Review Article

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Low-Cost Assistive and Rehabilitation Devices: Practical Solutions for Stroke and Disability Care: Literature Review

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ABSTRACT

Background: Stroke and other disabling conditions are leading contributors to long-term morbidity worldwide, imposing significant functional, psychosocial, and economic burdens. Survivors often face persistent motor, cognitive, and communication impairments that require prolonged rehabilitation, which remains largely inaccessible in low- and middle-income countries due to high costs and limited healthcare infrastructure.

Importance: Affordable and low-cost assistive and rehabilitation devices offer a practical solution to bridge this gap, promoting independence, functional recovery, and social reintegration for patients in resource-constrained settings.

Aim and Scope: This review aims to systematically evaluate the types, clinical effectiveness, implementation strategies, and technological innovations in low-cost assistive and rehabilitation devices, with a focus on their applicability in low-resource environments.

Key Findings: Evidence suggests that mobility aids, upper and lower limb devices, communication tools, and home-based technologies significantly improve activities of daily living, mobility, and quality of life. Technological innovations, including 3D printing, smartphone applications, and simplified robotics, enhance accessibility and cost-effectiveness. Successful implementation depends on community-based rehabilitation, cultural acceptance, policy support, and multidisciplinary collaboration.

Implications: Integrating affordable rehabilitation devices into clinical practice and national programs can reduce disability burden, optimize healthcare resources, and empower patients and caregivers, especially in low-resource settings. Future research should address long-term effectiveness, standardization, and culturally tailored solutions.

Keywords: Low-Cost Rehabilitation; Assistive Devices; Stroke Recovery; Disability Care; Community-Based Rehabilitation; 3D Printing; Tele-Rehabilitation

Abbreviations: DALYs: Disability-Adjusted Life Years; LMICs: Low- And Middle-Income Countries; ADLs: Activities of Daily Living; CBR: Community-Based Rehabilitation; AFOs: Ankle-Foot Orthoses

Introduction

Global Burden of Stroke and Disability

Stroke remains one of the leading causes of death and long-term disability worldwide, affecting millions of individuals annually. Over the past three decades, the absolute number of stroke cases has increased due to population aging, lifestyle changes, and the growing prevalence of vascular risk factors such as hypertension, diabetes, and obesity. Despite improvements in acute stroke management, a substantial proportion of survivors experience persistent physical, cognitive, and psychological impairments that require prolonged rehabilitation and supportive care. Stroke contributes significantly to disability-adjusted life years (DALYs), reflecting both premature mortality and years lived with disability, thereby placing a considerable burden on healthcare systems and caregivers globally. Importantly, approximately 70–80% of stroke cases and related deaths occur in low- and middle-income countries (LMICs), where limited healthcare resources, delayed diagnosis, and inadequate rehabilitation services exacerbate functional outcomes and societal impact [1-3] (Figure 1).

