© 2026 THE AUTHORS
Open access at https://www.minervamedica.it

European Journal of Physical and Rehabilitation 2026 April;62(2):119-26
DOI: 10.23736/S1973-9087.26.09138-0

REVIEW

The adoption of innovative technologies in Physical and Rehabilitation Medicine: state of the art and unmet needs

Sanaz POURNAJAF [1, 2] *, Giovanni MORONE [3], Sofia STRAUDI [4], Marco PAOLETTA [2], Annibale ANTONIONI [4], Marco FRANCESCHINI [1], Francesca GIMIGLIANO [2], Mauro ZAMPOLINI [5], Alessandro GIUSTINI [6]

[1]Research Area in Neuromotor Rehabilitation and Rehabilitation Robotics, Department of Neuroscience, IRCCS San Raffaele, Rome Italy; [2]Department of Mental and Physical Health and Preventive Medicine, Luigi Vanvitelli University of Campania, Naples, Italy; [3]Department of Life, Health and Environmental Sciences, University of L'Aquila, L'Aquila, Italy; [4]Department of Neuroscience and Rehabilitation, University of Ferrara, Ferrara, Italy; [5]Foligno Hospital, Foligno, Perugia, Italy; [6]European Society of Physical Rehabilitation Medicine, Trento, Italy

*Corresponding author: Sanaz Pournajaf, Research Area in Neuromotor Rehabilitation and Rehabilitation Robotics, Department of Neuroscience, IRCCS San Raffaele, via della Pisana, 235, 00163 Rome, Italy. E-mail: sanaz.pournajaf@sanraffaele.it

This is an open access article distributed under the terms of the Creative Commons CC BY-NC-ND license which allows users to copy and distribute the manuscript, as long as this is not done for commercial purposes and further does not permit distribution of the manuscript if it is changed or edited in any way, and as long as the user gives appropriate credits to the original author(s) and the source (with a link to the formal publication through the relevant DOI) and provides a link to the license. Full details on the CC BY-NC-ND 4.0 are available at https://creativecommons.org/licenses/by-nc-nd/4.0/.

ABSTRACT

BACKGROUND: The integration of innovative technologies in Physical and Rehabilitation Medicine (PRM) has significantly advanced patient care, enhancing functional recovery and optimizing rehabilitation processes. Despite growing clinical adoption, a translational gap persists between technological advancements and routine clinical implementation. This study aims to map the available evidence on rehabilitation technologies, identifying their applications, effectiveness, and existing limitations.

METHODS: A mapping review of systematic reviews was conducted to explore the role of technological innovations in PRM. A systematic search of the MEDLINE (PubMed) database was performed up to July 14th, 2024. Eligible studies were screened based on predefined inclusion and exclusion criteria. Data extraction focused on rehabilitation domains, technological interventions, target populations, and Health Technology Assessment (HTA) aspects.

RESULTS: Of 5124 identified records, 623 systematic reviews (12.2%) met the inclusion criteria. Neurological conditions represented the primary focus (56.8%), followed by musculoskeletal (23.7%) and cardiovascular rehabilitation (11.5%). The most frequently studied technologies included virtual reality (28.5%), non-invasive brain stimulation (18.7%), robotics (16.3%), and telerehabilitation (13.4%). Most studies assessed motor recovery (45%), pain management (22%), and cognitive or language rehabilitation (18%). Only 4.8% addressed HTA aspects such as cost-effectiveness and acceptability, highlighting a gap in real-world implementation studies.

CONCLUSIONS: This mapping review underscores the increasing interest in technology-assisted rehabilitation but also highlights critical gaps, particularly in HTA assessments and training for PRM specialists. Standardized guidelines, structured training programs, and economic evaluations are essential to optimize integrating rehabilitation technologies into clinical practice. Further research should focus on long-term efficacy, accessibility, and sustainability to ensure equitable access to innovative rehabilitation solutions.

(*Cite this article as:* Pournajaf S, Morone G, Straudi S, Paoletta M, Antonioni A, Franceschini M, *et al*. The adoption of innovative technologies in Physical and Rehabilitation Medicine: state of the art and unmet needs. Eur J Phys Rehabil Med 2026;62:119-26. DOI: 10.23736/S1973-9087.26.09138-0)

KEY WORDS: Physical and rehabilitation medicine; Rehabilitation; Virtual reality; Robotics; Telerehabilitation; Biomedical technology assessment.

