with academic content and manage their well-being.

A notable finding is the negative correlation between adaptive technology use and stress levels, suggesting that students who actively utilize digital planners, mindfulness apps, and organizational tools often feel more in control of their tasks and emotional states. These outcomes align with prior research indicating that improved self-regulation and time management, facilitated by technology, contribute to reduced academic stress.

However, qualitative insights from the interviews revealed several challenges that must not be overlooked. While technology offers greater flexibility and personalized learning opportunities, it can also introduce new stressors. Students reported

experiences of information overload, technical disruptions, and an increased dependency on constant digital engagement, which sometimes resulted in anxiety and reduced focus.

These challenges underscore the importance of digital literacy and the need for students to develop healthy digital habits. Without adequate training and awareness, the very tools intended to ease the academic burden can become sources of stress themselves.

Overall, the findings support the conclusion that technology, when applied strategically and in moderation, is a powerful tool for enhancing both academic success and mental well-being. Educational institutions should adopt a proactive role in guiding students on effective and balanced technology use.

Challenges and Considerations

While the study affirms the benefits of educational technology, several challenges emerged from the qualitative data:

- **Digital Fatigue:** Extended periods of screen time led to burnout for some students.
- **Technical Difficulties:** Problems such as unstable internet connections or malfunctioning devices created added pressure during key academic activities.
- **Limited Digital Competence:** Some participants lacked the skills needed to use digital platforms effectively, which hindered their academic performance.

These issues highlight the need for institutions to offer ongoing support and resources, ensuring that students not only have access to digital tools but also know how to use them effectively and healthily.

Implications for Educators and Institutions

Based on the findings, several recommendations can be made for academic institutions and educators:

- Integrate evidence-based educational technologies into curricula to enhance student engagement and learning outcomes.
- Provide training sessions and workshops on time management, digital wellness, and effective use of academic technologies.
- Offer access to mental health support, including digital platforms for counseling, stress tracking, and mindfulness.
- Encourage balanced technology usage, fostering habits that prevent burnout and overreliance.

By implementing these strategies, institutions can create a more supportive and productive learning environment.

CONCLUSION

This study highlights the critical role of technology in supporting academic performance and stress management among undergraduate students. The data indicate that students who frequently and effectively use digital tools—ranging from learning platforms to mental wellness apps—experience improved academic outcomes and reduced stress.

However, the benefits of technology are accompanied by potential drawbacks, such as digital fatigue, technical issues, and the risk of overdependence. These concerns point to the importance of structured guidance, training, and support systems to ensure that students can navigate the digital learning environment successfully.

In summary, when used intentionally and with adequate support, technology emerges as a valuable educational asset. It not only enhances academic engagement but also contributes to better emotional and mental health. Future research should continue to explore innovative, inclusive, and sustainable approaches to optimizing technology use in diverse educational settings.

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COMMUNITY-LEVEL WORKFORCE MOBILITY FOR PERSONS WITH DISABILITIES: CHALLENGES AND OPPORTUNITIES

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INTRODUCTION

Workforce mobility is essential for economic inclusion and empowerment. For persons with disabilities (PWDs), access to employment is often hindered by multiple barriers, including social stigma, physical inaccessibility, and lack of policy implementation. At the community level, these issues are magnified due to resource constraints and localized discrimination. Yet, with targeted interventions and inclusive planning, communities can become catalysts for empowering PWDs and promoting their economic independence.

Challenges to Workforce Mobility for Persons with Disabilities

1. Physical Inaccessibility

Many communities lack accessible transportation and infrastructure, such as ramps, elevators, and tactile signage. Public transport systems are often not equipped to accommodate wheelchairs or assistive technologies, making it difficult for PWDs to commute to work.

2. Limited Education and Skill Development

Educational institutions at the grassroots often fail to provide inclusive learning environments. The absence of specialized teaching staff and adaptive tools restricts learning, which subsequently affects employment prospects.

3. Societal Stigma and Discrimination

Deep-rooted misconceptions about disability continue to influence hiring decisions. Employers may underestimate the capabilities of individuals with disabilities or be unaware of the accommodations that can facilitate their productivity.

4. Policy Gaps and Weak Implementation

While disability rights are enshrined in various national and international frameworks, their implementation at the community level is often weak. Local authorities may lack the training or resources to enforce policies supporting PWD inclusion.

5. Lack of Local Employment Opportunities

Many rural or semi-urban communities have limited job opportunities in general. For PWDs, this challenge is compounded by the need for specific accommodations, making employment even more elusive.

Opportunities for Enhancing Workforce Mobility

1. Inclusive Infrastructure Development

Community development projects can integrate universal design principles to ensure that buildings, transportation, and public spaces are accessible. Involving PWDs in planning and feedback mechanisms can ensure infrastructure truly meets their needs.

2. Community-Based Vocational Training

Tailored vocational and skill development programs at the local level can empower PWDs with relevant competencies. Partnerships with NGOs and social enterprises can help deliver accessible training modules.

3. Awareness Campaigns and Sensitization

Changing societal perceptions requires continuous education. Community-led awareness programs can challenge stereotypes and encourage inclusive attitudes among employers, co-workers, and the general public.

4. Supportive Local Governance

Local governments can play a transformative role by adopting inclusive hiring practices, offering incentives to businesses that employ PWDs, and ensuring local policies align with national disability rights frameworks.

5. Leveraging Technology

Digital platforms offer flexible employment options such as remote work, freelancing, and micro-entrepreneurship. Providing access to affordable internet and digital literacy training can bridge the employment gap for many PWDs.

CONCLUSION

Workforce mobility for persons with disabilities is not merely about physical movement—it encompasses the ability to access, retain, and grow in employment. While challenges at the community level are significant, they are not insurmountable. Through a combination of policy reform, inclusive infrastructure, community sensitization, and targeted vocational training, local ecosystems can become enablers rather than barriers. The journey toward inclusive workforce mobility must be collaborative, involving stakeholders from all sectors to create equitable opportunities for everyone.

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CHALLENGES RELATED TO EMPLOYMENT AND FINANCIAL SUSTAINABILITY AMONGST PHYSIOTHERAPISTS IN INDIA

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ABSTRACT
The field of physiotherapy plays a crucial role in modern healthcare, offering therapeutic support in prevention, rehabilitation, chronic illness management, and functional restoration. However, in India, physiotherapists face significant challenges regarding stable employment and financial sustainability. These challenges limit career progression, deter potential candidates, and affect overall healthcare service delivery. This review critically examines the employment and financial difficulties physiotherapists face in India. Using a literature review methodology, key themes were identified, including low pay, limited job opportunities, lack of financial benefits, poor public sector absorption, and inadequate policy frameworks. The review concludes that comprehensive reforms are necessary to enhance professional dignity and financial viability for physiotherapists, including policy development, expanded public employment opportunities and public awareness campaigns.

INTRODUCTION

Physiotherapy has emerged as a vital branch of rehabilitative healthcare across the world. In India, the increasing burden of non-communicable diseases, injuries, post-operative care needs, and aging populations has expanded the demand for physiotherapy services. Despite the growing need, physiotherapists in India face persistent employment and income challenges. The lack of a centralized regulatory framework, inconsistent education standards, and limited job security have restricted the development of the profession.

It is usually seen that only a small fraction of physiotherapy graduates secure employment in government healthcare facilities. Most are absorbed into the unregulated private sector, where income variability and lack of benefits contribute to financial instability. Furthermore, public perception of physiotherapy as a supplementary rather than essential service hampers its demand and limits professional growth. These employment and financial barriers not only impact individual practitioners but also constrain India's broader healthcare delivery system.

Aim:
The aim of this review is to analyze the employment and financial sustainability challenges encountered by physiotherapists in India

Objectives:

1. To explore employment trends among physiotherapists in India.
2. To assess the financial challenges and income variability in the profession.

3. To evaluate the extent of public sector support and regulation.

METHODOLOGY

This study uses a literature review methodology. Peer-reviewed journal articles and organizational publications published between 2015 and 2024 were reviewed. Databases searched included Google Scholar, PubMed and official websites such as the Ministry of Health and Family Welfare. The keywords used included "physiotherapy India," "employment challenges physiotherapists," "healthcare workforce India," "financial sustainability healthcare," and "allied health professions." A thematic analysis was conducted to identify recurring trends, structural issues, and contextual factors.

RESULTS

Major challenges faced by physiotherapists working in hospitals in India are hindrance to professional development, non-standardization of salary scales, lack of proper formation of boards or councils for professional upliftment, low pay scale. Encroachment over physiotherapy profession through malpractice by quacks is also present. Public healthcare systems have minimal physiotherapist representation, limiting job security and career advancement. Physiotherapists in India largely depend on private clinics, hospitals, or personal practice for employment.[1]The average monthly earnings for early-career physiotherapists in India range from INR 10,000 to 20,000, far below their counterparts in the filed of healthcare. In the absence of standard pay scales, income is often irregular, especially for those in private practice (Singh & Mehta, 2020). Most physiotherapists lack access to pensions, health insurance, or maternity benefits. The absence of employment contracts or formal employment relationships leads to exclusion from social security systems (Barman et al., 2019).

DISCUSSION

The results highlight a systemic lack of structure in physiotherapy employment across India. Unlike mainstream medical fields, physiotherapy has not received adequate institutional support or policy focus. This has led to a fragmented professional identity, poor public understanding, and insufficient financial sustainability. Low salaries, lack of social benefits, and employment insecurity deter prospective students and contribute to high attrition rates[1]. Young professionals, often burdened with educational loans, struggle to achieve economic independence. In the absence of a regulatory council, there is no central mechanism to ensure fair employment practices or develop a standard compensation framework. Women in physiotherapy face career breaks due to family responsibilities often result in long-term economic disadvantages, especially in the absence of supportive employment policies.[2] The geographical disparity in employment opportunities restricts healthcare access in rural areas and contributes to urban oversaturation. Employment opportunities are concentrated in urban centers, while rural regions suffer from both lack of services and employment. Professionals in these areas face poor pay and limited infrastructure. [3]The lack of digital infrastructure further marginalizes rural physiotherapists, who

cannot transition to online consultation models. Policy reforms are crucial to addressing these issues. Inclusion of physiotherapy services in Ayushman Bharat and other public schemes, and inclusion in employee welfare programs could significantly improve employment prospects. Public awareness campaigns can also help in reshaping societal perceptions, increasing demand, and justifying higher compensation. Moreover, there is a pressing need for benchmarking professional standards and setting minimum wage thresholds for physiotherapists, especially in private practice. Drawing parallels from other developed countries could help Indian policy makers implement structured job roles, career ladders, and benefits packages that promote long-term financial sustainability. Stakeholder engagement is another important aspect. Active collaboration among educational institutions, healthcare organizations, and policy makers can lead to the development of a national registry, standard licensing exams, and guidelines for ethical practice. These measures would not only professionalize the field but also enhance accountability and transparency. Entrepreneurship in physiotherapy is a growing area of interest. With appropriate training and support, physiotherapists can set up community rehabilitation centers, telehealth platforms, and wellness clinics. However, this requires start-up capital, business acumen, and infrastructural support—areas that are currently underdeveloped. Government and private sector funding initiatives can be used to support innovation in this sector. Furthermore, continuous professional development should be made mandatory. It will help physiotherapists stay abreast of new techniques, research findings, and technologies, improving their employability and effectiveness. Unfortunately, India lacks an organized system to facilitate and track such educational activities. The role of technology cannot be underestimated. The post-pandemic world has seen a shift toward digital health solutions. For physiotherapists, this includes tele-rehabilitation, app-based monitoring, and remote exercise prescription. However, adoption is limited due to inadequate training and infrastructure. Investment in digital literacy and tools can create new employment avenues and help professionals reach underserved populations. Importantly, there is also a need to address mental health among physiotherapists. Financial insecurity, job stress, and lack of recognition contribute to burnout and dissatisfaction. Mental health support systems, workplace wellness initiatives, and peer networks can play a key role in improving job satisfaction and retention. Policy advocacy must become a priority. Physiotherapists must be involved in decision-making processes at the institutional and governmental levels. Representation in healthcare councils, participation in workforce planning, and inclusion in legislative discussions are necessary to ensure that their concerns are acknowledged and addressed[4]. In addition to policy and infrastructure-related reforms, strengthening academic and research capacities in physiotherapy is equally important. There is a need for investment in research grants, doctoral programs, and academic-industry linkages that can support innovation and evidence-based practice. Encouraging interdisciplinary research with fields like occupational therapy, orthopaedics, and geriatrics can provide physiotherapists with new avenues for specialization and income generation. A nationwide employment mapping and needs assessment should also be conducted to

understand regional disparities and align education output with market demand. Without accurate data on physiotherapy services across different regions and sectors, planning and resource allocation will remain ineffective. Another emerging issue is the role of insurance in physiotherapy. Most health insurance policies in India either exclude or severely limit reimbursement for physiotherapy services. Vey few cover pre and post hospitalisation and out patient department physiotherapy services. By advocating for broader coverage under both public and private insurance plans, the demand for services and the financial viability of physiotherapists can be significantly improved[5]. This inclusion would also protect patients from out-of-pocket expenditure, thereby increasing service utilization. Furthermore, integrating physiotherapists into primary healthcare teams and school-based health programs can expand their roles beyond hospitals and clinics. Such a move would not only diversify employment opportunities but also contribute to preventive healthcare goals[6].

The employment and financial sustainability of physiotherapists in India is a multifaceted issue that requires collaborative action. Sustainable progress will depend on the alignment of educational quality, policy frameworks, healthcare infrastructure, public perception, and financial investment. Only through such a holistic approach can physiotherapists be empowered to serve as integral contributors to India's healthcare delivery system.

CONCLUSION

Physiotherapists in India face substantial challenges related to employment and financial sustainability. These include poor job availability, income insecurity, lack of social protection, and minimal regulatory support. Also, rural professionals experience heightened vulnerabilities. If unaddressed, these issues threaten the profession's growth and its contributions to public health. Reforms include the creation of regulatory frameworks, expansion of public sector employment, standardized pay structures, and inclusion in national health policies. Only then can physiotherapists be empowered to fulfill their critical role in India's healthcare ecosystem.