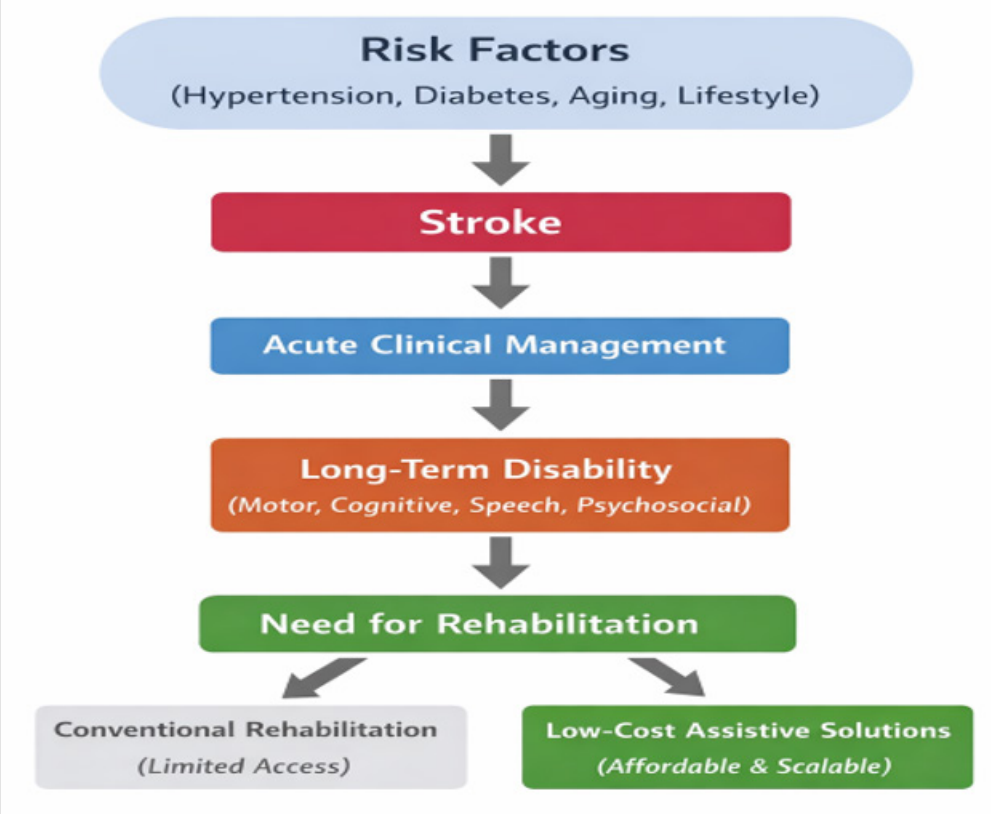

Figure 1.

Challenges in Conventional Rehabilitation

Conventional stroke rehabilitation often relies on advanced technologies such as robotic therapy devices, computerized gait trainers, and specialized neuro-rehabilitation programs. While these interventions have demonstrated clinical benefits, their high cost restricts availability, particularly in resource-limited settings. Furthermore, specialized rehabilitation centers are usually concentrated in urban areas, making access difficult for rural populations. Many LMICs also face severe shortages of trained physiotherapists, occupational therapists, and speech-language specialists, further limiting rehabilitation coverage. Infrastructure constraints, including inadequate transportation systems and insufficient rehabilitation equipment, contribute to delayed or incomplete recovery for many stroke survivors [4,5].

Rationale for Low-Cost Assistive Technologies

The growing global burden of disability has created an urgent demand for affordable and scalable rehabilitation solutions. Low-cost assistive technologies, including locally manufactured orthoses, simple mechanical rehabilitation tools, and mobile health applications, offer practical alternatives to expensive conventional systems. These

devices are often designed using locally available materials and can be adapted to cultural and socioeconomic contexts. By facilitating early and continuous rehabilitation, such technologies can enhance functional independence, improve mobility, and promote social reintegration. Additionally, low-cost solutions can empower caregivers and community health workers to participate actively in rehabilitation, thereby extending care beyond hospital settings [6,7] (Figure 2).

Figure 2.

Objectives of the Review

This review aims to systematically evaluate the types, clinical effectiveness, and implementation strategies of low-cost assistive and rehabilitation devices for stroke and disability care, with particular emphasis on their applicability in resource-constrained environments.

Methodology

Literature Search Strategy

A comprehensive literature search was conducted across PubMed, Scopus, Web of Science, and Google Scholar to identify relevant studies on low-cost assistive and rehabilitation devices. Keywords and MeSH terms included combinations of "stroke rehabilitation," "assistive technology," "low-cost devices," and "disability care." Studies published in English between 2005 and 2025 were included. Articles lacking clinical relevance, duplicate publications, and non-peer-reviewed sources were excluded, following systematic review standards [8,9].

Study Selection and Data Extraction

Studies were screened through title, abstract, and full-text review. Data on device type, clinical outcomes, and implementation feasibility were extracted. Methodological quality was assessed using validated appraisal frameworks to ensure reliability and bias reduction [9,10].

Classification of Low-Cost Assistive and Rehabilitation Devices

Mobility Assistive Devices

Mobility aids form the foundation of post-stroke rehabilitation, helping patients regain independence and prevent complications such as falls and muscle atrophy. Low-cost wheelchairs and walkers, often produced using lightweight and locally available materials, have

improved accessibility in resource-constrained regions. Locally fabricated orthotic and prosthetic devices, designed through community-based rehabilitation programs, provide customized support at a fraction of the cost of imported products. Additionally, modified walking aids, including bamboo or metal-framed supports and adaptive crutches, offer practical and culturally acceptable mobility solutions in many LMICs [6,7].