Introduction

In recent years, the field of rehabilitation medicine has witnessed remarkable advancements through the application of innovative technological solutions designed to enhance patient functional recovery and optimize care processes. This evolution has been driven not only by the increasing availability of digital health tools and artificial intelligence (AI)-based solutions, but also by the growing global burden of disability. According to the latest Global Burden of Disease Study, musculoskeletal, neurological, and other disabling conditions remain among the leading causes of years lived with disability (YLDs) worldwide, highlighting the urgent need for effective, scalable, and patient-centered rehabilitation approaches.[1, 2]

The convergence of medicine and AI, described as "high-performance medicine," is reshaping the way health professionals design and deliver care, including in rehabilitation settings, by enabling more precise, adaptive, and personalized interventions.[3] For instance, deep learning approaches have shown significant promise in diagnostic classification and prognostic prediction in neurodegenerative diseases, such as Alzheimer's disease, based on neuroimaging data.[4] The increase in scientific publications regarding the implementation of technology in all rehabilitation settings reflects a growing pool of experience and highlights the ongoing shift towards evidence-based, technology-assisted rehabilitation paradigms.[5, 6]

In recent years, innovative and robotic technologies have gained popularity not only in academic and research hospitals, both public and private, but also in community rehabilitation facilities.[7, 8] This trend underscores the widespread clinical belief among Physical and Rehabilitation Medicine (PRM) specialists globally that the use of these devices plays a key role in enhancing neuroplasticity, motor recovery, and independence for patients with limitations and disabilities arising from various clinical and personal conditions.[9-13]

However, despite significant progress, a persistent translational gap remains between scientific advancements in technology and their integration into everyday clinical practice, as highlighted by a recent Consensus Conference on robotic treatment for neurological disabilities held in Italy.[14, 15] This discrepancy raises critical questions about these technological innovations' clinical applicability, regulatory frameworks, and economic sustainability within rehabilitation protocols. Key barriers include limited standardization of treatment protocols, heterogeneity in patient selection criteria, and insufficient training programs for healthcare providers.[16, 17] While prototype or experimental tools provide fertile ground for developing new and improved technologies, their transition from research to routine practice requires stringent validation through clinical trials and health technology assessments (HTA). Moreover, regulatory approval processes, such as CE marking in Europe and FDA clearance in the US, are critical to ensuring efficacy, safety, usability, and cost-effectiveness.[18, 19] Within the process of integrating technology into individualized rehabilitation programs, the role of the PRM specialist is crucial. However, this role is evolving, requiring clinical expertise and competence in technology assessment, data interpretation, and interdisciplinary collaboration with engineers and policymakers. Therefore, it is necessary to pay attention to the effectiveness of technologies and their impact on clinical workflows, economic sustainability, accessibility, and workforce training. Ensuring equitable access to technology-assisted rehabilitation is paramount, necessitating well-defined criteria for patient selection and reimbursement policies.[16, 17] In light of this scenario, this mapping review aims to evaluate technological adoption in rehabilitation medicine comprehensively. Specifically, it will analyze which types of technology are most widely implemented, for which disabling conditions they are utilized, and their effectiveness in achieving rehabilitation goals. Furthermore, it will explore existing limitations and identify critical gaps in integrating these innovations into conventional rehabilitation therapies.

The ultimate goal of this mapping review is to enhance the effectiveness of rehabilitation interventions by bridging the gap between innovation and clinical application. By identifying areas for improvement and addressing unmet needs, we aim to optimize rehabilitation outcomes, improve patient access to advanced treatments, and support healthcare professionals in adapting to the rapidly evolving landscape of technology-driven rehabilitation.

Methods

We performed a mapping analysis of systematic reviews to identify relevant literature on technology applications in Physical and Rehabilitation Medicine (PRM). The study protocol was registered in the 'Open Science Framework' (OSF, https://doi.org/10.17605/OSF.IO/SFW5P). Specifically, the included systematic reviews involved three main areas:

- effectiveness, to evaluate the impact of various technologies on rehabilitation outcomes, focusing on their

ability to improve body functions, activities, and participation across different patient populations;

• assessment, to identify technologies used to evaluate and/or monitor relevant measures in the field of PRM;

• health technology assessment (HTA), to analyze broader aspects such as cost-effectiveness, organizational implications, and the integration of these technologies within healthcare systems.

