



Editorial

Novel Approaches of Physical Therapy-Based Rehabilitation

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Special Issue

Novel Approaches of Physical Therapy-Based Rehabilitation

Edited by

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1. Introduction

The field of physical therapy and rehabilitation sciences is currently undergoing a profound transformation. This Special Issue, titled “Novel Approaches in Physical Therapy and Rehabilitation”, was conceived to bring together cutting-edge research and evidence-based practices that are redefining the discipline, promoting knowledge exchange across research, clinical, and academic communities.

The 13 published papers in this edition offer diverse perspectives on how technology and novel clinical strategies can improve functional outcomes across a wide range of populations.

2. Overview of Published Articles

The contributions to this Special Issue provide valuable insights into several key pillars of modern rehabilitation. These can be broadly categorized into three main areas: telerehabilitation, advanced technologies in rehabilitation, and holistic clinical interventions.

2.1. Telerehabilitation

Traditional models of rehabilitation usually require regular face-to-face interactions between patients and healthcare professionals for assessment, monitoring, and intervention. Although this approach offers clear benefits, the conventional rehabilitation method is not accessible or feasible for everyone. Worldwide, millions of people encounter either geographical, socioeconomic, or physical barriers that limit their access to adequate rehabilitation [1,2].

In this context, digital health has emerged as a promising alternative to expand healthcare access. Commonly defined as the use of information and communication technologies in healthcare, digital health can improve healthcare delivery and service coverage, and reinforce health promotion [3]. The WHO Global Health Strategy for Digital Health (2020–2025) recognizes the pivotal role of digital health in strengthening healthcare systems, addressing global health issues, and improving healthcare outcomes.

Telerehabilitation is one of the digital health strategies that deliver remote rehabilitation services through digital tools (smartphones, wearable devices, or virtual reality systems), allowing clinicians to conduct virtual consultations, monitor patient progress, and guide rehabilitation at a distance [4]. Despite the challenges associated with implementing telerehabilitation [5,6], it can represent an effective and even preferable treatment option for certain populations and particularly challenging contexts, such as during COVID-19 [7]. Two of the papers included in this Special Issue reinforce this approach by demonstrating the positive effects of telerehabilitation programs based on therapeutic exercise among home-office workers (Contribution 2) and of gamification for children with neurodevelopmental disabilities in war-affected Ukraine (Contribution 1). The positive effects were



Received: 20 February 2026

Accepted: 16 March 2026

Published: 19 March 2026

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expressed in improvements in both musculoskeletal and mental health domains in home-office workers and in mood, balance, and functional mobility in children with neurodevelopmental disabilities in war-affected Ukraine. Another paper included in this special study demonstrated the feasibility of gamification for postoperative hand mobilization (Contribution 3). In fact, similar benefits have been observed when comparing gamified interventions to conventional exercise programs across different post-surgical conditions, such as anterior cruciate ligament reconstruction (ACL) [8,9] and shoulder arthroscopy [10], suggesting the potential of this tool to extend rehabilitation beyond healthcare settings after surgery. By incorporating elements of reward and challenge, gamification can stimulate dopaminergic pathways in the brain, improving synaptic connections and facilitating learning through long-term potentiation [11]. This shows that, beyond demonstrating feasibility, therapy gamification may also increase patient motivation and engagement.

2.2. Advanced Technologies in Rehabilitation

Precision in diagnosis and therapy is increasingly supported by high-tech solutions, and Artificial Intelligence (AI) is gradually transforming the field of rehabilitation by enabling more data-driven, personalized, and effective approaches to patient care. Several key applications have already been identified, including the development of personalized treatment plans, the use of predictive analytics to support clinical decision-making, the implementation of remote monitoring systems, and advances in rehabilitation robotics [12].

Two of the studies included in this Special Issue demonstrate the advantages of these technologies in neurological rehabilitation. Rojek et al. (Contribution 4) demonstrated the suitability and superiority of Convolutional Neural Networks (CNNs) for capturing complex gait patterns and their potential for supporting clinical decision-making and planning personalized stroke rehabilitation. In a complementary area, Casanova et al. (Contribution 5) presented a gamified robotic framework for upper-limb rehabilitation that integrates kinematic and electromyography (EMG) metrics of different upper-limb muscles to monitor real-time performance and progress, with potential for exploration in patients with acquired brain injury (ABI). Both studies highlight the potential and shortcomings of these advanced technologies in rehabilitation.