Upper Limb Rehabilitation Devices

Upper limb impairment is common after stroke and significantly affects daily activities. Simple mechanical hand rehabilitation devices, such as spring-loaded finger exercisers and pulley-based systems, help improve motor strength and coordination. Elastic resistance-based rehabilitation tools, including therapy bands and grip trainers, are widely used due to their affordability and ease of use. Recent advances in 3D printing have enabled the development of low-cost assistive gloves and splints, which enhance hand function and allow personalized fitting, thereby improving patient adherence and rehabilitation outcomes [11,12].

Lower Limb Rehabilitation Devices

Lower limb rehabilitation focuses on restoring balance and gait stability. Low-cost ankle-foot orthoses (AFOs), often manufactured using thermoplastics or locally sourced materials, help correct foot drop and improve walking efficiency. Mechanical gait training devices, such as parallel bars and simple treadmill adaptations, allow repetitive training without expensive robotic systems. Locally manufactured braces and limb supports provide structural stability and are particularly beneficial in settings where advanced rehabilitation technologies are unavailable [13].

Communication and Cognitive Rehabilitation Aids

Stroke survivors frequently experience speech and cognitive impairments that hinder social interaction and independence. Smartphone-based rehabilitation applications provide guided speech exercises, cognitive training programs, and remote monitoring. Low-cost speech therapy tools, including picture boards and digital voice-assisted communication aids, help patients with aphasia communicate effectively. Memory and cognitive training aids, such as interactive mobile games and structured activity booklets, support cognitive recovery and patient engagement [14].

Home-Based Rehabilitation Devices

Home-based rehabilitation devices play a crucial role in ensuring continuity of care. Do-it-yourself (DIY) rehabilitation kits, often assembled using simple mechanical components, enable patients to perform exercises independently. Household item-based therapeutic adaptations, such as using water bottles as weights or towels for resistance exercises, provide practical alternatives to formal equipment. Telerehabilitation technologies, including video-based physiotherapy sessions and mobile monitoring platforms, further expand access to rehabilitation services, particularly for patients living in remote areas [6,15].

Technological Innovations in Affordable Rehabilitation

3D Printing and Open-Source Designs

Three-dimensional (3D) printing has emerged as a transformative approach in affordable rehabilitation by enabling rapid prototyping and personalized device fabrication. Using open-source designs, clinicians and engineers can customize splints, orthoses, and assistive tools according to individual anatomical and functional needs. This approach significantly improves accessibility, particularly in regions where conventional manufacturing and supply chains are limited. Importantly, 3D printing reduces production costs, minimizes material waste, and allows local fabrication, making large-scale deployment feasible in low-resource settings. Open-source repositories further support scalability by facilitating global knowledge sharing and continuous design improvements [16,17].

Smartphone and Wearable Technologies

The widespread availability of smartphones has accelerated the adoption of mobile-based rehabilitation solutions. Smartphone applications provide structured exercise guidance, real-time feedback, and motivational support, enabling patients to continue therapy outside clinical environments. Wearable sensors, including accelerometers and gyroscopes, allow objective monitoring of movement patterns, exercise adherence, and functional recovery. These technologies support remote supervision by healthcare providers, reducing the need for frequent hospital visits while maintaining rehabilitation quality. Their relatively low cost and ease of integration make them particularly suitable for long-term stroke care [18,19].

Robotics and Semi-Automated Devices

Although traditional robotic rehabilitation systems are often expensive, simplified robotic and semi-automated devices are increasingly being developed as cost-effective alternatives. Basic robotic exoskeletons and motor-assisted training devices focus on essential repetitive movements rather than complex automation, thereby reducing costs while retaining therapeutic benefits. Affordable motorized rehabilitation tools, such as powered hand or ankle trainers, support intensive task-oriented therapy and can be used in both clinical and home settings. These innovations offer a balanced approach between technological assistance and affordability, expanding rehabilitation access for underserved populations [20,21] (Figure 3).