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EFFECT OF PNF V/S BLACKBURN EXERCISES ON NECK PAIN AND SCAPULAR DYSKINESIA IN IT PROFESSIONALS: A COMPARATIVE STUDY

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ABSTRACT

Neck pain that lasts for three months or more is determined as chronic neck pain. The neck region and altered neuromuscular control of cervical muscles are the main risk factors for nonspecific neck pain stated in the literature. Changes in scapular posture and muscle activation patterns are cited as potential risk factors for chronic neck pain (CNP). To compare the effect of PNF versus Blackburn's exercises on neck pain, neck disability and scapular dyskinesis in I.T. professionals. Both PNF and Blackburn's showed significant improvement in pain levels, improving disability and scapular dyskinesia. But when the two groups were compared, Blackburn's was more effective than the two in reducing pain and disability levels and improving scapular dyskinesia.

Keywords: *PNF, Blackburn, neck pain, scapular dyskinesis, IT professionals*

INTRODUCTION

Mechanism of nonspecific neck pain is still not clearly understood. While neck pain as etiology is multifactorial and includes working conditions, sedentary lifestyle, postural abnormalities, previous trauma to the neck region and altered neuromuscular control of cervical muscles are the main risk factors for nonspecific neck pain stated in the literature. Changes in scapular posture and muscle activation patterns are cited as potential risk factors for chronic neck pain (CNP). Subjects with chronic neck pain tend to have more protracted shoulders compared with asymptomatic issues. An altered kinematic of the scapula may be present in subjects with chronic neck pain, which can play a substantial role in the maintaining or intensifying of symptoms in these patients.[1]

Scapular Dyskinesia defined as "SICK scapula S- Scapular malposition, I- Inferior medial winging scapula, C- Coracoid tenderness, K- dyskinesis of scapular movement ;which results in Scapular Dyskinesis which is an alteration in normal position or motion of scapula during coupled Scapulo-humeral movements". Upward rotation is the predominant Scapulothoracic motion. Co-ordinated Scapulothoracic and Glenohumeral movements during arm elevation, known as SH rhythm provides range of motion while allowing for proper length tension relationships between various axioscapular and Glenohumeral muscles rhythm alters in dyskinesia, generally the ratio of scapula and humerus is 1:2 i.e., when arm abducted to 1800,600 occurs by rotation of scapula and 1200 by rotation of humerus at shoulder joint. Controversy exists about overall ratio of movement between Glenohumeral and Scapulothoracic

articulations, as well as changes in the ratio throughout the arc of motion during arm elevation.[2]

The Scapulothoracic joint is one of the least congruent joints in the body. No actual bony articulation exists between the scapula and the thorax, which allows tremendous mobility in many directions, including protraction, retraction, elevation, depression, and rotation. The lack of bony attachment predisposes this joint to pathologic movement, and, consequently, makes the Glenohumeral joint highly dependent on the surrounding musculature for stability and normal motion. The muscles that adhere to the medial side of the scapula, such as the middle and lower parts of the trapezius muscle, rhomboid major and minor, and serratus anterior, are the critical muscles for stabilization.[3]

With respect to scapular orientation in the resting position, it has also been demonstrated that individuals with neck pain may display altered postural behaviour, especially when performing prolonged sitting tasks, such as during computer use. Increased cervical and thoracic curves and a slouched posture are known to affect scapular orientation, shoulder muscle strength and shoulder range of motion. Scapular dynamic stability has primarily been investigated in association with shoulder pathologies where a reduced clavicle retraction, scapular upward rotation, scapular posterior tilt and increased clavicle elevation have been reported. Recently, Helgadottir et al demonstrated a significantly reduced clavicle retraction on the dominant side in patients with insidious onset neck pain and whiplash-associated disorders (WAD) both at rest and during arm elevation. These changes in scapular kinematics can be attributed not only to altered scapular recruitment patterns (e.g., altered serratus anterior muscle activity) or muscle performance (e.g., force imbalance in the upper and lower trapezius muscle), but also flexibility deficits in the soft tissue surrounding the scapula may restrict normal scapular movement during daily activity and sport-specific movements.[4, 5]

Hush et al. indicated that the 1-year incidence of neck pain in office workers was 49 %. The quantitative results show that physical, workplace and psychosocial factors lead to this pain.Factors like gender, exercise frequency, mobility of the cervical spine and psychological stress were revealed that can impact on the risk of developing neck pain.

The incidence percentage of scapular dyskinesia was found high at office worker in this pilot study. Although the number of people affects the reliability of the results, study will be developed by increasing the number of people in the future.[6]

Kibler has defined three dyskinesia patterns:

Type I is the prominence of the inferomedial border of the scapula due to abnormal posterior tilt the scapula; when this type occurs isolated, the scapula may be lower than the opposite side.

Type II consists in the prominence of its entire medial border of the scapula. These types could be seen with superior labrum injuries (SLAPs).

Type III displays upward rotation of the superomedial border of the scapula around of the scapula, this type can be seen when the size of the acromio humeral space decrease or potential rotator cuff injuries occur. Also Type IV is defined as normal scapular position and motion.[7]

a) **Neck Pain and Disability Index (NDI):** Test-retest reliability was calculated using an intraclass correlation coefficient (ICC) (NDI ICC=.50; 95% confidence interval [CI], .25-.67). [8]

b) **The Visual Analog Scale (VAS):** It is a valid and reliable measure of chronic pain intensity. Studies that examined the correlation between a vertically oriented VAS for pain with a horizontally oriented VAS found correlations of 0.99 and 0.91 when they were given within 10 minutes of each other to patients with a variety of rheumatic diseases.[9]

c) **Lateral Scapula Slide Test (LSST):** The test determines the stability of scapula during Glenohumeral movements. The patient now sits or stands with the arms resting at the side. The examiner measures the distance of base of scapula to spinous process of T2 or T3, from the inferior angle of scapula to the spinous process of T7 to T9, or from T2 to the superior angle of the scapula. The test is done in 2 or 4 other positions: 45 degree abduction, 90 degree abduction with medial rotation, 120 degree abduction, and 150 degree abduction. The distance measured should not vary for more than 1cm to 1.5cm from the original measure.[10]

Conventional treatments have been studied earlier. Other studies have included techniques like scapular stabilization exercises, neck stabilization training along with scapula thoracic mobilization.

Scapular PNF pattern: Anterior elevation and Posterior depression, Posterior elevation and anterior depression with 20 repetitions.Each exercise was performed for 3x20 repetitions, 3 days per-week for 6weeks. Patient's position was side lying, on the unaffected side while the therapist stood in the line of desired motion. Firstly, the therapist gave preparatory instructions. In the beginning of the pattern, the therapist would pull the scapula to the elongated position and then give instructions for the desired movement. Rhythmic initiation and repeated contractions facilitation techniques applied in all patterns.[11]

Blackburn retraction exercises areused to strengthen the scapular retractors and posteriorrotator cuff. The study carried out Experimental group will include Blackburn exercises and hot pack for 10 minutes prior to the application of exercises; 3 days/week for a total of 6 weeks.

These exercises will include prone horizontal abduction neutral and with full external rotation, prone horizontal scaption neutral and with full external rotation, prone horizontal external rotation, prone horizontal extension. All these exercises will be performed 3x20 repetitions with 20 seconds rest interval.The base line data was collected at the beginning of the protocol. The patients were evaluated at the end of 1st week and the end of the 6th week.[12]

AIMS AND OBJECTIVES

Aim of the study:
To compare the effect of PNF versus Blackburn's exercises on neck pain, neck disability and scapular dyskinesis in I.T. professionals.

Objectives of the study:
- To study the effect of PNF on Neck Pain, Neck Disability and Scapular dyskinesis at the end of 3 weeks.
- To study the effect of Blackburn's exercise on Neck Pain, Neck Disability and Scapular dyskinesis at the end of 3 weeks.
- To compare the effects of PNF vs Blackburn's exercises on Neck Pain, Neck Disability and scapular dyskinesis at the end of 3 weeks.

METHOD AND METHODOLOGY

Type of Study: Comparative Study

Study Design: Pre and post comparative study

Type of Sampling: Convenient sampling

Sample Size: 64

Group A (PNF):32

Group B (Blackburn's):32

Treatment Duration: 3weeks (6 sessions/ week)

Inclusion criteria:
1. Age between 24 to 50 years, both males and females
2. Working in IT sector since at least one year
3. Working at least 20 hours a week.
4. Ongoing bilateral neck pain for three months or more.
5. Moderate pain intensity (between 3 and 7 based on VAS).
6. Bilateral difference > 1.5 cm in Lateral Scapular Slide Test

Exclusion criteria:
1. Obese individuals (BMI> 39 kg / m^2).
2. History of upper limb surgeries in past one year
3. Undergone physiotherapy treatment for the same complaint in the last 3 months.
4. Structural deformities.

MATERIALS:
1. Assessment proforma

2. Measuring Tape OR a Normal Scale.
3. Towel roll.
4. Plinth

OUTCOME MEASURES:

1. Neck Disability Index (NDI):
NDI is a 10 item questionnaire which asks patients about their symptoms and the effect of their neck pain on a range of functional activities. The items in the questionnaire are pain intensity, personal care, lifting, reading, headache, concentration, working, driving, sleeping and recreation. The subjects are instructed to circle one of the six options which describes the severity of each item (0 - 5). The NDI score is calculated as the sum of the scores for each question multiplied by 2 (range = 0-100). A higher score is indicative of greater disability associated with neck disorder.ICC = 0.93[14]

2. Modified Lateral Scapula Slide Test: (MLSST):
The test determines the stability of scapula during Glenohumeral movements. The patient now sits or stands with the arms resting at the side. The examiner measures the distance of base of scapula to spinous process of T2 or T3, from the inferior angle of scapula to the spinous process of T7 to T9, or from T2 to the superior angle of the scapula. The MLSST introduces 2 variations to the original LSST: one, in 90˚ of shoulder abduction a load of one kg is added; and two, a further position is added of unloaded arm abduction to 180˚. The distance should be no more than 1.2 to 1.5 cm. ICC = 0.6- 0.72.

3. Visual Analogue Scale (VAS):
The VAS provides a continuous scale for subjective magnitude estimation and consists of a straight line. The line is usually 10 cm long and vertical, though different lengths and orientation have been employed and proven satisfactory. The VAS is often used to evaluate the analgesic properties of various treatments and accomplishes this by measuring either pain relief or pain severity. Its reliability is 0.76-0.84.[15]

RESULTS

GROUP A- PNF Exercises

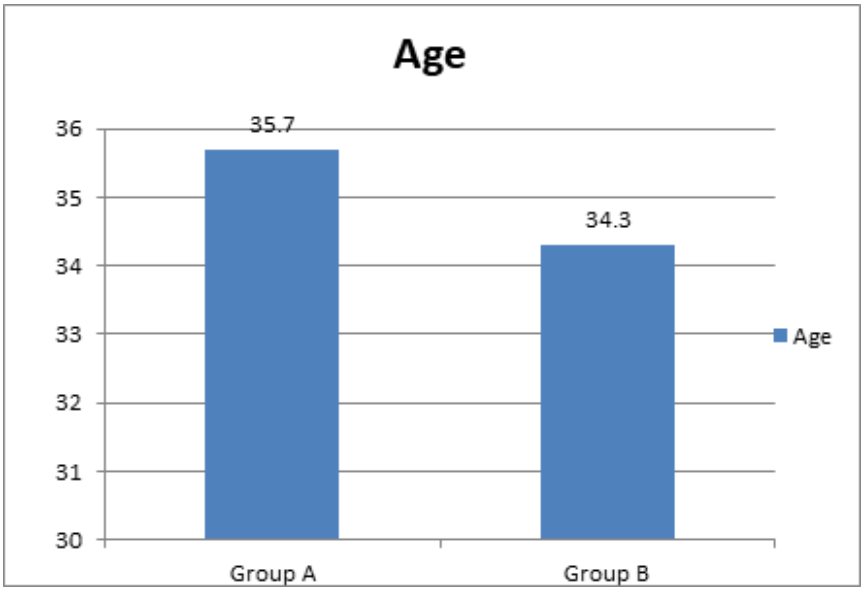
GROUP B- Blackburn's Exercises

Table 1: showing inter group comparison of Age & Screen time

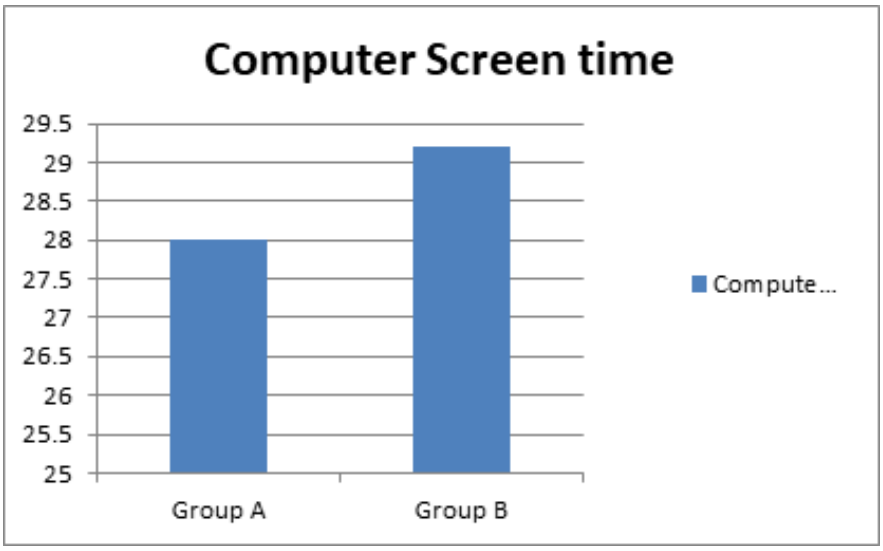
	Group	N	Mean	Std. Deviation	Std. Error Mean	T value	p value of t test
Age	A	32	35.7 ± 8.4	8.4	1.49	0.65	0.52
	B	32	34.3 ± 8.1	8.1	1.43		
Screen time	A	32	28 ± 3.8	3.8	0.67	1.01	0.32
	B	32	29.2 ± 5.4	5.4	0.96		

Interpretation: Table 1 represents thatinter-group comparison was done using t- test. There was statistically, a non-significant difference seen for the values between the groups (p>0.05) for Age & Screen time. Hence, the groups were comparable at baseline.

Studies have shown increased incidence of scapular dyskinesis with neck pain in age group of 24 to 50. The mean age of our subjects also fall within the prevalence range.[16]



Graph 1: representing inter-group comparison of age in both the groups.