Beyond neurological rehabilitation, technological advances are also expanding our understanding of neuromuscular control in musculoskeletal conditions. Vélez-Gutiérrez et al. (Contribution 6) conducted a scoping review examining functional and neuroplastic adaptations during ACL rehabilitation. Their findings suggest that unilateral training of the uninjured limb induces bilateral neuroplastic adaptations, representing a cost-effective strategy during early rehabilitation stages. Neuroplasticity refers to the brain's capacity to reorganize its structure and function in response to experiences, learning processes, or recovery from injury or disease [13]. Although it was once assumed that significant neuroplasticity occurred primarily during early development, research now shows that the brain retains this adaptive capacity throughout the lifespan [13]. These adaptive changes are fundamental for skill acquisition, rehabilitation, and healthy aging [14]. For these reasons, a deeper understanding of neuroplastic mechanisms is critical for designing targeted interventions that promote beneficial neuroplasticity while minimizing potentially harmful neural reorganization [15]. Supporting these findings, Mateus et al. (Contribution 7) used advanced three-dimensional motion capture systems to identify persistent interlimb asymmetries in kinetic and muscle-level variables up to 9 months after ACL reconstruction during drop-jump tasks, revealing long-lasting neuromuscular adaptations. In the context of injury prevention, Tedeschi et al. (Contribution 8) emphasized the role of high-speed sprint training in enhancing hamstring tissue resilience. They advocated integrating it with eccentric strengthening protocols to reduce injury risk.

Overall, the integration of AI, robotics, and advanced biomechanical analysis has the potential to improve the delivery of care by offering flexible, tailored, and highly effective treatment interventions [4,16]. These technologies enable clinicians not only to monitor performance with greater precision but also to better understand the neurophysiological mechanisms underlying recovery. By combining data-driven approaches with insights into neuroplasticity and neuromuscular control, rehabilitation can evolve toward more adaptive, individualized, and mechanism-based interventions that improve patient engagement, satisfaction, and long-term clinical outcomes [12].

2.3. Clinical Interventions and Holistic Care

Holistic health incorporates multiple dimensions of well-being, including physical, mental, social, emotional, and spiritual health [17]. Within this framework, rehabilitation should be understood not only as a process of restoring physical function but also as an opportunity to promote broader well-being. Physiotherapy, in particular, can positively influence physical, mental, and social health outcomes among individuals with mental health conditions [18].

Despite the evidence, rehabilitation programs have traditionally focused primarily on physical recovery, often overlooking the psychological and social dimensions of health, posing a significant risk for long-term mental health issues and overall rehabilitation outcomes [19,20]. While restoring physical function remains crucial, rehabilitation must consider well-being as a central component, addressing emotional and social aspects as well.

A meta-analysis of rehabilitation programs found that programs incorporating psychological and social support strategies reported significantly better long-term mental health outcomes (GBD 2021 Diseases and Injuries Collaborators [21]). These findings reinforce the need for rehabilitation models to shift from a physical restoration to a more comprehensive, integrated model in which well-being is viewed as an integral part of recovery [22].

Several studies focused on specific populations and the psychosocial dimensions of health. Morais et al. (Contribution 9) highlighted the effectiveness of a structured group exercise and relaxation plan, which fosters body awareness and exercise physiology, and its role in promoting well-being, directly encouraging self-care and thus improving the health literacy intervention program in improving the health literacy of informal caregivers of children with special needs. Carcelén-Fraile et al. (Contribution 12) performed a meta-analysis confirming the positive impact of aerobic training on the mental health of children and adolescents, particularly in reducing stress and enhancing self-esteem. Finally, Golec et al. (Contribution 13) investigated diaphragmatic therapy, revealing its potential to reduce resting pelvic floor muscle activity and alleviate emotional stress in women. In oncology, de Hoop et al. (Contribution 10) explored physiotherapists' perspectives on exercise immunology, emphasizing the need for tailored training to support the immune function of cancer patients. Oncology physiotherapists recognized the potential value of incorporating knowledge of exercise immunology to better tailor training and inform patients about the health benefits of exercise. They were eager to learn more about the topic. For post-surgical recovery, Guerero et al. (Contribution 11) evaluated adhesive elastic taping after saphenectomy, noting significant benefits in ecchymosis control, skin elasticity, and functional recovery against conventional post-surgical treatment.

