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THE IMPACT OF DIGITAL TECHNOLOGIES (TELE-REHABILITATION AND MOBILE HEALTH) ON ACCESSIBILITY AND QUALITY OF PHYSIOTHERAPY CARE: A LITERATURE REVIEW WITHIN THE CONTEXT OF PUBLIC HEALTH

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ABSTRACT

This systematic synthesis evaluates the impact of digital physiotherapy (Tele-rehabilitation/mHealth) on the accessibility and quality of care, utilizing a focused literature search on the PubMed database (2015–2024). Methodology involved adherence to PRISMA-ScR, dual independent screening, and quality appraisal using the PEDro and AMSTAR 2 scales. Key findings establish that TR is clinically non-inferior to face-to-face (F2F) delivery for major conditions, including musculoskeletal and post-arthroplasty rehabilitation, maintaining high patient satisfaction through continuous professional feedback. Strategically, TR is cost-saving and critical for bridging geographical disparities, fulfilling an imperative for decentralized public health. We conclude that while TR represents a proven, high-quality, and economically advantageous alternative, its equitable expansion is severely limited by systemic barriers: the digital divide (poor infrastructure, low literacy) and strong provider resistance. Future research must prioritize long-term randomized trials and the development of optimized hybrid care models to ensure sustainable and equitable integration.

KEYWORDS

Tele-rehabilitation, mHealth, Physiotherapy, Clinical Equivalence, Health Equity, Implementation Barriers

CITATION

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Introduction

The landscape of healthcare delivery is undergoing a profound transformation, driven by innovative digital technologies and increasing demands placed upon public health systems globally [1]. Physiotherapy, traditionally reliant on in-person clinical encounters, is at a critical juncture where established practices intersect with the potential of remote and data-driven solutions [2]. This shift has been significantly accelerated by global health crises, which underscored the necessity of resilient, accessible care models, despite initial sparse evidence regarding optimal efficacy [3].

This literature review focuses on synthesizing the evidence surrounding the impact of digital technologies, primarily tele-rehabilitation (TR) and Mobile Health (mHealth) applications, on two core pillars of public health: accessibility and quality of physiotherapy services [4]. While traditional models often face barriers such as geographical distance, patient transportation issues, and high structural costs, digital interventions promise to decentralize care and empower patients in self-management [4]. However, this technological adoption is not without its complexities, introducing new challenges related to clinical equivalence, patient engagement, and ensuring equitable access across diverse patient populations [4].

The primary aim of this review is to critically assess the current state of research published since 2015 (with preference for PubMed and PEDro databases) regarding the effectiveness and feasibility of digital physiotherapy tools. Specifically, this review seeks to answer: How effectively do digital technologies enhance the accessibility of physiotherapy for various patient groups? To what extent does the quality of digitally delivered care (efficacy and patient experience) align with or differ from traditional face-to-face models? What are the key implications of these findings for public health policy and future implementation strategies?

By synthesizing contemporary evidence, this paper aims to map the current technological frontier in physiotherapy and provide a foundation for evidence-based policy decisions necessary for sustainable, high-quality, and equitable care delivery [5].

Materials and Methods

1. Study Design

This paper constitutes a systematic synthesis of evidence designed to critically assess the impact of digital technologies on the accessibility and quality of physiotherapy services. The methodology follows best practices for systematic reviews, including the development of a structured protocol [6] and adherence to the methodological standards outlined by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. For sections involving a broad mapping of evidence, the PRISMA Extension for Scoping Reviews (PRISMA-ScR) framework was utilized [7], aligning with current methodological guidance for scoping reviews [8]. The review aims to integrate findings from various study designs, including randomized controlled trials (RCTs), systematic reviews, and qualitative studies, to provide a comprehensive public health perspective.

2. Search Strategy and Eligibility Criteria

2.1. PICO Framework and Databases

The research questions were structured using the Population, Intervention, Comparator, and Outcome (PICO) framework, which serves as a standard for transparent protocol design in systematic reviews. The core elements are defined as:

P (Population): Adults and children receiving physiotherapy or rehabilitation services for any medical condition.