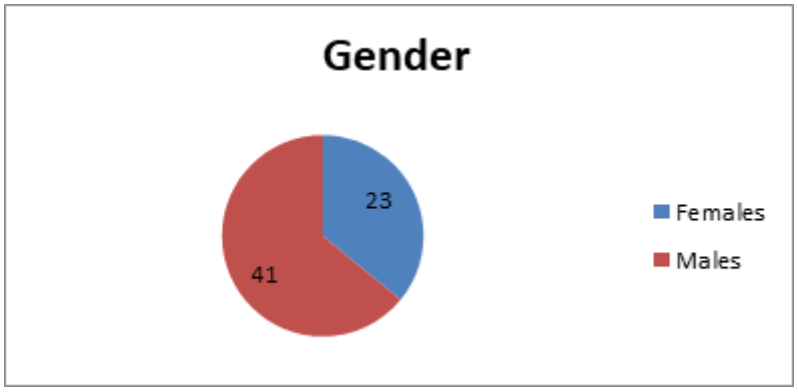


Graph 2: representing inter-group comparison of screen time in both the groups.

Distribution as per Gender:

Table 2: Depicting distribution of gender in the study

	Frequency	Percent
F	23	36
M	41	64
Total	64	100.0



Graph 3: Representing the distribution of gender

Interpretation:

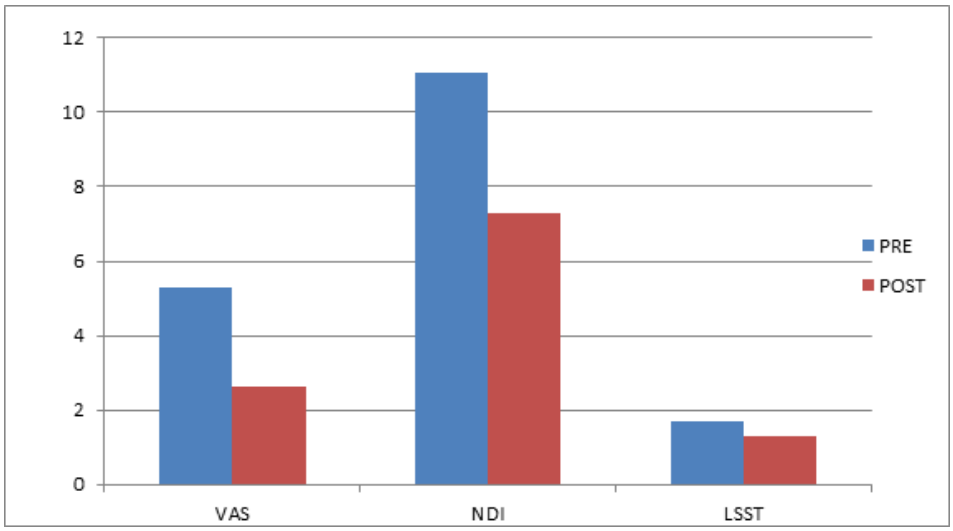
As graph 3 suggests; out of 64 subjects, 36% i.e. 23 were females and 64% i.e. 41 were males. Studies regarding gender prevalence in I.T. professionals with neck pain had a greater incidence in the male population, due to longer working hours, work related stress and in general increased male population in I.T. sector. The percentage in our study corresponds to gender prevalence found in the literature.[21]

1. GROUP A:

Intra-group comparison of Pre and post values in group A

Table 3: comparison of pre and post values in group A

	Mean.	**Std. Deviation**	**Mean diff**	**SD of diff**	**Z value**	**p value of Wilcoxon Signed Ranks Test**
VAS pre	5.27± 1.14	1.14	2.63	0.85	4.86	<0.0001*
VAS post	2.63± 0.76	0.76				
NDI pre	11.07±2.75	2.75	3.77	1.61	4.81	<0.0001*
NDI post	7.30± 2.73	2.73				
LSST pre	1.71± 0.17	0.17	0.42	0.18	4.80	<0.0001*
LSST post	1.29± 0.22	0.22				



Graph 4; representing pre and post values in group A

Interpretation:

As table 3 suggests, the intergroup comparison of pre and post values of VAS, NDI AND LSST was done using Wilcoxon matched test.

VAS: In pretest the mean value was 5.27 and in post- test it was 2.63and the p value was 0.0001. The p values were <0.05 which indicates that there's significant variability in pre and post value in Group A. This indicates the treatment was effective in reducing neck pain as represented in graph 4.

NDI: In pretest the mean value was 11.07 and in post test it was 7.30 and the p value was 0.0001. The p values were <0.05 which indicates that there's significant variability in pre and post value in Group A. This indicates the treatment was effective in reducing neck disability as represented in graph 4.

LSST: In pretest the mean value was 1.71 and in post- test it was 1.29 and the p value was 0.0001. The p values were <0.05 which indicates that there's significant variability in pre and post value in Group A. This indicates the treatment was effective in improving scapular dyskinesis as represented in graph 4.

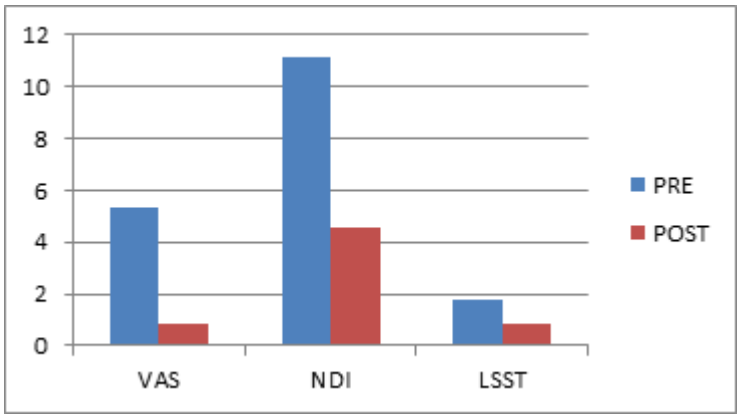
2. GROUP B:

Intra-group comparison of Pre and post values in group B

Table 4: Comparison of pre and post values in group B

	Mean	Std. Deviation	Mean diff	SD of diff	Z value	p value of Wilcoxon Signed Ranks Test
VAS pre	5.31± 1.18	1.18	4.28	1.06	4.75	<0.0001*
VAS post	0.86± 0.79	0.79				
NDI pre	11.16±2.13	2.13	6.69	1.83	4.72	<0.0001*

NDI post	4.59± 1.76	1.76				
LSST pre	1.79± 0.21	0.21	0.89	0.06	4.71	<0.0001*
LSST post	0.87± 0.38	0.38				



Graph 5; representing pre and post values in group B

Interpretation:
As table 4suggests, the intergroup comparison of pre and post values of VAS, NDI AND LSST was done using Wilcoxon matched test.

VAS: In pretest the mean value was 5.31 and in post- test it was 0.86and the p value was 0.0001. The p values were <0.05 which indicates that there's significant variability in pre and post value in Group B. This indicates the treatment was effective in reducing neck pain as represented in graph 5.

NDI: In pretest the mean value was 11.16 and in post test it was 4.59 and the p value was 0.0001. The p values were <0.05 which indicates that there's significant variability in pre and post value in Group B. This indicates the treatment was effective in reducing neck disability as represented in graph 5.

LSST: In pretest the mean value was 1.79 and in post- test it was 0.87 and the p value was 0.0001. The p values were <0.05 which indicates that there's significant variability in pre and post value in Group B. This indicates the treatment was effective in improving scapular dyskinesis as represented in graph 5.

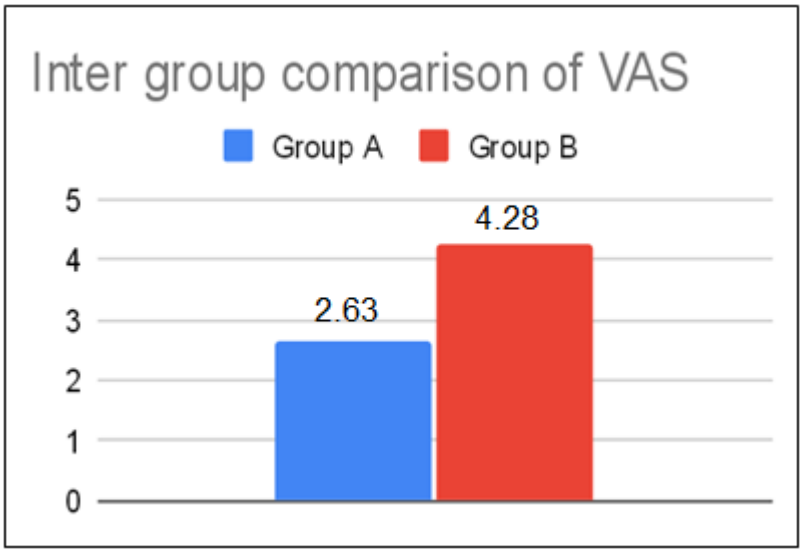
Comparison of Group A & B:

Inter group comparison

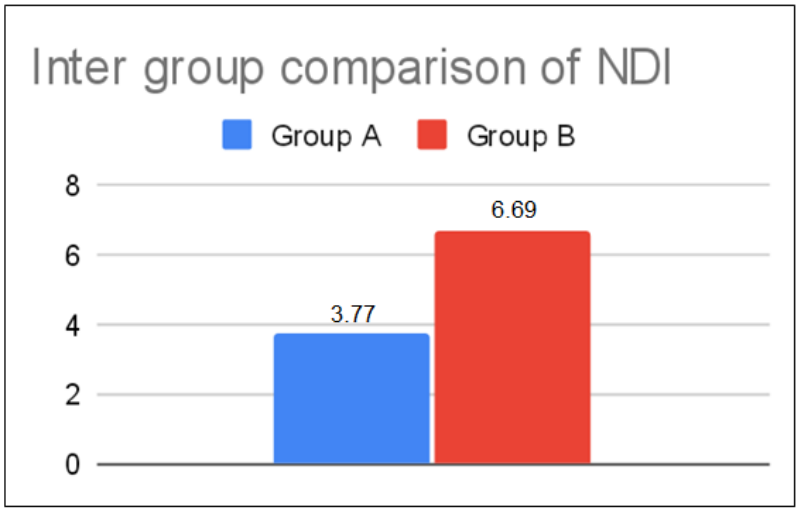
Table 5; showing inter group comparison of outcomes

	Group	N	Mean	Std. Deviation	Mean Diff	95% CI of difference	Z value	p value of Mann-Whitney U test
VAS diff	A	27	2.63± 0.76	0.76	1.65	1.37- 2.18	5.90	<0.0001*

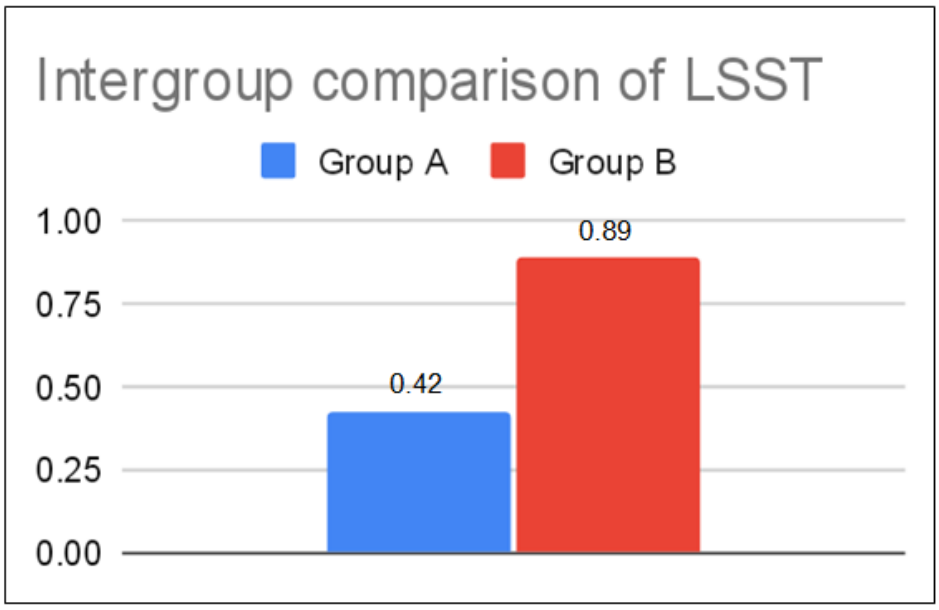
	B	27	4.28± 0.79	0.79				
NDI Diff	A	27	3.77± 2.73	2.73	2.92	1.51- 3.92	3.89	<0.0001*
	B	27	6.69± 1.76	1.76				
LSST diff	A	27	0.42± 0.22	0.22	0.47	0.25-0.58	4.13	<0.0001*
	B	27	0.89± 0.38	0.38				



Graph 6; representing mean difference of VAS between group A and B



Graph 7; representing mean difference of NDI between group A and B



Graph 8; representing mean difference of LSST between group A and B

Interpretation: As table 5 suggests, the Intra group comparison was done using Wilcoxon Signed rank test.

VAS: The mean difference of group A is 2.63 and mean difference of group B is 4.28. p value is 0.0001 which is <0.05 indicating that the difference is significant. Hence, it can be said that Group B i.e. Blackburn's exercise was more effective in reducing neck pain as represented in graph 6.

NDI: The mean difference of group A is 3.77 and mean difference of group B is 6.69. p value is 0.0001 which is <0.05 indicating that the difference is significant. Hence, it can be said that Group B i.e. Blackburn's exercise was more effective in reducing neck disability as represented in graph 7.

LSST: The mean difference of group A is 0.42 and mean difference of group B is 0.89. p value 0.0001 which is <0.05 indicating that the difference is significant. Hence, it can be said that Group B i.e. Blackburn's exercise was more effective in improving scapular dyskinesis as represented in graph 8.

DISCUSSION

In order to combat the COVID-19 pandemic, India went into a lockdown, (home confinement) as a measure to mitigate disease outbreak. The pandemic and subsequent lockdown resulted in social distancing .Use of cellphones among the office workers and students increased enormously, and most significantly desktop/laptop use among office workers increased to keep pace with the work from the home.[17]

The development of musculoskeletal disorders among office workers especially IT professionals may be due to the awkward posture adopted by them during work from home for long hours. Any changes in the normal scapular position and movement during prolonged improper sitting posture lead to scapular asymmetry. So the damage to scapular movement is one of the factors that cause disability to take place in upper extremity and the neck of office workers.[18]

Our study was titled "Comparative effect of PNF versus Blackburns exercise on neck pain, disability and scapular dyskinesia in IT professionals."The study was carried out for 3 weeks.