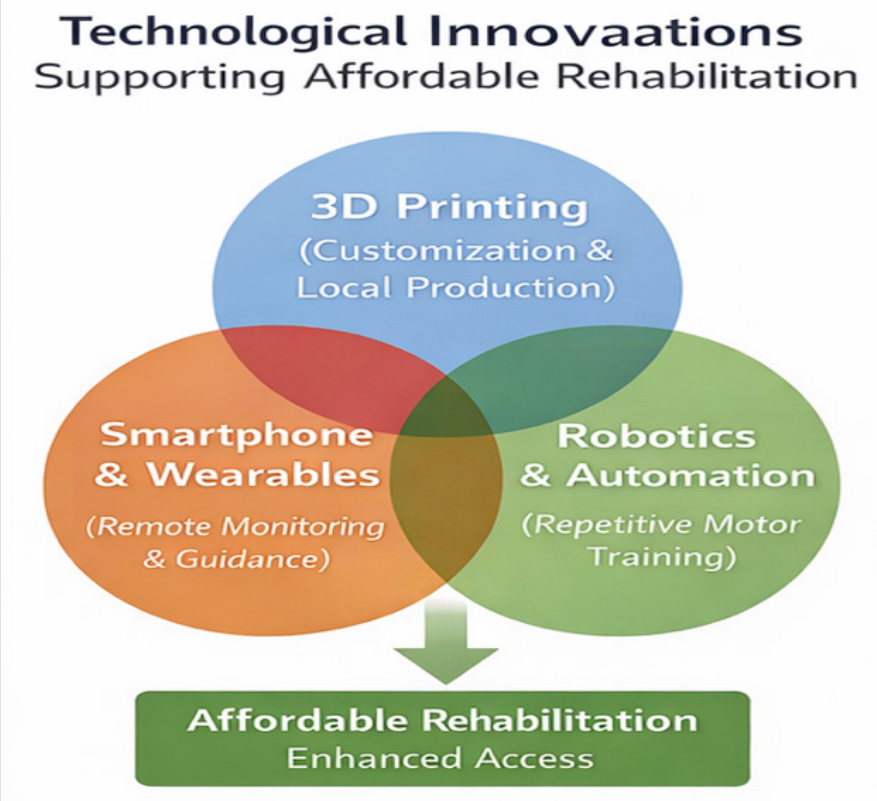

Figure 3.

Clinical Effectiveness and Patient Outcomes

Functional Recovery and Independence

Low-cost assistive and rehabilitation devices have demonstrated meaningful contributions to functional recovery among stroke survivors. These devices support repetitive and task-oriented exercises that are essential for neuroplasticity and motor relearning. Studies have shown that consistent use of affordable rehabilitation tools improves activities of daily living (ADLs), such as feeding, dressing, and personal hygiene, thereby promoting patient independence. Mobility outcomes also improve with the use of supportive orthoses, walking aids, and home-based exercise equipment, which help restore gait stability and limb coordination, ultimately reducing long-term disability [4,22].

Quality of Life and Psychosocial Benefits

Beyond physical recovery, accessible rehabilitation devices positively influence emotional well-being and social participation. Patients using simple and affordable assistive tools often report higher satisfaction due to ease of use and the ability to continue therapy at home. Improved functional capacity enhances confidence and encourages active community engagement. Additionally, family involvement in home-based rehabilitation strengthens caregiver support and reduces feelings of isolation commonly experienced by stroke survivors, contributing to better psychosocial adjustment and adherence to therapy programs [23].

Cost-Effectiveness Analysis

Economic evaluations suggest that low-cost rehabilitation technologies provide substantial value, particularly in resource-limited healthcare systems. Affordable devices reduce the need for prolonged hospital stays and repeated institutional rehabilitation sessions. Early functional recovery facilitated by these interventions lowers the risk of complications such as falls, contractures, and recurrent hospitalizations. Over time, these benefits translate into reduced healthcare expenditure and improved workforce participation, highlighting the long-term economic advantages of integrating low-cost assistive technologies into stroke rehabilitation strategies [5,6] (Figure 4).