Literature search and selection criteria

The MEDLINE (via PubMed) electronic bibliographic database was searched for eligible articles from inception to July 14th, 2024. Specifically, the search strategy combined MeSH terms "tech*" and rehab* with Boolean operators to identify all eligible papers. Exclusion criteria were types of publications other than systematic reviews. The studies retrieved were listed in Ryyan (//rayyan.org, Rayyan Systems Inc, Qatar). In the first step, studies were selected by screening the titles and abstracts by five independent blinded reviewers (S.S., G.M., A.A., S.P., and M.P.), and duplicate studies were removed. In the second phase, full articles were reviewed by two blinded authors (S.S. and A.A.) for inclusion in this study. Disagreements were resolved by discussion or, when needed, by group meetings (involving G.M., S.P., M.P., I.C., F.G., and M.Z.) for final consensus.

Data collection

Two reviewers (A.A. and S.S.) independently extracted the data from a properly developed electronic spreadsheet. The following data were extracted from systematic reviews on the effectiveness of technology: year of publication, population, intervention, outcome. Moreover, we included systematic reviews related to HTA, such as acceptability, cost-effectiveness. Specifically, relevant data were defined as follows:

Population: the patient population was described according to a person-centered perspective, focusing on individuals' rehabilitation needs across different health conditions and life stages, rather than on rehabilitation specialties alone. Specifically, populations were classified based on two dimensions:

• rehabilitation needs: referring to functional limitations and participation restrictions requiring rehabilitation interventions, such as motor impairment, balance disorders, cognitive deficits, communication difficulties, chronic pain, reduced autonomy in activities of daily living, and psychosocial participation issues;

• health condition: referring to the underlying clinical diagnoses or health states (*e.g.*, neurological, musculoskeletal, cardiovascular, oncological, pediatric, or mixed conditions) associated with these rehabilitation needs. This approach allowed a more comprehensive and user-oriented representation of the target populations, aligned with the person-centered framework of PRM.

Intervention (type of technology): the technological tools or systems employed in rehabilitation interventions. These include a broad spectrum of modalities, such as virtual reality, central neuromodulation, peripheral neuromodulation (when combined with other technologies), vibration therapy, auditory stimulation, telerehabilitation, biofeedback, treatment based on the activity performed by the mirror neuron system, artificial intelligence, brain-computer interfaces (BCI), and robotic devices. In addition, tools designed explicitly for rehabilitating cognitive functions or to evaluate rehabilitation-related outcomes were classified as computer-assisted cognitive technologies or assessment technologies, respectively.

Definition of innovative technologies

For the purpose of this mapping review, *innovative technologies* were defined as digital, robotic, or technology-enhanced tools and systems applied in rehabilitation with the aim of supporting assessment, treatment, monitoring, or clinical decision-making processes beyond conventional face-to-face therapy. This definition acknowledges the temporal and contextual nature of innovation in rehabilitation, recognizing that technologies initially considered innovative in the past (*e.g.*, early computer-assisted therapies or basic robotic devices) may now represent established practices, whereas current innovations include more advanced solutions such as immersive virtual reality, artificial intelligence-based systems, brain–computer interfaces, wearable sensors, advanced robotics, and tele-rehabilitation platforms.

Accordingly, in this review, a technology was considered *innovative* if it introduced a significant technological component into the rehabilitation process, modifying traditional clinical pathways through automation, digitalization, remote delivery, intelligent feedback, or data-driven personalization of interventions.

Outcome: the targeted domains of rehabilitation, distinguishing between:

• body functions, which address impairments in specific physiological or psychological functions, including the upper and lower limb, language, swallowing, pelvic floor, muscle tone, pain, psychophysical well-being, and attention (such as neglect) impairments;

• activities and participation focus on enhancing functional performance and societal engagement. These include gait, balance, physical activity, activities of daily living (ADL), and quality of life (QoL);
• education, identifying technologies aimed at supporting self-management and education.

HTA: relevant data about cost-effectiveness, acceptability (including users' needs), and organization were collected.

Data synthesis

In line with the methodological approach of mapping reviews, no formal quality appraisal of the included systematic reviews was performed. The primary aim of this study was to map the breadth and distribution of the available evidence on innovative technologies in PRM, rather than to critically assess the methodological quality or risk of bias of individual studies. A qualitative synthesis approach was employed to integrate and summarize the findings of the systematic reviews included in this mapping analysis. The extracted data were categorized and analyzed to capture the breadth of technology applications within the field of PRM. Specifically, the synthesis emphasized the diversity of populations, interventions, and outcomes reported in the reviews. Findings were grouped into thematic domains, including the technologies used, their target rehabilitation areas, and their primary outcomes. In addition, data related to HTA were integrated to provide a comprehensive understanding of the impact and feasibility of these technologies in PRM. This qualitative approach allows for a nuanced exploration of the literature, highlighting gaps, emerging trends, and areas requiring further research, while accommodating the heterogeneity of the included studies.