It had a sample size of 64 in total divided into 2 groups : Group A performed PNF exercise's and had 32 subjects, Group B performed Blackburns exercises and had 32 subjects in it. The effects were observed after 3 weeks.

In this study, as Table 1 suggests, I.T. professionals were recruited between ages 24 to 50, with computer screen time of 20 hours/ week, minimum which is depicted in graph 1 and 2. Table 2 demonstrates that the study had 64 participants, 41 males and 23 females andrepresented in graph 3. The average age was 35 years and average computer screen time was 30 hours as shown in Table 1. Both the groups had non-significant difference and were comparable at baseline.Male were suffering more from signs and symptoms as compared to the female population. This variation in the study can be due to the fact that in our society all heavy and prolonged work are being done by the males. Another reason could be that, working hours differences in both gender i.e males work longer hours (up to more than 5 hours daily, accounting upto 30 hours/week) as compared to the female.[19]

While using a desktop/ laptop, the eyes are maintained at horizontal. During this posture, the head and neck move anteriorly. This posture causes a decrease in cervical lordosis, as well as altered thoracic kyphosis and changes in scapular positioning including protraction and downward rotation, in part due to weakness of the rhomboids (scapular retractors) and middle trapezius.[20] Studies by Lluch E, Arguisuelas et al have shown immediate improvement when scapular position was actively corrected.Although the mechanisms underlying the immediate positive effect of the active exercise cannot be deduced from the study, the effect may be due to reciprocal inhibition of the elevator muscles (eg, upper trapezius, levator scapulae) after activation of the scapular depressors. Reciprocal inhibition is the physiological phenomenon in which there is an automatic inhibition of a muscle when its antagonist contracts, also known as Sherrington's law.[21]

Table 3 suggests, the intergroup comparison of pre and post values of VAS, NDI of Group A (PNF Protocol) was done using Wilcoxon matched test and LSST using paired t-test. For VAS pretest mean value was 5.31 and in post- test it was 0.86 and the p value was 0.0001 since the p values were <0.05 which indicates that there's significant variability in pre and post value in Group A. This indicates the treatment was effective in reducing neck pain as represented in Graph 4. Now the MCID score

for VAS-neck ranged from 4.6 to 21.4 and according to the mean difference in Table 3, the mean difference was 2.63 which tells us that the PNF protocol was not clinically effective in reducing neck pain for the patients included our study.For NDI pretest mean value was 11.07 and in post test it was 7.30 and the p value was 0.0001since the p values were <0.05 which indicates that there's significant variability in pre and post value in Group A. This indicates the treatment was effective in reducing neck disability as represented in graph 4.Now according to the MCID score of NDI i.e, 7.5 points, the mean difference was 4.81 as shown in Table 3. this score tells us that PNF protocol was not effective in reducing the disability of neck in the patients in our study. For LSST pretest mean value was 1.71 and in post-test it was 1.29 and the p value was 0.0001 since the p values were <0.05 which indicates that there's significant variability in pre and post value in Group A. This indicates the treatment was effective in improving scapular dyskinesis as represented in graph 4.Now according to the MDC score of LSST i.e, 0.67 - 1.40cm, the mean difference was 0.42cm as shown in Table 3. This score tells us that PNF protocol was not effective in correcting the Scapular dyskinesis in the patients in our study.

The PNF muscle control exercise as shown in Fig 1 differed from the other group in that it involved manual contact by a physiotherapist. This contact helped the participants move in the right direction through the information transmitted to the skin receptors. This also caused contraction and irritation of the co-coordination muscles, thus strengthening the movements, promoting stabilization of the axis, and further strengthening the contraction force of pressure on the muscles, movement control exercise for the scapula produced significant improvements in scapula position, neck disability and neck pain, as shown in table 3.One possible mechanism to describe the effect of exercise in reducing pain is that muscle contraction from the exercise training stimulated mechanoreceptors, including the muscle spindle, Golgi tendon organ, and proprioceptors of joints. Signals from the receptors cause the release of endogenous opioids and stimulate the release of endorphins from thepituitary gland.[13]

Table 4 suggests, intergroup comparison of pre and post values of VAS, NDI was done using Wilcoxon matched test and LSST using paired t-test of Group B (Blackburns Protocol).For VAS pretest the mean value was 5.31 and in post- test it was 0.86 and the p value was 0.0001 since the p values were <0.05 which indicates that there's significant variability in pre and post value in Group B. This indicates the treatment was effective in reducing neck pain as represented in Graph 5.Now according to the MCID score of VAS i.e, 4.6 to 21.4, the mean difference was 4.28 as shown in Table 4. this score tells us that Blackburns protocol was not effective clinically in reducing the neck pain in the patients in our study. For NDI pretest mean value was 11.16 and in post test it was 4.59 and the p value was 0.0001 since the p values were <0.05 which indicates that there's significant variability in pre and post value in Group B. This indicates the treatment was effective in reducing neck disability as represented in graph 5.Now according to the MCID score of NDI i.e, 7.5, the mean difference was 6.69 as shown in Table 4. This score tells us that Blackburns

protocol was not effective clinically in reducing the neck disability in the patients in our study.For LSST pretest mean value was 1.79 and in post- test it was 0.87 and the p value was 0.0001 since the p values were <0.05 which indicates that there's significant variability in pre and post value in Group B. This indicates the treatment was effective in improving scapular dyskinesisas represented in graph 5.Now according to the MDC score of LSST i.e, 0.67 – 1.40cm, the mean difference was 0.89cm as shown in Table 4. This score tells us that Blackburns protocol was effective clinically correcting Scapular Dyskinesis in the patients in our study.

Furthermore, in this study, there was improvement of scapular dyskinesia and reduction in neck pain and disability levels in Group B performing Blackburn's retraction exercises as shown Table 4.Prone Y's were performed with the participant's arms elevated to 120° in the scapular plane and externally rotated. Prone T's were performed with the participant's arms elevated to 90° in the frontal plane, elbows fully extended. (Figure 1b). Prone W's were performed with the participant's shoulders off the edge of the table and elbows flexed to 90°[23]. The participants performed 10 repetitions with two sets with appropriate rest intervals. In the 3rd week, exercise was progressed by increasing the number of sets to three. As the exercise is progressed over the time, the muscles slowly start adapting to the increased demands. This leads to increase in capillary bed density and increase in mitochondrial density and volume of the skeletal muscle. Thus Blackburn's retraction exercises strengthens the posterior rotator cuff and scapular retractors which includes middle and lower fibers of trapezius, rhomboid major and minor.

Table 5 shows comparison between both the exercise interventions after 3 weeks. When outcome measures were compared between the two groups, i.e. VAS (graph 6) showed significant reduction of pain in group B. Group B performing Blackburn's exercise was seen to be more effective for reducing Neck disability as shown in Graph 7. For Scapular Dyskinesia, outcome measure used was LSST, which was significantly lower between the groups as shown in graph 8.Therefore, it can be said that Blackburn's retraction exercises was more effective in reducing neck pain and neck disability, while improving scapular dyskinesis. This can be explained by muscles getting adapted with increased repetitions along with holds seen in Group B. Whereas in Group A, mechanoreceptors were stimulated due to proprioceptionwhich led to reduction in pain levels due to pain gate mechanism. Overall it focused on correcting muscle recruitment and achieving motor control.

Biomechanical imbalances of the scapula as the dynamic base for the most mobile joint in the human body, (Quillen et al 2004) might lead to an abnormal distribution of tension and result in an overload in the soft tissues of the glenohumeral joint. Scapular exercises decrease dyskinesia (Başkurt et al 2011), which might result in a more gradual distribution of tension and load on soft tissues throughout the active movements, thus facilitating the healing process.[22]

Altered neuromuscular control of axioscapular muscles is revealed to be one of the contributors for scapular dyskinesia. In particular, upper, middle, and lower parts of

the trapezius and serratus anterior muscles have altered activity patterns during upper limb tasks. Therefore, we recruited scapular stabilization exercise to this study and aimed to improve the dynamic control of the scapula. The primary aim of the treatment approaches is to decrease the pain severity in patients with mechanical neck pain. Besides, immediate active or passive correction of the scapula has been shown to decrease neck pain.[6]It was indicated that the correction of the scapular position may reduce the tension in the axioscapular muscles and abnormal cervical loads, and therefore the pain decreases.[23]

Our study aimed to correct scapular dyskinesia to improve symptoms of neck pain. Scapular retraction training was done using two protocols viz. Blackburn's retraction and PNF of scapula in subjects with chronic neck pain. Group A performedPNF of scapula exercise and Group B performed Blackburns retraction exercises for three weeks, (6 sessions for 3 weeks).Both groups showed significant reduction in neck pain, neck disability and improvement in scapular dyskinesia. When group A and B were compared, group B performed better.As per the statistical proof as explained in the results and the clinical proof of MCID scores and also the physiology that explained why Group B performed better, was explainedin the discussion.

CONCLUSION

Both PNF and Blackburn's showed significant improvement in pain levels, improving disability and scapular dyskinesia. But when the two groups were compared, Blackburn's was more effective than the two in reducing pain and disability levels and improving scapular dyskinesia.

CLINICAL IMPLICATIONS:

The literature on neck pain secondary to scapular dyskinesia and its management is limited. As this study had 3 week intervention, this can be further explored.

This can also be used to further explore the syndrome, its effect on different population and rehabilitative measures for managing the symptoms.

A more detailed and a longer study can be done in future to look for a better clinical results on a larger sample size.

Blackburn's Retraction exercises was found to be more effective. Therefore, these exercises can also be performed by patients supervised and/or un-supervised a home.

FUTURE SCOPE OF STUDY

The literature on neck pain secondary to scapular dyskinesia and its management is limited. As this study had 3 week intervention, it did not showcase long term effects, this can be further explored. This can also be used to further explore the syndrome, its effect on different population and rehabilitative measures for managing the symptoms.

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NON-INVASIVE BRAIN STIMULATION IN NEUROREHABILITATION: EMERGING APPLICATIONS

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ABSTRACT

Non-Invasive Brain Stimulation (NIBS) is gaining attention in the field of neurorehabilitation as a valuable tool to support recovery in people with neurological conditions. Techniques like Transcranial Magnetic Stimulation (TMS) and Transcranial Direct Current Stimulation (tDCS) help modulate brain activity in ways that can enhance movement, thinking, and function. This review explores how NIBS works and highlights its use in various conditions, including stroke, Parkinson's disease, traumatic brain injury, multiple sclerosis, and cerebral palsy. Research shows that when NIBS is paired with traditional therapies—such as physical training or movement-focused exercises—it can lead to better outcomes. New developments, such as brain mapping to guide stimulation and personalized, at-home devices, are making these treatments more targeted and accessible. While the potential is exciting, challenges remain. Responses to treatment vary between individuals, and long-term effects are not fully understood. More research is needed, especially in vulnerable groups like children and older adults, to ensure safety and effectiveness. Still, NIBS offers a hopeful, non-drug-based approach to improving recovery and quality of life for people living with neurological disorders.

Keywords: *Transcranial Magnetic Stimulation, Transcranial Direct Current Stimulation, Neuroplasticity, Stroke Rehabilitation, Non-Invasive Brain Stimulation, Neurorehabilitation*

INTRODUCTION

Neurorehabilitation has undergone a paradigm shift with increasing emphasis on enhancing neuroplasticity to promote recovery following damage to the central nervous system. Disorders such as stroke, traumatic brain injury (TBI), multiple sclerosis, and Parkinson's disease often result in long-term disability despite conventional rehabilitation. In recent years, Non-Invasive Brain Stimulation (NIBS**)** techniques have emerged as promising adjuncts to traditional therapy by facilitating cortical reorganization and promoting functional recovery(Lefaucheur et al., 2020)

The two most widely studied NIBS techniques are Transcranial Magnetic Stimulation (TMS) and Transcranial Direct Current Stimulation (tDCS)**.** TMS uses magnetic fields to induce electric currents in targeted brain regions, modulating cortical excitability either by excitation or inhibition depending on the frequency and location of stimulation. tDCS, on the other hand, applies a low-intensity constant current through scalp electrodes to alter neuronal membrane potentials, thereby modulating cortical excitability in a polarity-dependent manner(Dionísio et al., 2018)(Rossi et al., 2021).

Both techniques have shown encouraging results in enhancing motor recovery post-stroke, improving gait and balance in Parkinson's disease, and reducing spasticity and pain in various neurological conditions(Elsner et al., 2016). The safety profile of these methods, coupled with the increasing portability of stimulation devices, has accelerated their adoption in both research and clinical settings.

Moreover, the integration of neuroimaging and neuronavigation allows for precise targeting of stimulation sites, while individualized protocols based on neurophysiological markers are paving the way for personalized neurorehabilitation(Lefaucheur et al., 2020). As our understanding of brain-behavior relationships grows, NIBS is likely to become an essential tool in promoting recovery and improving quality of life in individuals with neurological impairments.

Non-Invasive Brain Stimulation in Neurorehabilitation: Emerging Applications

LITERATURE REVIEW

1. Overview of Non-Invasive Brain Stimulation (NIBS)

Non-Invasive Brain Stimulation (NIBS) includes techniques that modulate brain activity without surgical procedures. The two most extensively studied modalities are Transcranial Magnetic Stimulation (TMS) and Transcranial Direct Current Stimulation (tDCS).

TMS, first introduced by Barker et al. (1985)(Barker et al., 1985), uses electromagnetic induction to stimulate neural tissue. Depending on the frequency, TMS can either excite (≥5 Hz) or inhibit (≤1 Hz) cortical neurons. Repetitive TMS (rTMS) has gained clinical traction for its therapeutic potential in modulating cortical excitability and enhancing neuroplasticity (Lefaucheur et al., 2020).

tDCS involves application of a weak direct current (usually 1–2 mA) across the scalp. Anodal stimulation typically increases cortical excitability, while cathodal stimulation decreases it(Nitsche & Paulus, 2000) It is portable, low-cost, and has fewer adverse effects compared to TMS, making it a favorable option for both clinical and home-based neurorehabilitation.

2. Mechanisms of Action in Neurorehabilitation

The primary mechanism through which NIBS promotes recovery is by modulating cortical excitability and enhancing neuroplasticity. In stroke, for instance, the interhemispheric imbalance theory posits that the unaffected hemisphere exerts excessive inhibitory influence on the lesioned side. Both TMS and tDCS can rebalance interhemispheric activity(Hummel & Cohen, 2006).