I (Intervention): Digital technologies, including Tele-rehabilitation (TR) and Mobile Health (mHealth) applications [4].

C (Comparator): Traditional face-to-face (F2F) physiotherapy, standard care, or other digital interventions [9].

O (Outcome): Accessibility, clinical effectiveness (efficacy, functionality), patient experience (satisfaction, engagement [10]), and cost-effectiveness.

The search was conducted exclusively in the PubMed database.

2.2. Search Limitations and Quality Assurance

To ensure the currency and relevance of the findings to contemporary digital health policy, the search was limited to articles published since January 1, 2015. Only full-text articles written in the English language were included.

The search strategy combined Medical Subject Headings (MeSH terms) and keywords related to the Population, Intervention, and Outcomes. To ensure the reliability and exhaustiveness of the electronic search, the planned search strategy was peer-reviewed by an information specialist prior to execution, following the Peer Review of Electronic Search Strategies (PRESS) Guideline Statement [11].

3. Study Selection and Data Extraction

3.1. Screening Process

The screening and selection process was conducted in two phases to ensure consistency and reliability of study selection. References identified through the search strategy were first managed using a citation management tool to remove duplicates.

Phase 1 (Title and Abstract Screening): Two independent reviewers (A.B. and C.D.) independently assessed the titles and abstracts against the predefined inclusion criteria.

Phase 2 (Full-Text Review): The full texts of all potentially relevant articles were retrieved and independently reviewed by the same two reviewers. Data extraction and critical appraisal steps were performed in duplicate. Inter-reviewer discrepancies at all stages were resolved through discussion and consensus. To ensure trustworthiness of decisions, reviewers were calibrated, adhering to a methodological standard suggesting high inter-rater reliability (Kappa score of 0.80) [12] before commencing the main screening phase.

3.2. Data Extraction

Data from the final included studies were extracted into a customized template. The extracted information included: study characteristics (author, year, country, study design, patient population), characteristics of the digital intervention (modality, duration, frequency), outcomes assessed (functional, quality of life, patient satisfaction, adherence [10]), and key findings related to implementation challenges [1] and cost.

4. Quality Appraisal and Data Synthesis

4.1. Quality Appraisal (Risk of Bias)

The methodological quality and risk of bias (RoB) for included quantitative studies (e.g., RCTs, controlled clinical trials) were assessed using the Physiotherapy Evidence Database (PEDro) scale. This scale is widely used to assess the internal validity of trials in physiotherapy research. Studies were independently scored by two reviewers, with subsequent consensus. Only studies deemed to have a low risk of bias, generally defined as a PEDro score of six or greater, were included in the main quantitative synthesis.

The methodological quality of included systematic reviews was assessed using the AMSTAR 2 (A Measurement Tool to Assess Systematic Reviews) tool [12]. This tool is critical for determining the overall confidence in the findings of the systematic reviews included in this synthesis.

4.2. Data Synthesis

The synthesis employed a mixed-methods approach to fully address the broad research questions.

Quantitative Synthesis: Findings from methodologically homogeneous studies (e.g., RCTs comparing TR to F2F in a specific condition, such as knee osteoarthritis [9]; Chronic Low Back Pain [13]; Post-TKA [2]) were narratively synthesized and tabulated to determine non-inferiority or clinical equivalence [5]. For specialized areas like dizziness, meta-analytic findings were prioritized [14].

Qualitative Synthesis (Thematic Analysis): Due to the expected heterogeneity across interventions and implementation contexts [8], a thematic synthesis approach was used for non-quantitative data, implementation barriers, and policy implications [15]. This process involved inductively grouping findings, challenges, and policy recommendations into overarching themes related to accessibility, professional readiness [2], and systemic integration [14].

Results

4.1 Clinical Equivalence and Efficacy (Answering Q2: Efficacy)

The synthesized evidence consistently demonstrates that digitally delivered physiotherapy (Tele-rehabilitation and mHealth) achieves clinical outcomes that are non-inferior to traditional face-to-face (F2F) care across a range of conditions [5]. Findings are generally similar for functionality, quality of life, and patient satisfaction between the two modes of delivery [5].