Results

The mapping review identified 5124 records, of which 623 studies (12.2%) were included after title and abstract screening. These studies provided insights into the application of rehabilitation technologies across diverse populations and clinical conditions.

Regarding the population-based distribution, most studies (56.8%) focused on neurological conditions, including stroke, traumatic brain injury, and spinal cord injury (Figure 1). A smaller proportion addressed musculoskeletal conditions (23.7%), such as arthritis and post-operative orthopedic recovery. Cardiovascular conditions accounted for 11.5% of the included studies, while 8.0% focused on mixed or other rehabilitation-requiring conditions.

The technologies examined in the included studies were primarily focused on interventions such as virtual reality (28.5%), non-invasive brain stimulation (NIBS) techniques, including transcranial direct current stimulation (tDCS) and repetitive transcranial magnetic stimulation (rTMS) (18.7%), robotics (16.3%), and tele-rehabilitation (13.4%) (Figure 2). These technologies enabled intensive, task-specific, and tailored interventions across various rehabilitation contexts. Virtual reality and NIBS demonstrated particular efficacy in enhancing motor and cognitive

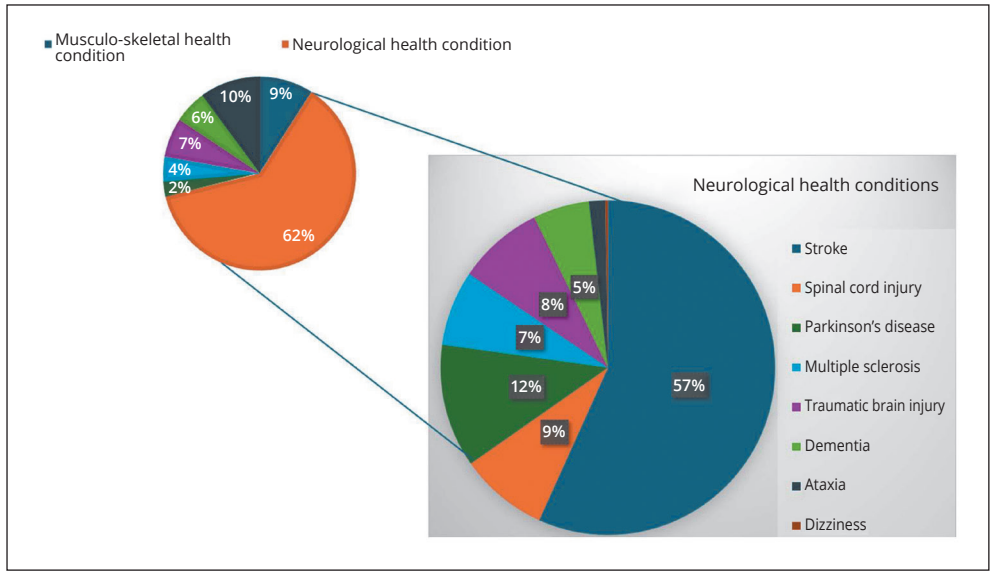


Figure 1.—Population-based distribution of included studies and representative conditions for technology use in neurological health conditions. Summary of various conditions, with a detailed focus on the neurological conditions most frequently addressed by rehabilitation technologies, including stroke, traumatic brain injury, and spinal cord injury.

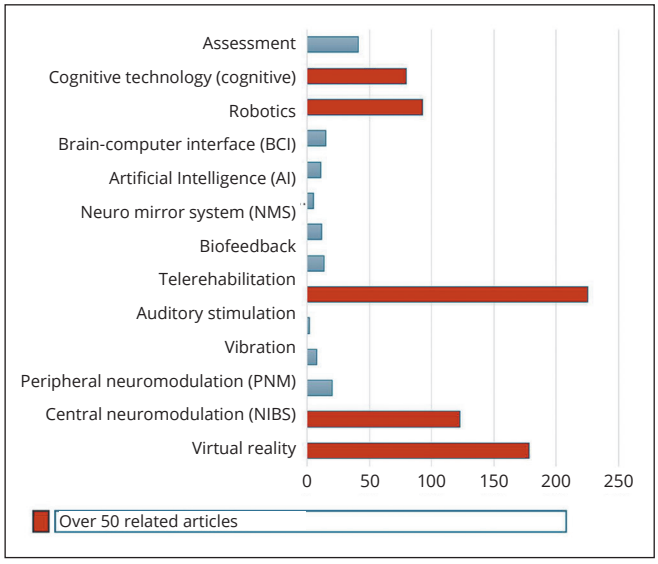


Figure 2.—Intervention-based distribution of included studies. Proportion of studies categorized by rehabilitation technology interventions, including virtual reality, non-invasive brain stimulation, robotics, and tele-rehabilitation.

recovery, while robotics and tele-rehabilitation expanded access to and intensity of care.