3. Conclusions

The research presented in this Special Issue confirms that the future of physical therapy lies in the synergy between technological innovation and personalized clinical reasoning. From the use of AI for diagnostics to health literacy to support the vital role of informal caregivers and patients, these findings underscore that modern rehabilitation must be

both interdisciplinary and adaptable. We hope this collection serves as a benchmark for clinicians and researchers, inspiring further innovations that enhance the quality of life and functional independence of diverse patient populations.

Author Contributions: Conceptualization, A.N., A.S.P.S. and A.F.; investigation, A.N., A.S.P.S., A.F.; writing—original draft preparation, A.N., A.S.P.S. and A.F.; writing—review and editing, A.N., A.S.P.S. and A.F. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Acknowledgments: The Guest Editors would like to thank all the authors for their innovative contributions and the reviewers for their rigorous work and constructive feedback, which ensured the high scientific quality of this first edition.

Conflicts of Interest: The authors declare no conflicts of interest.

List of Contributions

1. Kushnir, A.; Kachmar, O.; Bonnechère, B. Feasibility and Perceptions of Telerehabilitation Using Serious Games for Children with Disabilities in War-Affected Ukraine. *Appl. Sci.* **2025**, *15*, 8526.
2. Szilágyi, T.; Veres-Balajti, I.; Lukács, B.; Király, E.; Laczkó, A.M.; Jenei, Z. Pilot Study of an Online Exercise Therapy Programme for Home Office Workers in Terms of Musculoskeletal and Mental Health. *Appl. Sci.* **2025**, *15*, 10963.
3. Abdallah, H.B.; Tennler, J.; Seelmann, C.; Haverkamp, V.; Schmitz, C.; Homann, H.H.; Ohmann, T. Does a Novel Gamification Approach Improve Hand Function in Patients Undergoing Rehabilitation? A Mono-Centric Randomized Controlled Trial. *Appl. Sci.* **2026**, *16*, 987.
4. Rojek, I.; Mikołajewska, E.; Małolepsza, O.; Kozielski, M.; Mikołajewski, D. Comparative Analysis of Different AI Approaches to Stroke Patients' Gait Analysis. *Appl. Sci.* **2025**, *15*, 10896.
5. Casanova, A.; Sempere, N.; Romero, C.; Porcel, K.; Ubeda, A.; Jara, C.A. A Robotic Gamified Framework for Upper-Limb Rehabilitation. *Appl. Sci.* **2025**, *15*, 11007.
6. Vélez-Gutiérrez, J.M.; Rojas-Jaramillo, A.; Ascuntar-Viteri, J.D.; Quintero, J.D.; García-Muro San José, F.; Bazuelo-Ruiz, B.; Cannataro, R.; Bonilla, D.A. Functional and Neuroplastic Effects of Cross-Education in Anterior Cruciate Ligament Rehabilitation: A Scoping Review with Bibliometric Analysis. *Appl. Sci.* **2025**, *15*, 8641.
7. Mateus, R.B.; Cabral, S.; Richter, C.; Veloso, A.P. Between-Limb Asymmetry Assessment During a Double-Leg Drop Jump Task After Anterior Cruciate Ligament Reconstruction—A Musculoskeletal Modelling Approach. *Appl. Sci.* **2025**, *15*, 12347.
8. Tedeschi, R.; Giorgi, F.; Donati, D. Sprint Training for Hamstring Injury Prevention: A Scoping Review. *Appl. Sci.* **2025**, *15*, 9003.
9. Morais, S.; Pimenta, R.E.; Morais, C.; Macedo, R.; Ribeiro, I.; Ferreira, P.L. Effectiveness of an Intervention Program for Informal Carers of Children Admitted to a Rehabilitation Centre. *Appl. Sci.* **2025**, *15*, 8544.
10. De Hoop, A.M.S.; Jäger, K.; Dronkers, J.J.; Veenhof, C.; Ruurda, J.P.; Krul, C.A.M.; Pieters, R.H.H.; Valkenet, K. Perspectives of Physiotherapists on Immune Functioning in Oncological Rehabilitation in the Netherlands: Insights from a Qualitative Study. *Appl. Sci.* **2025**, *15*, 8673.
11. Guerero, R.M.; Zordão, C.C.; Zampieri, E.H.S.; Noites, A.; Guirro, E.C.d.O. Effect of Taping on Postoperative Recovery Following Saphenectomy. *Appl. Sci.* **2025**, *15*, 9227.
12. Carcelén-Fraile, M.d.C.; Aibar-Almazán, A.; Hita-Contreras, F. Aerobic Training on Mental Health in Children and Adolescents: A Systematic Review with Meta-Analysis. *Appl. Sci.* **2025**, *15*, 9572.
13. Golec, J.; Gamrot, S.; Michalik, M.; Sulowska-Daszyk, I.; Nowak, M.; Balicka-Bom, J. Effects of Diaphragmatic Therapy on Pelvic Floor Muscle Activity, Stress Levels, and Sexual Life Satisfaction in Polish Women. *Appl. Sci.* **2025**, *15*, 12055.