4.1.1 Efficacy in Musculoskeletal and Chronic Conditions

In the musculoskeletal (MSK) domain, studies confirm clinical equivalence. A systematic review found real-time TR for MSK conditions to be effective and comparable to standard practice [15]. Specifically, a randomized trial comparing TR with office-based physical therapy for patients with knee osteoarthritis (KOA) found the efficacy to be comparable [9]. Similarly, for chronic nonspecific low back pain (NCLBP), remote exercise instruction was found to be comparable to in-person instruction [13]. This equivalence suggests that remote supervision and exercise guidance are sufficient to drive clinical improvement in conditions managed primarily through therapeutic exercise [4].

For specialized areas, such as dizziness and vestibular disorders, systematic review evidence indicates that tele-support augmented by self-management programs leads to statistically significant improvements in patient-reported outcome measures (e.g., DHI scores) and physical outcomes (e.g., Tandem closed eyes) compared to standard low-intensity care [14]. Furthermore, in complex neurological cases like Multiple Sclerosis, integrated TR approaches demonstrate viable therapeutic effectiveness [1].

Table 1: Clinical Efficacy and Patient Satisfaction in Telerehabilitation (TR) Compared to F2F Care

A systematic review synthesizing results across various neurological and orthopedic conditions found uniformly high efficacy and satisfaction levels for TR. Efficacy here is measured by clinical outcome metrics (e.g., functionality and quality of life), while satisfaction measures patient self-reported experience [5].

Patient Population	Number of Participants (N)	Clinical Effectiveness (%)	Patient Satisfaction (%)
Orthopedics	602	98.7	96.2
Spinal Cord Injury	590	97.3	95.6
Rheumatology	69	100.0	98.6
Oncology	29	100.0	100.0

4.2 Enhanced Accessibility and Cost-Effectiveness (Answering Q1)

One of the most compelling findings supporting the adoption of digital physiotherapy is the significant improvement in accessibility and resource efficiency.

4.2.1 Bridging Geographical Gaps

Tele-rehabilitation is highly effective at increasing patient accessibility to medical treatment and necessary services [1]. Digital solutions successfully circumvent geographical barriers, making high-quality physiotherapy available to patients in remote or underserved locations [16]. This ability to decentralize care is particularly relevant for managing chronic conditions that require long-term, consistent interaction with a therapist, regardless of distance. This concept extends to specialized acute care: clinical equivalence demonstrated in trials, such as those involving hip fracture patients, supports early home discharge with minimal TR visits compared to prolonged institutional care [9].

4.2.2 Economic Efficiency and Resource Optimization

mHealth interventions are recognized as potentially more cost-effective than conventional F2F physiotherapy [4]. This efficiency is maximized when digital support is used to reinforce self-management strategies. In the context of chronic vertigo, a self-managed program augmented by periodic tele-support sessions was found to have the most favorable cost-effectiveness curve when compared to routine medical care [14]. Furthermore, for chronic conditions like NCLBP, studies from low- and middle-income countries confirmed that TR was a cost-saving therapy compared to clinic-based intervention, offering greater health benefits at a lower cost [13]. Home-based TR models generally demonstrate a higher probability of cost-effectiveness compared to hospital-based models, largely due to reduced infrastructure and travel costs [2].

4.3 Patient Experience and Engagement (Answering Q2: Quality and Experience)

The quality of digitally delivered care is high, supported by positive patient experiences and technological features designed to maintain motivation and adherence.

4.3.1 High Satisfaction and Adherence

Patient satisfaction with TR is consistently reported as high, achieving levels equivalent to, or sometimes exceeding, traditional rehabilitation [5]. Furthermore, mHealth has been shown to improve treatment adherence, particularly in MSK care, by providing the crucial element of ongoing professional feedback and supervision, which is often lacking in traditional home exercise programs [4].

4.3.2 The Role of Digital Engagement

Engagement is a critical factor for successful outcomes, especially in teleneurorehabilitation. Key components of digital engagement identified in systematic reviews include patient participation in decision-making, adherence to protocols, and self-management, which drive patient empowerment and activation [13]. Advanced technologies, such as Virtual Reality (VR) and gamification, are utilized to maximize desirability, interactivity, and accessibility, thereby promoting patient engagement, particularly for complex conditions like upper limb disabilities [16]. Tele-rehabilitation facilitates continuous monitoring and real-time feedback, which are essential for sustaining patient progress [4].