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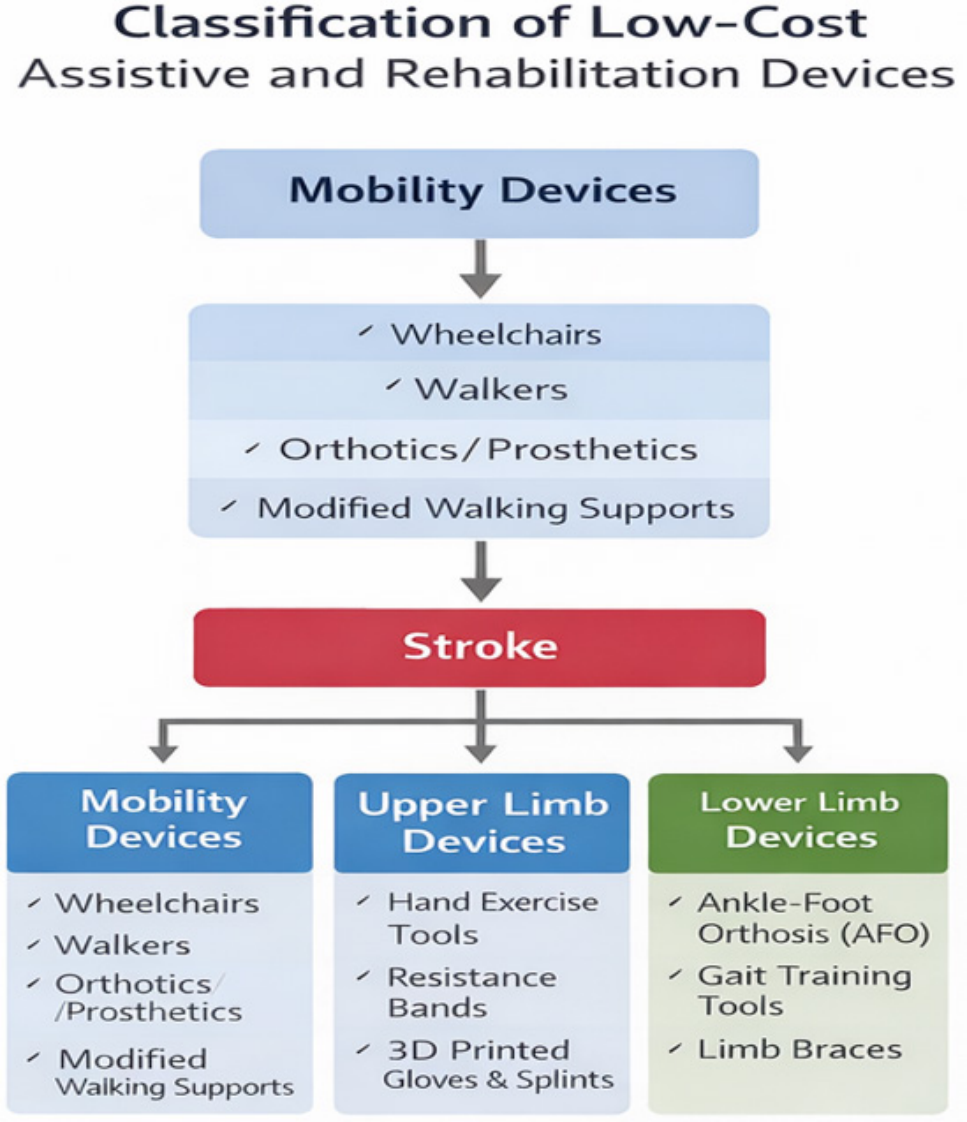

Figure 4.

Implementation in Low-Resource Settings

Role of Community-Based Rehabilitation (CBR)

Community-based rehabilitation plays a central role in extending stroke and disability care to underserved populations. By involving community health workers, rehabilitation services can be delivered closer to patients' homes, ensuring continuity of care and early functional training. These workers act as a bridge between healthcare facilities and communities, providing basic therapy guidance, monitoring progress, and encouraging adherence. Family-centered rehabilitation further strengthens outcomes, as caregivers are trained to assist with daily exercises and functional activities, fostering a supportive and sustainable rehabilitation environment [24,25] (Figure 5).

