Digital Health Tools and Technology

Authors

Esther Liyanage - University of Peradeniya, Sri Lanka
Surangika Wadugodapitiya- University of Peradeniya, Sri Lanka
Birgit Jocham- University of Applied Sciences FH JOANNEUM, Austria
Hannes Aftenberger- University of Applied Sciences FH JOANNEUM, Austria

Consortium CAPAGE

1. University of Applied Sciences FH JOANNEUM, Austria
2. JAMK University of Applied Sciences, Finland
3. Santa Maria Health School, Portugal
4. University of A Coruña, Spain
5. Eastern University of Sri Lanka
6. General Sir John Kotelawala Defence University, Sri Lanka
7. University of Colombo, Sri Lanka
8. University of Jaffna, Sri Lanka
9. University of Peradeniya, Sri Lanka
10. University of Ruhuna, Sri Lanka

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Introduction to Digital Health in Physiotherapy

- Definition and scope of digital health in physiotherapy
- The Global Digital Health Strategy 2020-2025 defines digital health as “the body of knowledge and practice associated with the development and use of digital technologies to improve health”. This definition encompasses eHealth and expands this concept to include digital consumers with a wider range of smart and connected devices. In addition, digital health also includes other applications of digital technologies in healthcare, such as the Internet of Things, advanced computing, big data analytics, artificial intelligence (including machine learning) and robotics. The definition of digital health thus takes into account a broad range of technologies and their application to promote health. It is not just about traditional eHealth applications, but also about new and emerging areas that have the potential to fundamentally change healthcare (*Global Strategy on Digital Health 2020-2025*, 2021).

According to the global strategies on digital health (2021) digital health is guided by four core principles:

Recognition that institutionalizing digital health within national health systems requires country-level decision-making and commitment: Each country has its own digital health action plan within its national context and adapts the implementation of digital health to its culture, values, national health policies, vision, goals, needs, and available resources.

Recognition that successful digital health initiatives require an integrated strategy: Digital technologies are essential components and enablers of sustainable health systems and universal health coverage. Initiatives must be embedded within broader health needs and the digital health ecosystem, guided by a strong strategy that integrates leadership, financial, organizational, human, and technological resources. Well-intentioned but uncoordinated or fragmented initiatives result in isolated solutions and poor service delivery.

Promotion of the appropriate use of digital technologies for health: This includes advocating for the use of digital public goods that are adaptable to various countries and contexts to address major health system challenges and support equitable access to digital resources—ensuring no one is left behind. It promotes the protection of individuals, populations, health workers, and systems from misinformation, misuse of information, malicious cyber activity, fraud, exploitation, inappropriate use of health data, racism, and human rights violations. "Digital determinants of health," such as literacy of information and communication technologies and access to devices, broadband, and the internet, are becoming increasingly important. The strategy emphasizes embedding digital fundamentals in national strategies and fostering collaboration across sectors and stakeholders. Appropriate use considers dimensions such as health promotion, patient safety, ethics, interoperability, intellectual property, data security (confidentiality, integrity, availability), privacy, cost-effectiveness, patient involvement, and affordability. It should be people-centered, trust-based, evidence-based, effective, efficient, sustainable, inclusive, equitable, and context-specific.

Recognition of the urgent need to overcome the main barriers faced by least developed countries in implementing digital health technologies: These barriers include a lack of an enabling environment,

adequate resources, infrastructure, education, human capacity, financial investment, and internet connectivity, as well as challenges related to legacy systems, technology ownership, data protection, security, and the adaptation and implementation of global standards.

The global digital health strategies aim to drive the digital health transformation globally and at national/subnational levels through four strategic objectives (*Global Strategy on Digital Health 2020-2025*, 2021):

Foster global collaboration and advance knowledge transfer in digital health: The goal is to align countries and stakeholders to share global opportunities, improve health, and work toward universal health coverage, while addressing challenges, identifying and communicating risks, and mitigating threats related to the use of digital technologies. This includes maximizing the impact of existing and new collaborations, assessing and promoting the latest, most appropriate, and innovative health technologies, and developing norms, standards, guidelines, and regulations.

Advance the implementation of national digital health strategies: This objective is to encourage and support every country in developing, adapting, and strengthening its own digital health strategy through a comprehensive multi-stakeholder approach that includes core components such as leadership, investment, services, integration, standards, infrastructure, workforce, legislation, ethics, and a human-centered approach.

Strengthen governance for digital health at global, regional, and national levels: This focuses on building sustainable and robust governance structures, developing capacity, and promoting standards for security, privacy, interoperability, and ethical data use. It also aims to enhance monitoring, evaluation, and research on the application of digital health in healthcare.

Promote people-centered health systems enabled by digital health: This objective supports digital health literacy, gender equality, and inclusive approaches in the deployment and management of digital health technologies. It puts people at the center of digital health—including patients, families, communities, and healthcare workers. The goal is to develop population health management approaches that shift from reactive to proactive, community-based models, and to establish mechanisms for more effective public engagement and transparency.