From an intervention-based perspective, virtual reality (28.5%) emerged as the most frequently explored technology, followed by non-invasive brain stimulation (NIBS) techniques (18.7%), robotics (16.3%), and tele-rehabilitation (13.4%). These technologies were applied across different rehabilitation domains, confirming their potential for personalized and targeted interventions.

Regarding rehabilitation outcomes, 45% of the studies focused on motor recovery, commonly assessed through standardized tools such as the Fugl-Meyer Assessment (Figure 3). Pain management was a key focus in 22% of the studies, addressing conditions such as chronic pain and phantom limb syndrome. Cognitive and language recovery were examined in 18% of the studies, with promising results for virtual reality and NIBS. Cost-effectiveness was explored in 15% of the studies, revealing that semi-immersive virtual reality and tele-rehabilitation were cost-effective interventions, while the economic benefits of robotics remained inconclusive.

Health technology assessment (HTA) was directly evaluated in 30 studies (4.8%), focusing on criteria such as acceptability, efficacy, cost-effectiveness, and organizational models (Table I). These findings emphasized the need to integrate user-centered designs to enhance accessibility and reduce social and cultural barriers.

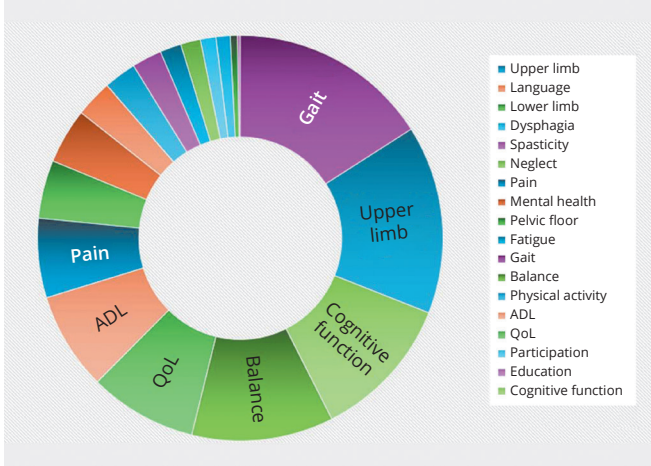


Figure 3.—Outcome-based distribution of included studies. Distribution of studies based on rehabilitation outcomes, including motor recovery, pain management, cognitive and language improvements, and cost-effectiveness evaluations.

TABLE I.—*Other aspects of health technology assessment.*

Field of interest	Topic	N. of articles found
Health technology assessment (N.=30; 4.8%)	Cost-effectiveness	12
	Acceptability	17
	Organization	1

These data highlight the escalating clinical interest in advanced rehabilitation technologies and its evolving in improving motor recovery, cognitive functions, and pain management. Figure 4 shows trends in the increasing interest and research output on rehabilitation technologies over time. At the same time, they underscore the need for specialized training for PRM specialists to ensure the effective integration of these technologies into clinical practice.

Discussion

The increasing adoption of rehabilitation technologies in recent years reflects the need for innovative and more accessible interventions for individuals with disabilities. The findings of this mapping review confirm that the most commonly used technologies are virtual reality, non-invasive brain stimulation, robotics, and tele-rehabilitation, with significant impacts on motor and cognitive recovery. These results align with recent literature highlighting the growing number of studies dedicated to these technologies (Figure 4).[14, 15]

The predominance of studies on neurological conditions aligns with clinical needs, where neuroplasticity is a key