NIBS may also enhance the effects of task-specific training by promoting long-term potentiation (LTP)-like mechanisms in motor pathways (Reis et al., 2009). These effects are further potentiated when NIBS is applied in combination with conventional rehabilitation(Bolognini et al., 2009).

3. Applications in Specific Neurological Conditions

a) Stroke Rehabilitation

Numerous meta-analyses show moderate to strong evidence for rTMS and tDCS in improving upper limb motor function post-(Dionísio et al., 2018). High-frequency rTMS (5–10 Hz) applied over the ipsilesional motor cortex and low-frequency rTMS (1 Hz) over the contralesional hemisphere have shown promising results (Lefaucheur et al., 2020). Similarly, anodal tDCS over the affected motor cortex improves fine motor skills and spasticity(Li et al., 2015).

b) Parkinson's Disease

rTMS over the supplementary motor area and dorsolateral prefrontal cortex has shown improvement in gait freezing and bradykinesia (Chou et al., 2015). tDCS applied to the prefrontal cortex has also demonstrated benefits in executive function and mood in Parkinson's disease(Benninger et al., 2011).

c) Traumatic Brain Injury (TBI)

In patients with TBI, studies suggest that tDCS may improve attention, working memory, and overall cognition (Ulam et al., 2015). While TMS results are less consistent, certain protocols have shown improvements in cognitive control and arousal(Rosti-Otajärvi & Hämäläinen, 2014).

d) Multiple Sclerosis

tDCS has been associated with improvement in fatigue, motor control, and cognitive deficits in MS patients (Rosti-Otajärvi & Hämäläinen, 2014). Some trials using TMS have also reported enhancement in sensory and motor function (Tecchio et al., 2014).

e) Cerebral Palsy

tDCS is increasingly being explored in pediatric neurorehabilitation. Preliminary trials have shown improvements in gross motor function and upper limb use when paired with physical therapy(Duarte et al., 2014). However, long-term efficacy and safety in children remain under investigation.

4. Combination Therapies: Enhancing Efficacy

The combination of NIBS with task-oriented rehabilitation, robot-assisted therapy, mirror therapy, or virtual reality may produce synergistic effects. For example, rTMS before constraint-induced movement therapy (CIMT) improves motor outcomes significantly more than CIMT alone(Khedr et al., 2010). Similarly, tDCS combined with gait training or balance exercises improves functional ambulation in stroke and Parkinson's disease(Schabrun et al., 2016).

5. Emerging Innovations and Personalization

Recent advances include neuronavigation-guided TMS, closed-loop tDCS systems, and EEG-informed stimulation protocols, which allow real-time modulation based on brain state (Thut et al., 2017). Personalized approaches using imaging biomarkers (e.g., corticospinal tract integrity, resting-state fMRI) are being developed to tailor stimulation parameters and improve predictability of outcomes(Stagg & Johansen-Berg, 2013).

6. Safety and Limitations

Both TMS and tDCS are generally safe when used within standard guidelines. The most common side effects include mild headache, scalp discomfort, and fatigue. Seizure risk with TMS is extremely low but must be considered, especially in patients with epilepsy or brain lesions (Rossi et al., 2021). Inter-individual variability in response remains a major challenge, necessitating further research on biomarkers and optimal dosing strategies.

7. Future Directions

- Development of home-based NIBS devices for long-term use
- Integration with AI and machine learning to customize protocols
- Exploration in non-motor domains like mood, language, and cognition
- Greater focus on pediatric and geriatric neurorehabilitation

DISCUSSION

The growing body of evidence supporting the efficacy of NIBS in neurorehabilitation marks a significant paradigm shift in the management of neurological disorders. The literature indicates that both TMS and tDCS possess the capacity to modulate cortical excitability and promote neuroplasticity, leading to functional improvements across a spectrum of neurological conditions. While stroke remains the most researched area, other conditions such as Parkinson's disease, TBI, MS, and cerebral palsy are increasingly receiving attention with promising results.

The synergy between NIBS and traditional rehabilitation approaches—such as task-specific training, CIMT, and gait therapy- underscores the importance of multimodal interventions in enhancing recovery. Furthermore, the evolution of technology toward personalized and real-time stimulation models paves the way for more effective, individualized treatment protocols.

Despite these advancements, several challenges persist. The heterogeneity in patient response, variability in protocols, and limited understanding of long-term outcomes highlight the need for more robust, large-scale randomized controlled trials. Ethical considerations, particularly in pediatric populations, and the standardization of safety protocols are also crucial areas for development.

CONCLUSION

Non-Invasive Brain Stimulation stands as a powerful adjunct to conventional neurorehabilitation, offering a non-pharmacological and relatively safe option to enhance recovery in various neurological conditions. The emerging innovations in personalized stimulation, real-time monitoring, and home-based applications signal a promising future for NIBS. However, translating this potential into standardized clinical practice will require further research, optimization of protocols, and integration into multidisciplinary rehabilitation frameworks. The continued evolution of NIBS holds substantial promise for reshaping neurorehabilitation and improving quality of life for individuals with neurological impairments.

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EFFECT OF PERTURBATION BASED BALANCE TELEREHABILITATION PROGRAMME IN DIABETIC PERIPHERAL NEUROPATHY: A CASE STUDY

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ABSTRACT

Diabetic neuropathy (DN) is a complex and progressive disorder characterized by symmetrical distal degeneration of peripheral nerves, leading to symptoms such as pain and loss of sensation. This condition disrupts the body's sensory and motor systems and may affect up to 50% of patients with diabetes mellitus, depending on the duration of the disease. Neuropathy is associated with impaired balance and an increased risk of falls. Sensory training that targets static strategies of the ankle and hip, by exposing patients to extrinsic perturbations with small movements of sway, can enhance balance and postural control. This case study presents a 12-week internet-based perturbation balance training program, developed as a tele-rehabilitation solution for individuals with diabetic neuropathy. A 58-year-old male patient, who experienced difficulty rising from the floor and recurrent falls over the past eight months, participated in the program. The Berg Balance Scale (BBS) and Fall Efficacy Scale (FES) were used as outcome measures before and after the intervention. Post-intervention scores showed significant improvements, indicating that perturbation-based training via telerehabilitation can be an effective strategy to improve balance and reduce fall risk in patients with diabetic neuropathy.

Keywords: *Diabetic Neuropathy, Perturbation-Based Balance Training, Telerehabilitation*

INTRODUCTION

Age-related degeneration in neuromuscular health is a well-documented phenomenon that leads to a decline in motor performance. While there is evidence that neural declines begin around the fifth decade of life, the functional outcomes are not significantly affected until about the age of 60.[1]

Diabetic Peripheral Neuropathy (DPN) is one of the most prevalent complications of diabetes mellitus, often affecting up to half of diabetic population.1 It has a negative impact on leg and ankle function (Strength and flexibility) which in itself affect

the patients's physical activity and quality of life.The progressive degeneration of peripheral nerves contributes to impairments in proprioception, muscle strength, and postural instability, which significantly elevate the risk of falls in affected individuals.2 Falls are a major cause of injury and reduced quality of life, particularly among older adults with diabetes. The Department of Health and Human Services physical activity guidelines recommend low-intensity aerobic exercise, namely walking exercise to have a good effect on DPN sufferers.4 Physical therapy can improve the overall quality of life of DPN patients, and can relieve symptoms of diabetic neuropathy. It can also improve muscle strength, joint mobility, balance, coordination and physical function, when done regularly, can reduce neuropathic pain and can help control blood sugar levels.5

Conventional physiotherapy focuses on strengthening, proprioceptive training, and balance exercises. However, accessibility concerns have highlighted the need for effective telerehabilitation alternatives.3

Perturbation-based balance training (PBBT) is an emerging rehabilitation approach that challenges the individual's stability through sudden, controlled external stimuli. This method encourages adaptive motor responses and postural control strategies. This case study investigates the effectiveness of a home-based, therapist-guided perturbation balance program delivered via telerehabilitation in improving balance and fall confidence in a patient with diabetic neuropathy.6 The purpose of this study was to determine whether balance training that utilized PBBT could reduce the fall rate in a sub-population of older adults.

CASE PRESENTATION

A 58-year-old male with a 10-year history of Type 2 Diabetes Mellitus(DM) presented with complaints of unsteadiness while walking, difficulty rising from the floor, and two instances of falls over the past 8 months. He reported tingling sensations and numbness in both feet, affecting his daily activities and mobility confidence. After suffering from DM, the patient routinely checks with the doctor and takes medication regularly, where the patient's sugar level is maintained. The drugs that the patient is taking include amlodipine 10 mg, glimepiride 1 mg, and metformin 500 mg. It is known that the patient has been to physiotherapy in the past month but with an irregular schedule, and complaints of numbness in both legs still occur frequently.

Clinical examination confirmed sensory deficits in the lower extremities and impaired balance.A total score of 3 was obtained where the patient included Diabetic Periphera l Neuropathy (DPN) because the total score was more than 2. Both patient's feet looke d dry (dry skin), ulcers appeared on the right foot, and vibration perception and exa mination with monofilament obtained normal results. Patient reported hypertensive as well since 8 years. The patient was medically stable and consented to participate in a 12-week telerehabilitation program.

INTERVENTION PROTOCOL

The patient underwent a 12-week perturbation-based balance training program delivered via videoconferencing. Sessions were conducted thrice weekly, each lasting approximately 45 minutes.

The training included:

- Warm-up exercises (marching, heel-to-toe stance)
- Static and dynamic balance tasks (e.g., tandem stance, single-leg stance)
- Perturbation activities introduced via: - Therapist-applied manual pushes (coordinated through a caregiver)
- Use form/balance board. (After 2 weeks to increase difficulty level)
- Sudden changes in visual input, Tandom standing with eyes open and eyes closed maintained for 10 seconds.
- Cool-down stretching and breathing exercises

Safety measures included caregiver assistance and environmental modifications (e.g., non-slip mats).

Outcome Measures

1. Berg Balance Scale (BBS):

- Pre-intervention: 32/56

- Post-intervention: 46/56

2. Fall Efficacy Scale (FES):

- Pre-intervention: 69

- Post-intervention: 38

These scores indicate a significant improvement in both functional balance and confidence in performing activities without falling.

DISCUSSION

The findings of this case study support the efficacy of perturbation-based balance training in enhancing postural stability among individuals with DPN. Decreased balance ability is most likely related to loss of strength in the lower extremities and decreased sensorimotor function.[7] Weakness in the distal body occurs late in the natural history of DPN. Instability in these muscles causes difficulty in maintaining balance and ultimately affects gait. Both static and dynamic balance are affected in DPN. Various factors that affect balance in this population are the result of significant sensory disturbances, impaired proprioception, impaired movement control, structural biomechanical disturbances, and disorientation. The literature reports significant improvements in balance and gait speed after multisensory training, as well as proper and safe balance training, and has the potential to improve balance and gait.[4]

By simulating real-life balance disturbances, PBBT promotes improved sensorimotor integration and neuromuscular control. Delivering the program through telerehabilitation allowed continuity of care while maintaining patient safety and engagement. The improvements in BBS and FES suggest enhanced dynamic balance and reduced fear of falling—critical factors for independence and fall prevention. This study also highlights the feasibility of remote rehabilitation interventions in managing chronic conditions like diabetic neuropathy, particularly in populations with limited access to in-person services.

CONCLUSION

Perturbation-based balance training, when delivered through a structured telerehabilitation protocol, can be a practical and effective intervention for improving balance and reducing fall risk in patients with diabetic peripheral neuropathy. Further research with larger sample sizes and controlled trials is recommended to validate these findings.

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INTEGRATIVE PAIN MANAGEMENT: ROLE OF PHYSIOTHERAPY IN MULTIDISCIPLINARY CARE – A NARRATIVE REVIEW

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ABSTRACT

Background: *Pain is a multidimensional experience involving physical, psychological, and social components. Integrative Pain Management (IPM), which incorporates various therapeutic modalities, has emerged as a holistic approach. Physiotherapy is a central component in multidisciplinary care, providing functional and non-pharmacologic interventions to alleviate pain and improve quality of life.*

Objective: *To review current literature on the role of physiotherapy in integrative pain management within multidisciplinary teams.*

Methods: *A narrative review methodology was utilized, sourcing literature from major databases including PubMed, Scopus, PEDro, and CINAHL from 2000 to 2024. Studies were reviewed and categorized thematically.*

Results: *Physiotherapy interventions such as therapeutic exercises, manual therapy, electrotherapy, and patient education significantly contribute to managing chronic pain across various populations. When integrated with psychological and pharmacological treatments, physiotherapy enhances outcomes, reduces opioid use, and improves functionality.*

Conclusion: *Physiotherapy is a vital and effective element in integrative, multidisciplinary pain management models. A team-based, patient-centered approach leads to improved pain control, functionality, and quality of life.*

Keywords: *Pain, Physiotherapy, multidisciplinary care, Pain management, rehabilitation*

INTRODUCTION

Chronic pain is a leading cause of disability worldwide, affecting over 1.5 billion individuals globally, impairing quality of life, limiting daily function, and leading to significant healthcare utilization and societal costs. Conditions such as low back pain, fibromyalgia, neuropathic pain, and arthritis are among the most common chronic pain syndromes seen in clinical settings.

Traditional models of care often emphasize a biomedical approach, focusing predominantly on pharmacologic or surgical interventions. However, these methods frequently fall short in addressing the complex, multifactorial nature of chronic pain. Moreover, long-term use of medications—particularly opioids—has contributed to significant public health concerns, including dependence and overdose.

Physiotherapy, a non-invasive and drug-free approach, emphasizes the restoration of movement and function through evidence-based interventions. It aligns with the goals of IPM by focusing not just on pain relief but also on rehabilitation, education, and empowerment of the patient.

In response, there has been a growing recognition of the biopsychosocial model of pain, which acknowledges the interplay between biological, psychological, and social dimensions of the pain experience. This has led to the evolution of Integrative Pain Management (IPM)—a comprehensive, multidisciplinary approach that utilizes a combination of medical, physical, psychological, and educational strategies to treat pain holistically.

Physiotherapy plays a pivotal role within IPM frameworks. Unlike purely pharmacological approaches, physiotherapy emphasizes functional restoration, movement re-education, and behavioural strategies to reduce pain and disability. Interventions such as therapeutic exercise, manual therapy, pain neuroscience education (PNE), electrotherapy, cognitive functional therapy (CFT), and hydrotherapy have shown significant evidence of effectiveness in various pain conditions.