References

1. Andrade, R.M.; Santana, B.G.; Schmidt, A.V.; Barsotti, C.E.; Baroni, M.P.; Saragiotto, B.T.; Ribeiro, A.P. Effect of traditional rehabilitation programme versus telerehabilitation in adolescents with idiopathic scoliosis during the COVID-19 pandemic: A cohort study. *J. Rehabil. Med.* **2024**, *56*, jrm5343. [[CrossRef](#)]

2. McMaughan, D.J.; Oloruntoba, O.; Smith, M.L. Socioeconomic Status and Access to Healthcare: Interrelated Drivers for Healthy Aging. *Front. Public Health* **2020**, *8*, 231. [CrossRef]
3. Ahmed, M.M.; Okesanya, O.J.; Olaleke, N.O.; Adigun, O.A.; Adebayo, U.O.; Oso, T.A.; Eshun, G.; Lucero-Prisno, D.E., 3rd. Integrating Digital Health Innovations to Achieve Universal Health Coverage: Promoting Health Outcomes and Quality Through Global Public Health Equity. *Healthcare* **2025**, *13*, 1060. [CrossRef] [PubMed]
4. Calabrò, R.S.; Mojdehdehbaheer, S. AI-Driven Telerehabilitation: Benefits and Challenges of a Transformative Healthcare Approach. *AI* **2025**, *6*, 62. [CrossRef]
5. Leochico, C.F.D.; Espiritu, A.I.; Ignacio, S.D.; Mojica, J.A.P. Challenges to the Emergence of Telerehabilitation in a Developing Country: A Systematic Review. *Front. Neurol.* **2020**, *11*, 1007. [CrossRef] [PubMed]
6. Rabanifar, N.; Abdi, K. Barriers and Challenges of Implementing Telerehabilitation: A Systematic Review. *Iran. Rehabil. J.* **2021**, *19*, 121–128. [CrossRef]
7. Matsumoto, M.E.; Wilske, G.C.; Tapia, R. Innovative approaches to delivering telehealth. *Phys. Med. Rehabil. Clin. N. Am.* **2021**, *32*, 451–465. [CrossRef]
8. Clausen, J.D.; Nahen, N.; Horstmann, H.; Lasch, F.; Krutsch, W.; Krettek, C.; Weber-Spickschen, T.S. Improving maximal strength in the initial postoperative phase after anterior cruciate ligament reconstruction surgery: Randomized controlled trial of an app-based serious gaming approach. *JMIR Serious Games* **2020**, *8*, e14282. [CrossRef]
9. McClincy, M.; Seabol, L.G.; Riffitts, M.; Ruh, E.; Novak, N.E.; Wasilko, R.; Hamm, M.E.; Bell, K.M. Perspectives on the gamification of an inter-active health technology for postoperative rehabilitation of pediatric anterior cruciate ligament reconstruction: User-centered design approach. *JMIR Serious Games* **2021**, *9*, e27195. [CrossRef]
10. Marley, W.D.; Barratt, A.; Pigott, T.; Granat, M.; Wilson, J.D.; Roy, B. A multicenter randomized controlled trial comparing gamification with remote monitoring against standard rehabilitation for patients after arthroscopic shoulder surgery. *J. Shoulder Elb. Surg.* **2022**, *31*, 8–16. [CrossRef]