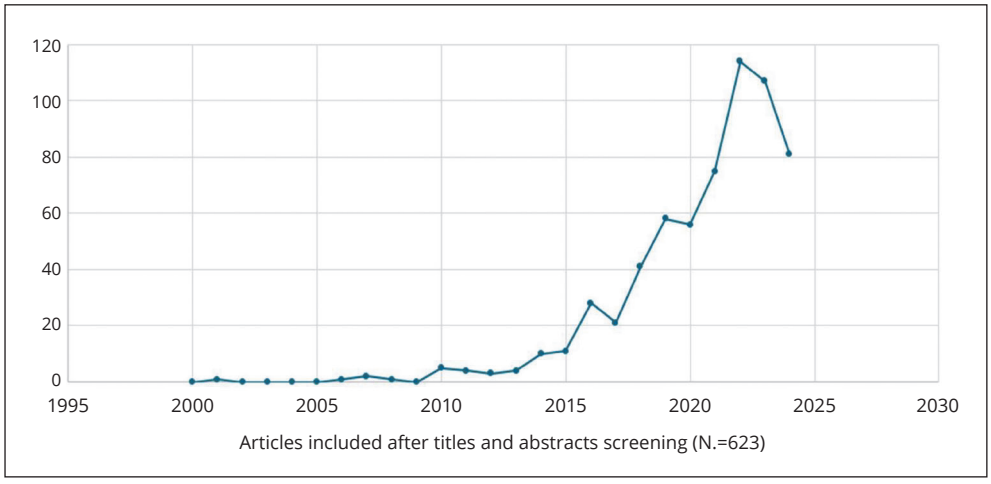


Figure 4.—Time-dependent evolution of interest in rehab technologies. Trends in the increasing interest and research output on rehabilitation technologies over time.

therapeutic target. However, the lower presence of studies on cardiovascular and musculoskeletal conditions raises concerns about the underutilization of these technologies in non-neurological rehabilitation settings (Figure 1).[17] Additionally, while some technologies, such as virtual reality and telerehabilitation, have demonstrated favorable cost-effectiveness profiles, robotics requires further studies to assess its long-term economic sustainability across different healthcare systems.[7, 8]

Another key issue is the need for training among PRM professionals. Literature suggests that the successful adoption of new technologies depends on their clinical effectiveness and healthcare providers' ability to use them optimally.[20, 21] Despite their proven efficacy and clinical relevance in various rehabilitation settings,[22] the absence of structured training programs for using technologies such as NIBS and robotics remains a significant barrier to large-scale integration.[10] This gap underscores the importance of aligning education and training pathways with formal European recommendations. The core curriculum proposed by the UEMS PRM Section and Board already identifies technological competencies as essential for the evolving role of PRM specialists in modern clinical practice.[19]

Finally, there is a need for further research in the field of HTA, as only a limited number of studies have comprehensively addressed the evaluation of effectiveness, safety, acceptability, and economic sustainability of rehabilitation technologies. The design of multicenter studies with rigorous methodologies, grounded in established frameworks for economic evaluation, is a crucial step in bridging these gaps and providing evidence-based guidelines for technological adoption in rehabilitation.[23] Studies such as ROBOTAS and TREAD_Stroke exemplify this approach, contributing to assessing advanced rehabilitation technologies in real-world clinical practice.[24, 25]

In summary, this mapping review highlights rehabilitation technologies' significant progress and potential to transform clinical practice. However, targeted strategies are needed to optimize implementation, improve healthcare providers' training, and ensure long-term sustainability within healthcare systems.[26, 27]

Limitations of the study

The limitations of this study include the heterogeneity of the included studies, as differences in study design, patient populations, and intervention protocols limit direct comparisons. This is consistent with concerns raised in the literature regarding the variable quality and potential redundancy in published systematic reviews.[26,27] Moreover, the lack of long-term follow-up makes it difficult to determine the lasting effects of the interventions. While virtual reality and telerehabilitation show promising cost-effectiveness, the financial sustainability of robotics remains unclear. Evidence from recent trials suggests that VR-based telerehabilitation can be effectively integrated into stroke care pathways with positive clinical and economic outcomes.[28] Nevertheless, real-world implementation data remain scarce for many other technologies, and few studies assess how these tools integrate into routine clinical practice. Selection bias is also a concern, with many studies focusing on neurological conditions while underrepresenting musculoskeletal and cardiovascular rehabilitation. Furthermore, there are gaps in training, as the need for PRM specialists to receive structured education on new technologies is often overlooked. Lastly, health technology assessment (HTA) remains incomplete, with few stud-

ies comprehensively evaluating the regulatory, economic, and organizational aspects of technology adoption.