Importantly, physiotherapists often serve as first-contact practitioners, particularly in musculoskeletal settings. They are trained not only to assess and manage pain but also to identify red flags, coordinate care, and collaborate with other disciplines such as psychology, occupational therapy, pain medicine, nursing, and pharmacy. This collaborative model enhances patient-centered care, improves functional outcomes, and can reduce reliance on invasive or pharmacologic treatments.

This narrative review aims to synthesize current evidence on the role of physiotherapy in multidisciplinary and integrative pain management models. It examines clinical outcomes, implementation strategies, and the challenges of interdisciplinary integration in various healthcare settings.

Chronic pain is a leading cause of disability worldwide, affecting over 1.5 billion individuals globally. Traditional medical models often fall short in managing complex, persistent pain conditions due to their singular focus on pharmacologic or surgical treatments. In contrast, Integrative Pain Management (IPM) leverages a biopsychosocial model, involving coordinated interventions from multiple disciplines.

Physiotherapy, a non-invasive and drug-free approach, emphasizes the restoration of movement and function through evidence-based interventions. It aligns with the goals of IPM by focusing not just on pain relief but also on rehabilitation, education, and empowerment

Need for the Study:

Although physiotherapy is well established in chronic pain care, there remains:

- A lack of standardized integration in multidisciplinary teams.
- Variable implementation across healthcare systems.

- Insufficient clinician and patient awareness of physiotherapy's comprehensive role in IPM.

Therefore, this review aims to synthesize and present the evolving evidence base for physiotherapy as a core component of integrative, multidisciplinary pain management.

METHODOLOGY

Study Design: Narrative review

Databases Searched: PubMed, Scopus, PEDro, CINAHL, Cochrane Library, and Google Scholar.

Search Terms Used: "Integrative pain management", "physiotherapy and chronic pain", "multidisciplinary pain care", "rehabilitation for pain", "biopsychosocial model and physiotherapy", "non-pharmacologic pain relief".

Inclusion Criteria:
- Peer-reviewed articles between 2000 and 2024
- Focused on adults with chronic pain conditions
- Mentioned physiotherapy within multidisciplinary or integrative care models

Exclusion Criteria:
- Acute pain or postoperative rehabilitation
- Paediatric pain management
- Isolated physiotherapy interventions without multidisciplinary context

Data Analysis:
- Thematic synthesis
- Descriptive categorization of intervention types and clinical outcomes

Procedure and Statistical Analysis:
While this review did not involve primary data or meta-analysis, findings were extracted and categorized using structured qualitative methods. Frequency tables were generated for common interventions and outcomes across the literature. Descriptive statistics (mean values and percentages) were derived where applicable, primarily for understanding treatment trends and efficacy reports.

RESULTS

1. Musculoskeletal Pain:
Physiotherapy interventions such as graded exercise, motor control training, manual therapy, and patient education are consistently effective. Guidelines recommend early physiotherapy for conditions like chronic low back pain, arthritis, and myofascial pain.

2. Neuropathic Pain and Fibromyalgia:
Moderate-to-strong evidence supports aerobic exercise, hydrotherapy, and TENS. Combined physiotherapy and CBT showed enhanced outcomes.

3. Cancer Pain:
Physiotherapy in oncology focuses on fatigue reduction, movement restoration, and pain modulation. Evidence supports early physiotherapy to prevent deconditioning and manage secondary musculoskeletal pain.

4. Interdisciplinary Integration:
Studies indicate that physiotherapy's impact is maximized in programs that include:

- Pain psychologists
- Occupational therapists
- Pain physicians and pharmacists

This collaboration improves pain scores, mobility, and patient satisfaction, and reduces opioid dependence.

DISCUSSION

The findings from the literature clearly support the integral role of physiotherapy within integrative pain management frameworks. Physiotherapy offers a broad spectrum of non-pharmacologic, function-oriented interventions that align with the goals of modern pain care—namely, restoring function, enhancing self-efficacy, and improving quality of life.

1. Multifaceted Contribution of Physiotherapy

Physiotherapists address both physical impairments and the psychological dimensions of pain. Through modalities such as graded activity, movement retraining, manual therapy, and education, they contribute to decreasing pain perception, reducing fear-avoidance behaviors, and restoring meaningful activity. This is especially important in chronic pain conditions where central sensitization, maladaptive movement patterns, and catastrophizing thoughts play key roles in perpetuating pain.

Furthermore, physiotherapy enhances the impact of interdisciplinary programs when combined with interventions like cognitive-behavioral therapy (CBT), mindfulness-based stress reduction (MBSR), pharmacologic support, and occupational therapy. Evidence shows that such multimodal programs lead to greater reductions in pain intensity, improved functional outcomes, and lower opioid consumption than unimodal interventions.

2. Effectiveness Across Populations and Conditions

In musculoskeletal pain (e.g., low back pain, neck pain), structured exercise and manual therapy have demonstrated consistent improvements in function and pain scores. For neuropathic pain and fibromyalgia, interventions such as aerobic conditioning, TENS, and hydrotherapy show moderate to strong benefits, particularly when paired with psychological support.

In oncologic pain, physiotherapy can help combat cancer-related fatigue, musculoskeletal deconditioning, and pain from treatment side effects. Emerging evidence supports early physiotherapy integration to optimize outcomes during and after cancer treatment.

3. Challenges to Integration

Despite robust evidence, there are significant barriers to full integration of physiotherapy in multidisciplinary pain management. These include:

- Fragmented care systems that hinder interdisciplinary collaboration
- Limited awareness among patients and providers about the scope of physiotherapy in chronic pain
- Geographic and economic disparities, particularly in rural or low-resource settings
- Lack of standardized referral pathways and treatment protocols
- Inconsistent training in pain neuroscience and behavioral approaches within physiotherapy education

Addressing these challenges requires not only healthcare policy reform but also interprofessional education, development of integrated care models, and increased support for telehealth and remote rehabilitation services.

4. Future Directions

To strengthen physiotherapy's role within integrative pain management, future efforts should focus on:

- Expanding access to physiotherapy in underserved regions
- Establishing standardized clinical pathways for chronic pain conditions
- Promoting team-based care models supported by electronic health records
- Enhancing research on the cost-effectiveness and long-term outcomes of integrated physiotherapy services
- Encouraging patient engagement through education and self-management support tools

SUMMARY

In summary, physiotherapy is more than just a physical intervention—it is a core therapeutic discipline in integrative pain care. Its multimodal, individualized, and non-pharmacological approach aligns with contemporary best practices for managing chronic pain. By embracing a biopsychosocial model and fostering collaboration within multidisciplinary teams, physiotherapists help patients move beyond pain toward functional recovery and improved well-being.

CONCLUSION

Physiotherapy is a cornerstone of integrative pain management. When embedded in a multidisciplinary framework, it improves physical, functional, and emotional outcomes for patients with chronic pain. Further research and systemic reforms are required to enhance access and integration globally.

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PREVALENCE OF ROUNDED SHOULDER POSTURE IN PHYSIOTHERAPY STUDENTS & NON-PROFESSIONAL UNDERGRADUATE STUDENTS BY USING MB-RULER SOFTWARE

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ABSTRACT

Good posture is that state of muscular and skeletal balance which protects the supporting structures of the body against injury or progressive deformity. Rounded shoulders occur due to reasons such as incorrect posture, occupational requirements, muscle weakness, poor core stability, sedentary lifestyle, poor fitness, stiffness in joints, poor ergonomic work stations, sitting for a long time in one posture during watching or playing games, using phones and computers for a greater time period.

Aim is to compare the prevalence of rounded shoulder posture in physiotherapy students & non-professional undergraduate students by using MB-Ruler software. Objective is to compare the assessment of rounded shoulder posture in students of physiotherapy with non-professional undergraduate students by using MB-Ruler software with age group between 18-25 and sample size of 134 and In this study, prevalence of rounded shoulder posture in non-professional UG students is 23.8% whereas in physiotherapy students it is 37.3%. It shows difference of 13.5% between both the groups which is significant.

Physiotherapy students found to be more prone than non-professional students because of their clinical practice, and working in poor ergonomic pattern. 37.3% of physiotherapy course students have Rounded Shoulder Posture (RSP). 23.8% of non-professional UG students have RSP. RSP is more in physiotherapy students than in non-professional UG students. Prevalence is higher in males among physiotherapy students whereas it is higher in females among non-professional UG students. Prevalence is higher in 21-23 years of age group in both the groups of the student.

It is concluded that physiotherapy students are more prone to rounded shoulder posture because of their clinical practice.

***Keywords**: Rounded shoulder posture, MB –Ruler software, Professional students*

INTRODUCTION

Posture is defined as the relative arrangements of the part of the body. Good posture is that state of muscular and skeletal balance which protects die supporting structures of the body against injury or progressive deformity, irrespective of the attitude (erect, lying, squatting, or stooping) in which these structures are working or resting. Under such conditions the muscles will function most efficiently and the optimum positions are afforded for the thoracic and abdominal organs. Poor posture is a faulty relationship of the various parts of the body which produces increased strain on the

supporting structures and in which there is less efficient balance of the body over its base of support.

When plumbline in lateral view passes equidistant through the joint it said to be in an ideal alignment of the shoulder. Position of the arm and shoulder is interrelated with the positions of scapulae and upper back. In good alignment the scapulae lie flat against the upper back, approximately 4 inches apart.

Rounded shoulders is used to describe a resting shoulder position that has moved forward from the body's ideal alignment. In rounded shoulder posture shortened muscles are pectoralis minor, serratus anterior, upper trapezius and lengthened as well as weakend muscles are middle and lower trapezius. In rounded shoulder posture position of the scapula is protracted, anteriorly tilted, abducted, elevated and internally rotated.

Rounded shoulders occur due to reasons such as illiterateness of correct posture, occupational requirements, muscle weakness, poor core stability, sedentary lifestyle,poor fitness, stiffness in joints, poor ergonomic work stations, sitting for a long time in one posture during watching or playing games, using phones and computers for a greater time period.

A physiotherapy is one of the professional group who has many harmful and damaging effects due to performed work which makes them a population at risk.

The type of the work in physiotherapist's practice is physically demanding and involves monotonous and constant tasks, persistent posture, manual techniques which demands a high force activities, uncomfortable positioning of joints during certain maneuvers, treatment techniques which exert direct pressure in particular joints. During majority of working time of profession, it involves lifting heavy weights, maintaining awkward position and performing twisting movements.

Physiotherapists reports a high incidence of injuries related to their work during their professional activities even though they have a great knowledge of musculoskeletal injuries and plan of action to prevent them because of their training and persistent professional development.

Other college going non-physiotherapy students also has prevalence of rounded shoulder posture who does not have too much physical activities in their academic period.

MB-Ruler software was used in this study for measuring forward shoulder angle (FSA)This software helps you to measure distances and angles on the screen and distances on a map. MB-ruler software goniometer used for evaluation of postural angles.

Need of The Study

Rounded shoulders with forward head posture leads to deranged muscle activity and scapular kinematics independent of shoulder pain. Rounded shoulders can lead to decrease in subacromial space, pain in shoulders postural derangements, imbalance in

muscular forces around a shoulder and scapula and also conditions like rotator cuff pathology, thoracic outlet syndrome, bicipital tendinitis.

Rounded shoulders can cause alteration while performing activities of daily living and also reduction in respiratory values of lungs. Physiotherapy course has different aspects in their academics from which a clinical practice is a very important aspect, but it also makes students prone to posture related changes. As students in their early period of education are not enlightened with accurate and reliable information on work ergonomics as well as working with patients rightly has not became a habit of the routine activity of the budding physiotherapist. Hence they seem to be specially exposed to posture related changes.

Rounded shoulder posture is also found in college going students who don't have significant physical work in their educational period. This study is important way to find out if there is affection of shoulder posture in physiotherapy students because of their clinical practice or it is just because some other common factors such as mobile phone usage, laptop usage or due to carrying heavy bags like in other students.

This study will also give information, if physiotherapy students have advantage because of their knowledge about work ergonomics or they are more prone to posture changes due to their clinical practice.

A necessary action is to analyse and observe the development of rounded shoulder posture of physiotherapy students, ranging from earliest period of their education. Information gained by this study will be helpful for appropriate preventive and early actions. This will also contribute to reducing the number of physical therapists with disorders of musculoskeletal system in future.

Aim

To Compare the prevalence of rounded shoulder posture in physiotherapy students & non-professional undergraduate students by using MB-Ruler software.

Objectives

1) To assess rounded shoulder posture & find out it's prevalence in physiotherapy students by using MB-Ruler software.

2) To asses rounded shoulder posture & find out it's prevalence in non-professional undergraduate students by using MB-Ruler software.

3) To compare the assessment of rounded shoulder posture in students of physiotherapy with non-professional undergraduate students by using MB-Ruler software.

Inclusion Criteria

Physiotherapy students from all years

Non-professional undergraduate students

Age group between 18-25 years (5)

Both male and female subjects

Exclusion Criteria

Any congenital anomaly of shoulder

Any pathological condition of shoulder

Any structural abnormality of spine like scoliosis

Recent shoulder surgeries and fracture

Students who are not willing to participate.

Materials And Methodology

Population: Physiotherapy students, non-professional UG students.

Study Setting: Physiotherapy College, Non-Professional Degree colleges.

Study Design: Cross Sectional Study.

Sampling Technique: Purposive random sampling.

Sample Size: 134 (67 in each group).

Materials Used: Camera (to click pictures),

Tripod (to adjust camera height),

Styrofoam balls 15 mm in circumference (to highlight anatomical landmarks,

Measuring tape (to measure distance of subject from tripod),

Double faced adhesive tape, Laptop HP.

Outcome Measures: MB ruler postural analysis software.

Forward shoulder angle (FSA) more than or equal to 52°

Styrofoam balls (15mm circumference)

Tripod (7 feet height)

Photographic recording

The volunteer signed a formal consent form to participate in the study. The photographs were taken according the method used by Thipen et al. and requirements of MB-Ruler software. For thispurpose, a Styrofoam balls were fixed at posterolateral aspect of acromion process and C7 vertebra. The subjects were positioned in such a way that the camera was positioned on a fixed tripod at a distance of 2 meters and at a1.5 meters of height. The subject was photographed in a lateral view of their dominant side.

Photogrammetry

After acquisition of photographs, the images were transferred to the laptop in the use of the MB-Ruler software, for photogrammetric posture analysis of all subjects. To

calibrate the image, mark the landmarks used by the protocol, create a report of analysis, and export it to excel. The angle between the bony landmarks determined by the protocol were quantified according to software conventions.