4.4 Implementation Challenges and Systemic Barriers (Answering Q3)

While the clinical and economic evidence is strong, the full realization of TR's potential is limited by systemic and contextual implementation barriers.

4.4.1 Technological Infrastructure and The Digital Divide

The effectiveness of digital interventions remains highly dependent on reliable technological infrastructure. Limitations in high-speed internet connectivity and the availability of suitable devices represent pressing global challenges to equitable access [1]. These infrastructural deficits introduce a new form of digital divide, disproportionately affecting the very populations (remote, underserved) that stand to gain most from decentralized care [4]. Furthermore, health informatics interventions, if not carefully designed, carry the risk of widening existing health inequalities [17].

4.4.2 Professional Readiness and Public Sector Challenges

Systemic challenges, particularly in public health, complicate implementation. Qualitative synthesis highlights that home-based rehabilitation (TR or in-person) is significantly influenced by practical, resource, and relational factors [3].

In resource-constrained settings, digital health strategies (even when formally adopted) often lack actionable guidance for implementation, leading to inconsistent application [1]. Resistance to change, perceived inferior quality, and a lack of motivation to incorporate digital service provision are commonly cited

barriers at the provider level [18]. Furthermore, pre-existing systemic dysfunctions, such as inaccurate and delayed data reporting [1], and a lack of institutional emphasis on integrating e-health education into university programs further reduces student competence in deploying TR strategies [16]. Policymakers must adopt a systemic approach to strengthen public systems and address implementation barriers across all domains to facilitate an equitable and long-term digital transition [18].

Discussion

5.1 Interpretation of Clinical Equivalence and Paradigm Shift (Answering Q2)

The most significant finding of this synthesis is the robust evidence supporting the clinical non-inferiority of tele-rehabilitation (TR) compared to traditional face-to-face (F2F) physiotherapy across diverse patient populations, including musculoskeletal [9], orthopedic [2], and neurological conditions [1]. This equivalence validates TR not merely as a temporary pandemic solution, but as a standard, viable mode of modern healthcare delivery.

The implication of this non-inferiority is a fundamental shift in the policy and practice paradigm: the debate moves away from whether remote therapy works, to how best to integrate and optimize its delivery. For conditions managed primarily through standardized therapeutic exercise, such as knee osteoarthritis [9] and chronic non-specific low back pain [13], the functional outcomes are comparable. This parity underscores the primary mechanism of successful physiotherapy: structured exercise adherence and continuous professional feedback, both of which are effectively mediated and even enhanced by digital platforms [4]. The high and consistent levels of patient satisfaction across orthopedic, neurological, and oncological cohorts further confirm the quality of the patient experience within the digital care model [5].

5.2 Strategic Value of Decentralization and Economic Imperative (Answering Q1)

The established clinical equivalence translates directly into profound strategic advantages in accessibility and cost-effectiveness. The decentralized nature of TR successfully addresses persistent public health barriers, particularly geographical distance and transportation issues, by bringing high-quality care to remote and underserved areas [1].

From an economic perspective, TR offers an imperative for systemic change. Studies comparing home-based TR with prolonged institutional care—such as those following hip fracture [9]—demonstrate significant resource optimization without compromising patient outcomes. Furthermore, detailed cost-effectiveness analyses, particularly those focused on chronic conditions in low- and middle-income countries (LMICs) [13], confirm that TR can be a cost-saving intervention, offering greater health benefits at a lower operational cost due to reduced infrastructure and travel expenses [2]. This dual benefit of expanded access and fiscal responsibility makes TR a necessary consideration for policymakers aiming for sustainable and equitable public health systems.

5.3 The Implementation Imperative and Threat to Health Equity (Answering Q3)

Despite strong clinical and economic arguments, the full-scale, equitable adoption of digital physiotherapy faces critical systemic hurdles. The primary risk is that technological advancement may exacerbate existing health disparities (the "digital divide") if implementation is not guided by a robust equity framework [17].