Conclusions

Advanced rehabilitation technologies are transforming the PRM field, offering new therapeutic possibilities for individuals across various conditions, with a predominant focus on neurological, musculoskeletal, and cardiovascular rehabilitation. There is a strong need for structured training programs to ensure the effective use of technologies such as NIBS, VR, and robotics in clinical practice. Standardized clinical guidelines and regulatory frameworks are essential to support these technologies' large-scale adoption and reimbursement. Future research should focus on long-term efficacy, accessibility, and economic viability to justify wider implementation in healthcare systems. Multidisciplinary collaboration is key to integrating these innovations effectively into patient-centered rehabilitation programs. Additionally, the education and continuous professional development of PRM specialists will be fundamental in ensuring the effective implementation and assessment of these technologies, enabling them to optimize patient care and technological integration within clinical practice.

References

1. GBD 2021 Diseases and Injuries Collaborators. Global incidence, prevalence, years lived with disability (YLDs), disability-adjusted life-years (DALYs), and healthy life expectancy (HALE) for 371 diseases and injuries in 204 countries and territories and 811 subnational locations, 1990-2021: a systematic analysis for the Global Burden of Disease Study 2021. Lancet 2024;403:2133–61.

2. Cieza A, Causey K, Kamenov K, Hanson SW, Chatterji S, Vos T. Global estimates of the need for rehabilitation based on the Global Burden of Disease study 2019: a systematic analysis for the Global Burden of Disease Study 2019. Lancet 2021;396:2006–17.

3. Topol EJ. High-performance medicine: the convergence of human and artificial intelligence. Nat Med 2019;25:44–56.

4. Jo T, Nho K, Saykin AJ. Deep learning in Alzheimer's disease: diagnostic classification and prognostic prediction using neuroimaging data. Front Aging Neurosci 2019;11:220.

5. Zuccon G, Lenzo B, Bottin M, Rosati G. Rehabilitation robotics after stroke: a bibliometric literature review. Expert Rev Med Devices 2022;19:405–21.

6. He D, Cao S, Le Y, Wang M, Chen Y, Qian B. Virtual reality technology in cognitive rehabilitation application: bibliometric analysis. JMIR Serious Games 2022;10:e38315.

7. Capecci M, Gandolfi M, Straudi S, Calabrò RS, Baldini N, Pepa L, *et al.*; HTA section of SIMFER (Italian Society of Physical and Rehabilitation Medicine). Advancing public health through technological rehabilitation: insights from a national clinician survey. BMC Health Serv Res 2024;24:1626.

8. Capecci M, Gandolfi M, Straudi S, Calabrò RS, Baldini N, Pepa L, *et al.*; HTA section of SIMFER (Italian Society of Physical and Rehabilitation Medicine). Shaping the future: an Italian survey unveils the unmet need to empower physical medicine and rehabilitation professionals with technological skills. Eur J Phys Rehabil Med 2024;60:540–3.

9. Hillier S, Hordacre B. Technology-assisted stroke rehabilitation. Neurology 2020;95:761–2.

10. Feys P, Straudi S. Beyond therapists: technology-aided physical MS rehabilitation delivery. Mult Scler 2019;25:1387–93.

11. Laver KE, Lange B, George S, Deutsch JE, Saposnik G, Crotty M. Virtual reality for stroke rehabilitation. Cochrane Database Syst Rev 2017;11:CD008349.

12. Mehrholz J, Pohl M, Platz T, Kugler J, Elsner B. Electromechanical and robot-assisted arm training for improving activities of daily living, arm function, and arm muscle strength after stroke. Cochrane Database Syst Rev 2018;9:CD006876.

13. Mehrholz J, Thomas S, Kugler J, Pohl M, Elsner B. Electromechanical-assisted training for walking after stroke. Cochrane Database Syst Rev 2020;10:CD006185.

14. Turolla A, Kiper P, Mazzarotto D, Cecchi F, Colucci M, D'Avenio G, *et al.*; Italian Consensus Conference on Robotics in Neurorehabilitation (CICERONE). Reference theories and future perspectives on robot-assisted rehabilitation in people with neurological conditions: A scoping review and recommendations from the Italian Consensus Conference on Robotics in Neurorehabilitation (CICERONE). NeuroRehabilitation 2022;51:681–91.

15. Morone G, Riener R, Mazzoleni S. Integrating robot-assisted therapy into neurorehabilitation clinical practice: where are we now? Where are we heading? NeuroRehabilitation 2022;51:537–9.

16. Gutenbrunner C, Meyer T, Melvin J, Stucki G. Towards a conceptual description of physical and rehabilitation medicine. J Rehabil Med 2011;43:760–4.