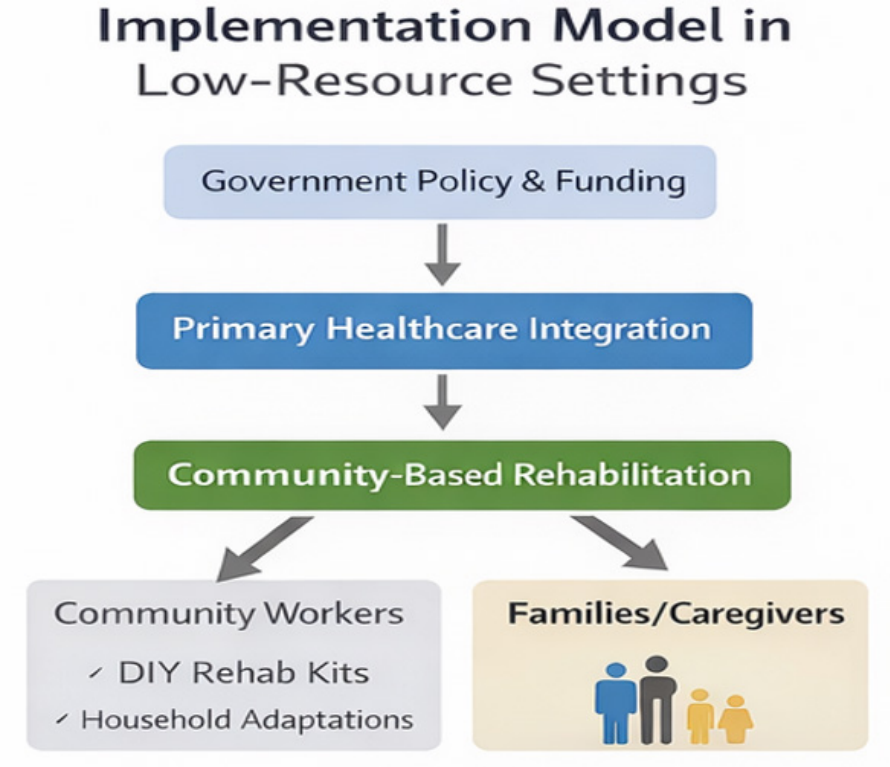

Figure 5.

Cultural and Socioeconomic Considerations

The success of low-cost assistive technologies largely depends on cultural acceptance and practical usability. Devices that align with local customs, daily routines, and physical environments are more likely to be adopted and used consistently. Socioeconomic constraints also necessitate affordable solutions that can be maintained without specialized resources. Local manufacturing using readily available materials not only reduces costs but also promotes sustainability, skill development, and community ownership, ensuring long-term availability of assistive devices [7].

Policy and Governmental Support

Strong policy frameworks are essential for scaling low-cost rehabilitation interventions. National disability programs can facilitate funding, training, and standardized distribution of assistive devices. Integrating rehabilitation services into primary healthcare systems improves early identification of disability and ensures timely intervention. Government support also enables partnerships with non-governmental organizations and local innovators, creating an ecosystem that supports inclusive and equitable rehabilitation services in low-resource settings [26,27].

Barriers and Challenges

Despite their potential, low-cost assistive and rehabilitation devices face several implementation barriers. The absence of standardized design and consistent quality control can lead to variability in safety, durability, and effectiveness. Additionally, many devices lack robust clinical validation, limiting confidence among healthcare professionals. Training difficulties also arise, as patients and caregivers may require proper instruction to use devices effectively. Furthermore, regulatory and distribution challenges, including limited approval pathways and weak supply chains, often delay availability, particularly in rural and underserved regions, restricting the widespread adoption of these affordable rehabilitation solutions.

Future Directions

Future rehabilitation strategies are expected to increasingly incorporate artificial intelligence and digital health tools to provide personalized therapy plans and real-time progress tracking. The expansion of tele-rehabilitation will further improve access to therapy, particularly for patients living in remote or underserved areas. Public-private partnerships can accelerate innovation, funding, and large-scale distribution of affordable assistive technologies. Howev-

er, important research gaps remain, including the need for long-term effectiveness studies, culturally adaptable device designs, and standardized outcome measures to ensure that emerging rehabilitation solutions are both clinically effective and widely accessible.

Conclusion

Low-cost assistive and rehabilitation devices have emerged as practical and effective solutions for improving functional recovery, independence, and quality of life among stroke survivors and individuals with disabilities, particularly in resource-limited settings. Their success relies on multidisciplinary collaboration among clinicians, engineers, policymakers, and community stakeholders to ensure safe design, usability, and sustainability. Integrating these devices into routine clinical practice and national rehabilitation programs can expand service coverage. Policymakers should prioritize funding, training, and regulatory support to promote equitable access and encourage innovation in affordable rehabilitation technologies.

Corresponding Author's Affirmation

None of the material in the manuscript is included in another manuscript, has been published previously, or is currently under consideration for publication elsewhere. Ethical guidelines were followed by the investigator in performing the study. Each author has participated sufficiently and equally in the work to take public responsibility for the content of the paper and for the final version of the manuscript. If needed, the data will be provided and will cooperate fully to provide the data on which the manuscript is based for examination by the editors or their assignees.

Declarations

Consent for Publication

All participants and coauthors provided consent for the publication of the data and the required information.

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Author Contributions

All the authors contributed to this study and approved the final manuscript.

Declarations of Competing Interest

The authors declare that they have no conflicts of interest.

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