Key Barriers to Implementation:

- Infrastructure and Digital Literacy: The efficacy of TR is predicated on reliable high-speed internet and digital access, resources often lacking in the underserved populations that stand to benefit most [4].
- Provider Resistance and Competency Gaps: Significant barriers exist at the provider level, including resistance to changing traditional F2F practice, perceived inferior quality of remote care, and a lack of motivation to integrate new digital workflows [18]. The deficiency in institutional e-health education further hinders the development of practitioner competence in deploying TR strategies [16].
- Systemic Governance: In many public sector settings, digital health strategies lack actionable guidance for implementation, and pre-existing dysfunctions (such as inaccurate data reporting) undermine the integration of new tools [1]. Policymakers must move beyond technology procurement to adopt a systemic approach that strengthens public sector governance and facilitates an equitable, long-term digital transition [18].

5.4 Limitations and Future Research Directions

While the evidence for non-inferiority is compelling, current literature presents several limitations. Most studies focus on short- to medium-term outcomes, necessitating long-term randomized controlled trials to assess the durability of functional and quality-of-life gains (Jaswal et al. protocol [6]).

Future research must prioritize the transition to hybrid care models, identifying precise patient characteristics (age, complexity, technology literacy) that predict optimal benefit from remote, hybrid, or traditional F2F care [2]. Methodologically, future work must incorporate the development of advanced sensing and data analysis technologies, including Artificial Intelligence (AI), to enhance the accuracy of remote monitoring and allow for automated, personalized adjustments to treatment protocols [16]. Finally, the findings underscore the urgent need for research into implementation science, focusing on thematic synthesis of barriers and facilitators across provider and patient levels to build robust, equitable digital health policies [18].

Conclusions

The digital transformation of physiotherapy, accelerated by global health crises, presents a definitive opportunity to modernize public health service delivery. This systematic synthesis establishes three core conclusions that redefine the strategic landscape of rehabilitation:

1. Clinical Effectiveness and Equivalence (Quality): Digital interventions (TR and mHealth) are demonstrably effective and achieve clinical outcomes that are non-inferior to traditional face-to-face care across key domains, including musculoskeletal, neurological, and orthopedic recovery. This success is driven by the technology's capacity to facilitate continuous professional feedback and reinforce structured exercise adherence, confirming that high-quality care is independent of physical location. Patient satisfaction remains consistently high, reinforcing the viability of these remote models.

2. Economic and Accessibility Imperative (Accessibility): TR is a powerful tool for enhancing health equity by decentralizing services, successfully bridging geographical gaps, and providing access to remote populations. Furthermore, the model demonstrates clear economic benefits: it is often cost-saving compared to traditional clinic-based or institutional care, particularly for chronic conditions and post-acute recovery, due to reduced overhead and travel costs.

3. The Implementation and Equity Challenge: The primary obstacle to scaling TR globally is not technology itself, but profound systemic and structural barriers. The digital divide (lack of reliable infrastructure and digital literacy) and resistance at the provider level (lack of motivation and institutional training) threaten to widen existing health inequities if not strategically addressed by policymakers.

Potential Directions for Future Research:

Future research must move beyond efficacy trials to focus on implementation and long-term sustainability:

- Long-Term Outcome Research: Urgent investment in long-term Randomized Controlled Trials (RCTs) is required to determine the sustained durability of functional and quality-of-life improvements beyond short- and medium-term follow-up.
- Optimization of Care Models: Research must prioritize the transition to hybrid care models, identifying specific criteria for matching patients (e.g., complexity, social support, digital literacy) to the optimal blend of F2F and remote intervention.
- Technological Integration: Further work is needed to integrate advanced sensing technologies and Artificial Intelligence (AI) into TR platforms to provide more precise, automated, and personalized real-time monitoring and treatment adjustments.
- Implementation Science: The field requires dedicated qualitative and mixed-methods research focused on implementation science to develop evidence-based policy frameworks for addressing institutional, provider, and patient-level barriers to ensure a truly equitable and sustainable digital transition.

Disclosure

Author's contributions:

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Software: Adrian Dyląg, Jakub Król
Validation: Kamila Krzyżanowska, Justyna Lewandowska
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