11. Janssen, J.; Verschuren, O.; Renger, W.J.; Ermers, J.; Ketelaar, M.; van Ee, R. Gamification in Physical Therapy: More Than Using Games. *Pediatr. Phys. Ther.* **2017**, *29*, 95–99. [CrossRef] [PubMed]
12. World Health Organization. Global Strategy on Digital Health 2020–2025. Licence: CC BY-NC-SA 3.0 IGO. 2021. Available online: <https://www.who.int/docs/default-source/documents/gsd4dhdaa2a9f352b0445bafbc79ca799dce4d.pdf> (accessed on 2 March 2026).
13. Gazerani, P. The neuroplastic brain: Current breakthroughs and emerging frontiers. *Brain Res.* **2025**, *1858*, 149643. [CrossRef] [PubMed]
14. Marzola, P.; Melzer, T.; Pavesi, E.; Gil-Mohapel, J.; Brocardo, P.S. Exploring the role of neuroplasticity in development, aging, and neurodegeneration. *Brain Sci.* **2023**, *13*, 1610. [CrossRef] [PubMed]
15. Hu, X.; Xu, W.; Ren, Y.; Wang, Z.; He, X.; Huang, R.; Ma, B.; Zhao, J.; Zhu, R.; Cheng, L. Spinal cord injury: Molecular mechanisms and therapeutic interventions. *Signal Transduct. Target. Ther.* **2023**, *8*, 245. [CrossRef]
16. Rahman, S.; Sarker, S.; Haque, A.K.M.N.; Uttsha, M.M.; Islam, M.F.; Deb, S. AI-driven stroke rehabilitation systems and assessment: A systematic review. *IEEE Trans. Neural Syst. Rehabil. Eng.* **2023**, *31*, 192–207. [CrossRef]
17. Mikkelsen, K.; Stojanovska, L.; Polenakovic, M.; Bosevski, M.; Apostolopoulos, V. Exercise and mental health. *Maturitas* **2017**, *106*, 48–56. [CrossRef]
18. Vancampfort, D.; Probst, M.; Helvik Skjaerven, L.; Catalán-Matamoros, D.; Lundvik-Gyllensten, A.; Gómez-Conesa, A.; Ijntema, R.; De Hert, M. Systematic review of the benefits of physical therapy within a multidisciplinary care approach for people with schizophrenia. *Phys. Ther.* **2012**, *92*, 11–23. [CrossRef]
19. Kirkbride, J.B.; Anglin, D.M.; Colman, I.; Dykxhoorn, J.; Jones, P.B.; Patalay, P.; Pitman, A.; Soneson, E.; Steare, T.; Wright, T.; et al. The social determinants of mental health and disorder: Evidence, prevention and recommendations. *World Psychiatry* **2024**, *23*, 58–90. [CrossRef]
20. Richardson, C.R.; Franklin, B.; Moy, M.L.; Jackson, E.A. Advances in rehabilitation for chronic diseases: Improving health outcomes and function. *BMJ* **2019**, *365*, 12191. [CrossRef]
21. 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*, 2133–2161. [CrossRef]
22. Marques, L.M.; Battistella, L.R. Well-being as a core element of rehabilitation: Preventing mental health challenges in a global context. *Glob. Health J.* **2025**, *9*, 1–5. [CrossRef]

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