PROCEDURE

Informed consent was obtained from each subject after explaining procedure. Students who were not fitting into inclusion criteria were excluded and 67 physiotherapy students and 67 non-professional UG students were included in the study.

Postural assessment was done using photography method. Before marking bony landmarks, students were told to perform shoulder flexion- abduction and cervical flexion-extension 5 times each.

Bony landmarks marked was posterolateral aspect of acromion process of dominant side and C7 spinous process. Markings were done by using Styrofoam balls (15 mm in circumference).

After that photos were taken according to a technique used by Thipen et al. Photos were clicked by using camera (13 mega pixel), fixed on a tripod at 1.5meters height and 2 meters away from the student.

Students were told to stand in their relaxed standing posture and lateral view photographs were clicked. These photographs were analysed using MB- Ruler software and FSP was calculated for each student. FSP is the angle between vertical lines that cross C7 spinous process and acromion, it was calculated by using MB-Ruler software.

RESULTS

Total 134 students participated in the study. Among 134 students 67 were from physiotherapy course and 67 were from non-professional UG courses. In physiotherapy 59 females and 8 males participated in the study. Students participated in the study was between 18-25 years of their age.

In non-professional UG courses 36 females and 37 males participated in the study. Prevalence of rounded shoulder posture in non-professional UG students is 23.8% whereas in physiotherapy students it is 37.3%.

Prevalence is higher in males (62.5%) than in females (33.8%) in physiotherapy students whereas it is higher in females (33.3%) than in males (16.12%) in non-professional UG students.

In physiotherapy students, prevalence is higher in 21-23 years age group (48.2%) followed by 18-21 years age group (34.4%) followed by 23-25 years of age group (11.1%).

In non-professional UG students, prevalence is higher in 21-23 years of age group (29.6%) followed by 23-25 years age group (21.4%) followed by 18-21 years age group (19.2%).

DISCUSSION

The purpose of this cross-sectional study was to find out the prevalence of RSP in physiotherapy students and comparing it with non-professional UG students. Total 134 students participated in this study, from which 67 was from physiotherapy course students from all years and 67 was from non-professional course's students.

They undergone photographic postural assessment for shoulder joint. Analysation was done by using MB-Ruler software.In the year of 2010 Thipen et al and in the year of 2014Arghavan Hajibashi et al also used same software during their study for postural assessment. Zeynep Hazar et al did study in 2015 for investigating inter & intra-rater reliability if MB-Ruler software for photographic posture analysis, and they concluded that inter and intra-rater reliability was in acceptable to excellent range.

In this study, prevalence of rounded shoulder posture in non-professional UG students is 23.8% whereas in physiotherapy students it is 37.3%. It shows difference of 13.5% between both the groups which is significant.

Physiotherapy students found to be more prone than non-professional students because of their clinical practice, and working in poor ergonomic pattern. Similar study was done in 2013 by Joanna Glista et al to verify the changes which may occur in student's posture due to their clinical practice, study concluded that there is considerable amount of abnormality in their posture. In their study they found deterioration in various parameters from which pelvic/shoulder obliquity and scapular distance was one of the parameters which was increased.

In this study prevalence of RSP in non-professional UG students is 23.8%, similarprevalence study done in non-medical female college going students in 2017 by S. Kruthika et al to study postural dysfunction among them. 19-24 years age group students were included in the study and they found out after forward head posture rounded shoulder posture is the most commonly found out in students and it was 8.3%.

In this study prevalence of RSP in physiotherapy students is 37.3%. Some studies are done for investigating postural disorders among health professionals. Leila Vakili et al did study in 2015 to find out postural disorders among academic dental staff and concluded that 68.80% of their subjects has rounded shoulder posture which was again most common after forward head posture similar as in study done by S. Kruthika et al.

In Malaysia, Nor Azlin M. Nordin et al did a research in 2011 to find out work related injuries among physiotherapist who were working in hospitals. They found that 71.6% prevalence among working physiotherapists. Which means even though physiotherapists have a knowledge about work ergonomics, they are also prone to work related musculoskeletal injuries. This result is similar to our study as even though physiotherapy students have a work ergonomics knowledge still, they are showing more prevalence of rounded shoulder posture than non-professional students.

In physiotherapy students from all years, males (62.5%) are found to be having more chances of RSP than in females(33.8%) but on the other hand situation is opposite as in non-professional UG students prevalence is higher in females (33.3%) than in males (16.2%).

In this study, prevalence of RSP is found to be more in 21-22 years of age group in physiotherapy students as well as non-professional UG students; this is supported by the study done in 2017 by S. Kruthika et al. In the study done by N. L. Holder et al in 1999; they also found out that young physiotherapists between 21-30 years of their age is having more problems regarding posture.

CONCLUSION

- 23.8% of non-professional UG students have RSP.
- 37.3% of physiotherapy course students have Rounded Shoulder Posture (RSP).
- RSP is more in physiotherapy students than in non-professional UG students.
- Prevalence is higher in males among physiotherapy students whereas it is higher in females among non-professional UG students.
- Prevalence is higher in 21-23 years of age group in both the groups of the student.
- Physiotherapy students are more prone to rounded shoulder posture because of their clinical practice.

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EFFECTIVENESS OF A MULTIDISCIPLINARY PHYSIOTHERAPY APPROACH FOR MANAGING POSTPARTUM LOW BACK PAIN: AN OBSERVATIONAL STUDY

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ABSTRACT
Low back pain (LBP) is a common musculoskeletal complaint in the postpartum population, with studies indicating a prevalence ranging from 30% to 70% among women following childbirth. Postpartum LBP results from a variety of factors, including hormonal changes (especially elevated levels of relaxin), ligamentous laxity, and biomechanical stress on the spine during pregnancy, deconditioning of the core musculature, and poor postural habits developed during breastfeeding and childcare. AIM: To evaluate the effectiveness of a multidisciplinary physiotherapy intervention in the management of postpartum low back pain. The findings of this observational study suggest that a multidisciplinary physiotherapy model significantly improves outcomes in postpartum low back pain management compared to standard care. The multidisciplinary group demonstrated superior reductions in pain, greater improvements in functional ability, and enhanced quality of life scores.

Keywords: *Postpartum Low Back Pain, Multidisciplinary, Physiotherapy Approach, Pain management, Pregnancy*

INTRODUCTION
Low back pain (LBP) is a common musculoskeletal complaint in the postpartum population, with studies indicating a prevalence ranging from 30% to 70% among women following childbirth [1, 2]. Often underestimated, this condition can significantly impair a mother's ability to care for her newborn and participate in daily activities, leading to reduced quality of life and increased healthcare utilization [3]. Postpartum LBP results from a variety of factors, including hormonal changes (especially elevated levels of relaxin), ligamentous laxity, and biomechanical stress on the spine during pregnancy, deconditioning of the core musculature, and poor postural habits developed during breastfeeding and childcare [4].

Traditional physiotherapy interventions primarily focus on restoring musculoskeletal balance through core strengthening, stretching, and posture correction. However, many women continue to experience persistent or recurrent symptoms despite these therapies [5]. This has led to growing recognition of the complex, multifactorial nature of postpartum LBP, which often includes psychological, ergonomic, and lifestylecomponents.

A multidisciplinary approach that combines physical therapy with psychological counseling, ergonomic education, nutritional guidance, and pain management may offer a more holistic solution [6]. For instance, psychological support can address

postpartum depression and pain-related fear-avoidance behaviors [7], while ergonomic training can help new mothers safely perform daily care giving tasks [8].

This observational study aims to evaluate the outcomes of a multidisciplinary physiotherapy program compared to standard physiotherapy care for postpartum women with low back pain. The hypothesis is that a collaborative, interdisciplinary treatment model will result in superior pain reduction, improved function, and higher patient satisfaction.

AIM AND OBJECTIVES

Aim:
To evaluate the effectiveness of a multidisciplinary physiotherapy intervention in the management of postpartum low back pain.

Objectives:

1. To observe changes in pain intensity and functional disability following a multidisciplinary intervention.
2. To compare the effectiveness of standard physiotherapy versus multidisciplinary physiotherapy.
3. To assess changes in quality of life and psychological well-being post-intervention.
4. To evaluate adherence and satisfaction with care among both treatment groups.

Need For the Study
Postpartum low back pain is often under diagnosed and undertreated, contributing to long-term disability and emotional distress in new mothers [9]. Current physiotherapy models may neglect psychological and ergonomic contributors, leading to incomplete recovery. There is a pressing need to explore integrated care models that encompass the physical, emotional, and social dimensions of postpartum health. This study attempts to fill this research gap by evaluating a multidisciplinary care strategy in a real-world setting.

METHODOLOGY

Study Design - Prospective observational comparative study

Study Setting- Tertiary care hospital and affiliated physiotherapy outpatient clinics

Sampling Method - Convenience sampling

Duration- 12 months

Sample Size – 100 participants (50 in each group)

Inclusion Criteria:

Women aged 20–40 years

6 weeks to 6 months postpartum

Reporting nonspecific low back pain for at least 2 weeks

Exclusion Criteria:
Pre-existing chronic low back conditions

Previous spinal surgery

Neurological deficits

High-risk pregnancies or complicated deliveries

PROCEDURE
Recruitment & Consent of Eligible participants will be briefed and informed consent obtained.

Group Allocation

Group A (Standard Physiotherapy): Postural education, pelvic floor and core strengthening, stretching.

Group B (Multidisciplinary Physiotherapy): Includes interventions from Group A plus:

Ergonomic counseling by an occupational therapist

Cognitive behavioral therapy (CBT)-based sessions

Nutritional advice and pain education

Intervention Period - 8 weeks (2 sessions per week)

Outcome Measures:

Pain Intensity- Visual Analog Scale (VAS)

Functional Disability- Oswestry Disability Index (ODI)

Quality of Life- Short Form-36 (SF-36)

Adherence & Satisfaction: Structured patient feedback questionnaire

Assessment Timeline:
Baseline

Mid-intervention (Week

STATISTICAL-ANALYSIS
Descriptive statistics for baseline characteristics

Paired t-test or Wilcoxon signed-rank test for within-group comparisons

Independent t-test or Mann–Whitney U test for between-group comparisons

Repeated Measures ANOVA for longitudinal data

Significance set at $p < 0.05$

SPSS (version 25.0) used for analysis

RESULTS

Outcome Measure	Group A (Standard)	Group B (Multidisciplinary)
VAS (Pain) reduction	2.5 ± 1.0	4.1 ± 1.2
ODI Improvement (%)	27%	48%
SF-36 QoL score increase	+12 points	+24 points
Adherence rate	65%	85%
Patient satisfaction	68% reported "satisfied"	90% reported "satisfied"

DISCUSSION

The findings of this observational study suggest that a multidisciplinary physiotherapy model significantly improves outcomes in postpartum low back pain management compared to standard care. The multidisciplinary group demonstrated superior reductions in pain, greater improvements in functional ability, and enhanced quality of life scores.

These outcomes validate the biopsychosocial model of pain management, which considers not only the anatomical and mechanical contributors but also the psychological and social dimensions. Psychological interventions such as CBT can help reframe maladaptive thoughts and encourage physical activity, which has been shown to improve both mental health and musculoskeletal outcomes [10]. The incorporation of ergonomic education in daily childcare activities—such as correct lifting techniques and feeding postures—also appears to reduce pain recurrence and foster sustainable behavior change [8].

Importantly, the study also revealed higher adherence and satisfaction rates in the multidisciplinary group. This suggests that patients may feel more supported and engaged when care is collaborative and tailored to their unique postpartum challenges.

However, several limitations must be acknowledged. As an observational study, causality cannot be definitively established. The sample size was relatively small, and participants were not randomized, which could introduce selection bias. Future randomized controlled trials with larger cohorts are needed to validate these findings and assess long-term effects.

Nevertheless, this study highlights the potential benefits of adopting a multidisciplinary strategy in postpartum care protocols. Healthcare systems should consider restructuring maternal rehabilitation services to be more integrative, patient-centered, and collaborative.

CONCLUSION

Postpartum low back pain is a multifaceted condition that requires a comprehensive treatment approach. A multidisciplinary physiotherapy model that incorporates

physical rehabilitation, psychological support, ergonomic education, and nutritional counseling significantly improves pain, function, and quality of life compared to standard care. This approach has the potential to become a gold standard in postpartum musculoskeletal rehabilitation.

The findings of this observational study suggest that a multidisciplinary physiotherapy model significantly improves outcomes in postpartum low back pain management compared to standard care. The multidisciplinary group demonstrated superior reductions in pain, greater improvements in functional ability, and enhanced quality of life scores.

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Postpartum low back pain is a multifaceted condition that requires a comprehensive treatment approach. A multidisciplinary physiotherapy model that incorporates physical rehabilitation, psychological support, ergonomic education, and nutritional counseling significantly improves pain, function, and quality of life compared to standard care. This approach has the potential to become a gold, standard in postpartum musculoskeletal-rehabilitation. However, several limitations must be acknowledged. As an observational study, causality cannot be definitively established. The sample size was relatively small, and participants were not randomized, which could introduce selection bias. Future randomized controlled trials with larger cohorts are needed to validate these findings and assess long-term effects.

Nevertheless, this study highlights the potential benefits of adopting a multidisciplinary strategy in postpartum care protocols. Healthcare systems should consider restructuring maternal rehabilitation services to be more integrative, patient-centered, and collaborative.