17. Zampolini M, Selb M, Boldrini P, Branco CA, Golyk V, Hu X, *et al.*; UEMS-PRM Section and Board. The individual rehabilitation project as the core of person-centered rehabilitation: the Physical and Rehabilitation Medicine Section and Board of the European Union of Medical Specialists framework for rehabilitation in Europe. Eur J Phys Rehabil Med 2022;58:503–10.

18. Morone G, Claudia ME, Bonanno M, Ciancarelli I, Mazzoleni S, Calabrò RS. Breaking the ice through an effective translationality in neurorehabilitation: are we heading to the right direction? Expert Rev Med Devices 2024;21:999–1006.

19. European Union of Medical Specialists. UEMS European Training Requirements - Physical and Rehabilitation Medicine; 2023 [Internet]. Available from: https://www.uems.eu/european-training-requirements [cited 2026 Jan 19]

20. Calabrò RS, Sorrentino G, Cassio A, Mazzoli D, Andrenelli E, Bizzarini E, *et al.*; Italian Consensus Conference on Robotics in Neurorehabilitation (CICERONE). Robotic-assisted gait rehabilitation following stroke: a systematic review of current guidelines and practical clinical recommendations. Eur J Phys Rehabil Med 2021;57:460–71.

21. Gutenbrunner C, Lemoine F, Yelnik A, Joseph PA, de Korvin G, Neumann V, *et al.* The field of competence of the specialist in physical and rehabilitation medicine (PRM). Ann Phys Rehabil Med 2011;54:298–318.

22. Straudi S, Baroni A, Mele S, Craighero L, Manfredini F, Lamberti N, *et al.* Effects of a robot-assisted arm training plus hand functional electrical stimulation on recovery after stroke: a randomized clinical trial. Arch Phys Med Rehabil 2020;101:309–16.

23. Adamiak G. Methods for the economic evaluation of health care programmes. J Epidemiol Community Health 2006;60:822–3.

24. Calabrò RS, Morone G, Naro A, Gandolfi M, Liotti V, D'aurizio C, *et al.* Robot-assisted training for upper limb in stroke (ROBOTAS): an observational, multicenter study to identify determinants of efficacy. J Clin Med 2021;10:5245.

25. Pournajaf S, Calabrò RS, Naro A, Goffredo M, Aprile I, Tamburella F, *et al.*; TreadStroke Group. Robotic versus conventional overground gait training in subacute stroke survivors: a multicenter controlled clinical trial. J Clin Med 2023;12:439.

26. Ioannidis JP. The mass production of redundant, misleading, and conflicted systematic reviews and meta-analyses. Milbank Q 2016;94:485–514.

27. Moher D, Shamseer L, Clarke M, Ghersi D, Liberati A, Petticrew M, *et al.*; PRISMA-P Group. Preferred reporting items for systematic review and meta-analysis protocols (PRISMA-P) 2015 statement. Syst Rev 2015;4:1.

28. Chen J, Jin W, Zhang XX, Xu W, Liu XN, Ren CC. Telerehabilitation approaches for stroke patients: systematic review and meta-analysis of randomized controlled trials. J Stroke Cerebrovasc Dis 2015;24:2660–8.

Conflicts of interest
The authors certify that there is no conflict of interest with any financial organization regarding the material discussed in the manuscript.

Funding
The Research Activity of Sanaz Pournajaf is funded by the Italian Ministry of Health (Ricerca Corrente).

Data availability
No data are available because this study did not generate any datasets.

Ethical approval
The authors confirm that this article does not report any studies involving human participants conducted by the authors. The authors confirm that this article does not report any studies involving embryos, gametes, and human embryonic stem cells conducted by the authors. The authors confirm that this article does not report any studies involving animals conducted by the authors.

Authors' contributions
Sanaz Pournajaf, Giovanni Morone, and Alessandro Giustini have given substantial contributions to the conception and design of the manuscript. Sanaz Pournajaf, Giovanni Morone, Sofia Straudi, and Francesca Gimigliano contributed to the acquisition, analysis, and interpretation of the data, with the support of Marco Paoletta and Annibale Antonioni. Sanaz Pournajaf drafted the manuscript. Sofia Straudi, Marco Franceschini, Francesca Gimigliano, Mauro Zampolini, and Alessandro Giustini revised it critically for important intellectual content. All authors read and approved the final version of the manuscript.

History
Article first published online: May 12, 2026. - Manuscript accepted: April 8, 2026. - Manuscript revised: January 27, 2026. - Manuscript received: June 18, 2025.