KNOWLEDGE OF GOVERNMENT HEALTH SCHEMES AMONG CAREGIVERS OF CHILDREN WITH AUTISM SPECTRUM DISORDER

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ABSTRCT

Background: *Children with Autism Spectrum Disorder (ASD) often require multidisciplinary interventions, including physiotherapy. The Indian government offers various health schemes to support such needs. However, the extent of caregiver's awareness and utilization of these schemes remains unclear.*

Objective: *To assess the level of awareness of Knowledge on Government Health Schemes Among Caregivers of Children with Autism Spectrum Disorder.*

Methods: *A pre-post quasi experimental study was conducted among 60 caregivers of children diagnosed with ASD and receiving physiotherapy treatment. A workshop was organised at educational institute, lecture was delivered which included awareness on Niramaya scheme description, funding pattern, eligibility criteria, process, scheme renewal and claim process. A structured questionnaire in English/Hindi assessed their knowledge about disability certification, rights, benefits, and various government welfare schemes.*

Result: *The study revealed a significant lack of awareness among caregivers regarding disability and government welfare schemes. Many caregivers were unaware of the existence of disability certification processes and the rights and benefits available under various government schemes. This lack of knowledge contributes to the underutilization of rehabilitation services and other support mechanisms.*

Conclusion: *To improve the quality of life for children with ASD, it is imperative that their caregivers are well-informed about available rights and welfare schemes. Efforts should focus on educating caregivers and healthcare providers to bridge the knowledge gap and facilitate better access to support services.*

Keywords: *Autism spectrum disorder (ASD), Knowledge, Government health schemes.*

INTRODUCTION

Autism spectrum disorder (ASD) is a childhood developmental disorder. It is characterized by multiple social, behavioural, and communication difficulties. ASD is accompanied by anatomical and functional changes in the brain of an ASD patient [1]. ASD could have varying degrees of severity, with some cases being moderate and others being severe. Severe cases necessitate a great deal of assistance and ongoing

support. Patients with ASD have a tendency to repeat certain behaviours and might not want change in their daily routine [1].

This disorder affects one out of every 44 children, and it can affect people of all races and ethnic groups. As a result, it is one of the most frequent developmental impairments among children [2]. There has been an increase in the incidence of ASD in the last two decades, and one possible reason for this increase is that, while this condition is a lifelong disorder, there is greater awareness of it today than in the previous two decades, and as a result, caregivers of ASD children are beginning to seek screening and diagnosis from a specialist [3].

ASD diagnosis is problematic because no direct tests, such as a blood test or particular biomarkers in the body, are available to confirm the diagnosis. A diagnosis for ASD is based on observing the child's behaviour [3]. In 2013, the Diagnostic and Statistical Manual of Mental Disorders (DSM)-5 of the American Psychiatric Association published their criteria for the diagnosis of ASD spectrum, adding pervasive developmental disorder and Asperger's disorder to the ASD spectrum. Before that, they were classified as different subgroupings of the ASD spectrum, but now they consider autistic syndrome, Asperger's disorder, and pervasive developmental disorder to be part of the ASD spectrum. According to the Diagnostic and Statistical Manual of Mental Disorders (DSM)-5, ASD is linked to a variety of mental disorders, including attention deficit hyperactivity disorder (ADHD), social anxiety disorder, depression, and intellectual disability [4–6].

Some of the risk factors for developing ASD include genetic and environmental variables [7]. Some medicines taken by the mother during pregnancy, such as valproic acid, have been linked to the development of ASD in children [8]. ASD is more likely to affect children born to older parents. Furthermore, the age of the pregnant lady, i.e., if the mother is over 40 years old, has an impact on the development of ASD [9]. Additionally, whether the mother was pregnant while suffering from hypertension or a viral or bacterial infection has a bearing on the development of the disorder [10]. A child's brother or sister is more likely than other siblings to have an ASD if he or she has an ASD. A genetic and chromosomal disorder, such as the Fragile X chromosome, can potentially cause ASD [11]. Besides, changes in the GABAergic, glutamatergic, serotonergic, and dopaminergic systems have been linked to ASD after exposure to neurotoxic chemicals [19]

There are many myths and misconceptions about ASD. For example, some people believe that vaccines are responsible for the development of ASD [11]. According to the World Health Organization website (WHO), there is no documented link between a vaccine and the development of ASD, and there is also no link between the MMR vaccine and the development of ASD disease [12-14].

There is no medical treatment for ASD that is able to cure the disorder. All the child's caregivers can do is to begin using special behavioural therapy, physiotherapy and occupational therapy as soon as the diagnosis is confirmed to help ASD patients

develop new abilities such as talking, looking in their eyes, playing with peers, walking, and socializing [15]. The cost of ASD management is considered high because there are direct and indirect costs to the family, such as health costs and the coast of extra educational support that is required, particularly for children with intellectual disabilities, which will place a financial strain on the family and, in many cases, result in mothers losing their jobs [16-18].

Disability amongst children is a matter of serious concern as it has wider implications. Parents are the most important persons in a child's life and render maximum assistance to children with disability. There are many special services which are required for children with ASD but their parents are not able to avail of those due to a lack of awareness regarding different programmes and schemes which are specially made for their child's benefit. For improving the quality of life of children with ASD, it is important that their parents are made aware of these rights.

To improve the quality of life of children with ASD, it is important that their caregiver, parents, special school educators, well-wishers are well aware of these rights. Very few studies have been conducted in India to assess the level of awareness of knowledge of Government Health Schemes among caregivers of children with ASD regarding the rights of their children with disability. Hence, a study was planned to determine the magnitude of awareness of health schemes amongst parents of children with autism spectrum disorder (ASD) regarding disability, disability certification, rights and benefits and welfare schemes.

AIM

- To study the knowledge of Government Health Schemes Among Caregivers of Children with Autism Spectrum Disorder.

OBJECTIVES

- To understand existing knowledge of Government Health Schemes Among Caregivers of Children with Autism Spectrum Disorder.
- To understand the effect of session delivered on knowledge of Government Health Schemes Among Caregivers of Children with Autism Spectrum Disorder.

HYPOTHESIS

- **Alternate hypothesis (H1):**

There is significant effect of session delivered on knowledge of Government Health Schemes Among Caregivers of Children with Autism Spectrum Disorder.

- **Null hypothesis (Ho):**

There is no effect of session delivered on knowledge of Government Health Schemes Among Caregivers of Children with Autism Spectrum Disorder.

METHODOLOGY

- **Study design:** Quasi Experimental Pretest and post- test study
- **Sampling:** Convenient sampling

- **Sample size:** 60
- **Study setting:** Educational Institute of special school.

Inclusion criteria:
- Parents of children diagnosed with autism spectrum disorder.
- Special school educators

Exclusion:
- Any other medical or surgical conditions.

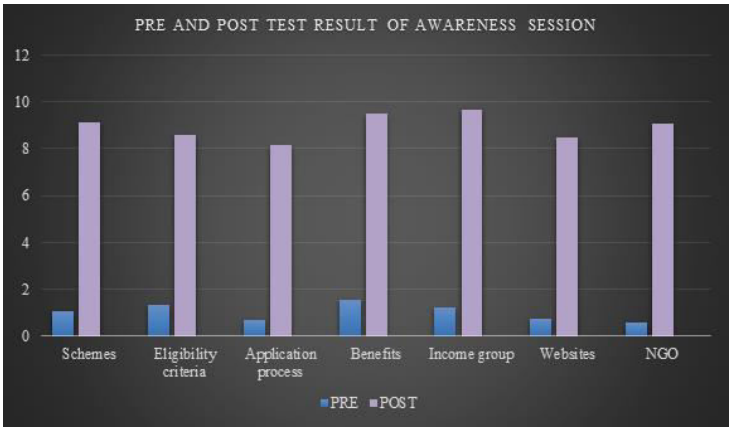
Materials:
- Pen and paper
- Self-administered questionnaire
- Consent form
- Power point presentation
- Feedback form

PROCEDURE

A study was conducted at Educational Institute at Kharghar area. Ethical clearance was obtained from the institute. Participants consent was taken. Lecture was delivered which included awareness on Niramaya scheme description, funding pattern, eligibility criteria, process, scheme renewal and claim process. A structured questionnaire in multiple regional language assessed their knowledge about disability certification, eligibility criteria, application process, benefits, and NGO's. In pre-test, questionnaire was administered in which subjects were asked to answer the questions based on their awareness regarding Government Health schemes. In post-test, the questionnaire was readministered to check the awareness of knowledge.

DATA ANALYSIS AND RESULTS

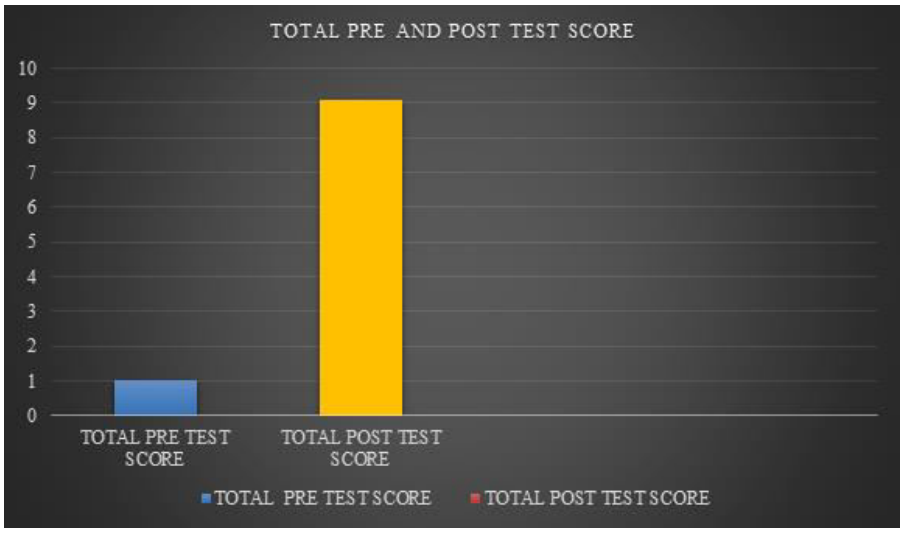
Statistical analysis was done using paired t-test.



Graph 1: Comparison of pre and post scores of awareness session:

	Schemes	Eligibility Criteria	Application process	Benefits	Income group	Websites	NGO
Pre score	1.06	1.36	0.69	1.56	1.23	0.73	0.57
Post score	9.108	8.55	8.11	9.45	9.66	8.43	9.06

Result: There is significant change ($p < 0.001$) in test score post awareness session.



Graph 2: Comparison of total pre and post scores of awareness session.

There is significant change ($p < 0.001$) in the total scores post awareness lecture.

Total pre value score	**1.04**
Total post value score	**9.08**
p- value	**0.001**

Result: There is significant change ($p < 0.001$) in the total scores post awareness lecture.

DISCUSSION

In the past two decades, India has made significant progress in the disability and health schemes, leading to major legislative changes, such as the RPWD Act, 2016, and the National Trust Act, 1999. These laws, along with initiatives such as the Right to Education (RTE) Act, Government schemes for autism disorders such as the Niramaya scheme, Disha scheme, Vikaas scheme, Samarth scheme, GHARUNDA scheme and BADHTE KADAM scheme, have aimed to provide affordable Health insurance to persons with autism, cerebral palsy, mental retardation and multiple

disabilities. However, the findings of this study reveal significant gaps in awareness and utilisation of these schemes amongst caregivers of children with ASD.

Our study shows that while a majority of caregivers are (9.08) are aware of government health schemes for autism children, there is a stark lack of knowledge about available government schemes, funding pattern, eligibility criteria, disability certificate, enrolment process, scheme renewal, claim process and legal rights. This is consistent with previous research, which also highlights a general lack of awareness amongst caregivers regarding benefits and schemes designed to support their children's needs. The limited awareness of initiatives such as the Universal Disability Identity card and the provisions under key legislations further hinder caregivers' ability to access necessary services. In this study, caregivers showed poor awareness on benefits regarding, Limit of Hospitalization (corrective surgeries, non-surgical, hospitalization), limit for Out Patient Department (medicines, pathology, diagnostic tests, regular medical check- up, dentistry) transportation costs which offer immediate practical value. However, knowledge of Government health schemes, including the Niramaya scheme, Disha scheme, Vikaas scheme, Samarth scheme, GHARUNDA scheme and BADHTE KADAM scheme remains notably poor. Similar findings were reported in other studies, which also pointed to limited knowledge of health schemes amongst parents of children with autism spectrum disorders.

Few studies have been conducted on the awareness of primary caregivers of the human rights of their children with intellectual disabilities.[19-20] Bailey conducted research on awareness, use and satisfaction with services for Latino parents of young children with disabilities and results revealed that only a minority of the sample had limited awareness and use of medical, early intervention, special education and social services.[21] A survey conducted by Venkatesan on knowledge and opinion on rights, immunities and privileges for persons with mental retardation revealed that most of the respondents were able to correctly answer only half of the items in the questionnaire.[22]

Research done by Sharma on the assessment of awareness levels of parents showed that all parents knew that children have rights and entitlements but could list only few. Parents voiced that only a few have access to these services. They added that the rights for disabled children were neither acknowledged nor accorded by society. They expressed their disappointment with society for creating discriminatory experiences for their children.[23]

A reality check is quite startling as the majority of caregivers of children with disabilities are not aware regarding the health schemes and the ones who are aware are not able to avail of them. To improve the quality of life of children with disability, it is important that their caregivers are well aware of these schemes. Very few studies have been conducted in India to assess the level of awareness amongst caregivers regarding the schemes of autism spectrum disorders.

Importantly, the results underscore the significant influence on pre- test core of eligibility criteria, application process, websites, NGO, income group, benefits, of awareness levels. Caregivers with higher education and professional occupations demonstrated better knowledge of disability rights and welfare schemes. Hence, a study was planned to determine the magnitude of awareness of health schemes amongst parents of children with autism spectrum disorder (ASD) regarding disability, disability certification, rights and benefits and welfare schemes.

CONCLUSION

This study highlights three critical findings:

1. **Low awareness of Government health schemes:** There is a significantly low level of awareness regarding various associated welfare schemes amongst caregivers.
2. **Underutilisation of services:** A considerable gap exists between the availability of schemes-related benefits and caregivers' awareness of how to access these services, leading to substantial underutilisation.
3. **Influence of socioeconomic factors:** Caregivers' education and occupation significantly influence their awareness levels. Those with higher education or professional occupations demonstrate greater knowledge of disability rights and welfare schemes, highlighting the need for targeted educational programmes to bridge this gap.

In conclusion, this study emphasises the urgent need for improved awareness and accessibility of resources. Ensuring that all caregivers – regardless of their socioeconomic background – are informed about the available support and services is crucial for enhancing the quality of life and inclusion of children with disabilities in society. Targeted interventions, particularly in underserved communities, will be vital in reducing disparities and promoting equal opportunities.

RECOMMENDATIONS

To address the identified gaps, we recommend the following:

1. **Awareness campaigns:** Nationwide awareness campaigns should be launched, particularly in rural and suburban areas, to educate caregivers on available welfare schemes.
2. **Training programmes for medical professionals:** Training programmes should be initiated for healthcare providers to ensure they can effectively guide families through the disability certification and welfare process.
3. **Improved accessibility:** The implementation of district-level certification and camp-based services should be enhanced to reach underserved areas, making services more accessible.

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