- Digital health literacy

Digital health literacy is defined as the set of skills necessary to search for, find, understand, evaluate and use digitally available health information and information about health services and opportunities in the health system. This encompasses not only the utilisation of digital technologies and resources, such as health applications, digital devices, social media, and online appointments, but also the capacity to employ and navigate these tools effectively. The proliferation of e-health services has led to a concomitant increase in the importance of these skills. The proliferation of digital health information and the myriad of channels through which it is disseminated necessitate the development of competent navigation skills in the digital domain. The ability to discern reliable information from that which is motivated by commercial or other interests is dependent upon the possession of critical-

analytical skills. Digital health information services can provide substantial support in this regard by offering high-quality information (Straßmayr et al., 2022).

The notion of digital health literacy is regarded as a developing concept that will continue to evolve in tandem with technological advancements. Digital health literacy is also influenced by multilevel contextual factors, including intrapersonal (e.g. demographics, age), interpersonal (e.g. social support) and technological factors (e.g. ease of use of digital services), as well as social and cultural factors (e.g. policies, social norms) (Ban et al., 2024).

The concept of eHealth literacy is frequently used in a similar manner to digital health literacy; however, digital health literacy is regarded as an extension of eHealth literacy, integrating technological advances and providing scope for continuous development. The concept of eHealth literacy was initially defined as the ability to locate, comprehend, appraise and utilise health-related information from digital sources. Digital health literacy is a broad and dynamic concept that is critical to equitable health in the digital age. However, if not promoted effectively, it has the potential to exacerbate existing disparities in health outcomes (Ban et al., 2024).

- **Sri Lankan context: current healthcare system and digital readiness**
  Current healthcare system in Sri Lanka (SL):

  Sri Lanka provides free healthcare to all its citizens. Government expenditure on Health was approximately 4.08% of GDP in 2019 and, despite the relatively low expenditure the country's health indicators have been on par with countries in the region. Sri Lankans can seek care from many different practices within the country; however, the allopathic system caters to the needs of most of the population via private and public delivery, with very minor additional services provided by non-profit organisations.

  The key agency for health services is the Ministry of Health (MoH) of the government of Sri Lanka. The Ministry is responsible for policy development, regulatory functions, resource allocation, medical supplies, and infrastructure development of the public health sector.

  The national policy describes a Health Information System (HIS) which facilitates an effective, equitable, economical, and quality service while ensuring privacy and confidentiality of care recipients. The national policy set forth objectives including:

  - Ensure that health institutions generate, share, and use timely and quality health information to support organisational management and development.
  - Make available systems for personalised and community-based health information management. Enabling the continuous care of recipients who receive care at different level of care ensure optimal data & information sharing and access to health information in relation to relevant sharable data in health information systems while ensuring ethical considerations and confidentiality of recipients.
  - Encourage suitable innovations related to health information management in all information processes while ensuring interoperability.

Information and the sharing of it, is a key driver in many business sectors and domains. The lack of availability or lack of quality of information in the healthcare sector can be particularly disruptive to streamlined care delivery. In Sri Lanka, digital health solutions have been developed for a variety of care settings.

For example, there are multiple hospital information systems (HIS) in use within Sri Lanka: Hospital Information Management System (HIMS – mostly used for inpatient hospital stays), Hospital Health Information Management System (HHIMS – mostly used for outpatient clinics, managed by ICTA), and a variety of private sector solutions.

This lack of interoperability and sharing currently adds an extra burden of sending/transferring hardcopies of requisitions, records, results, and summaries between institutions, and relies on patients, guardians, or medical workers to physically move records around and/or remember their own medical history. This lack of efficient sharing impacts the availability of clinical information where patients cannot produce summaries, recall their own history, or are in emergency situations where they are unable to produce this information. This reduces the accuracy of clinical assessments, treatment plan development, and overall decision making, potentially impacting the quality-of-care delivery. This inefficiency is also costly to the health system as it requires duplication of efforts and increased strain on supplies and reduces the overall capacity to deliver care.

The inadequate availability of aggregate data also hampers the ability for public health services to make real-time or near-real-time decisions on data submitted. Currently the availability of public health information in Sri Lanka is not directly integrated with clinical information systems, and accessing this information is sometimes difficult. This makes communicable disease surveillance challenging. It also makes the assessment of clinical quality and accessibility challenging, which may hamper administrative decision-making processes. All these issues can lead to a lack of transparency within the health sector. Accountability tracing within the health sector (i.e., staff to the central and provincial Ministries of Health) is difficult, if not impossible with manual processes. Understanding how individual data was disclosed, used, and collected is important for patients and administrators as it can indicate inappropriate use of assets, access of resources, and can provide insights into potential optimisations.

Further, the current level of digital literacy among health staff and clients is likely inadequate and the capacity to utilise digital health solutions will need to be addressed as the DHP is developed. There are different tiers of digital literacy required depending on the service need, for example operators/ end users of the system, hospital level system administrators, national level administrators, etc. It is vital to the financial sustainability and viability of the health system that efficient, effective, and appropriate use of health services by staff and patients be realised. Only through robust data capture, sharing, aggregation, and dissemination can this be achieved.

The National Health Policy established seven broad strategic directions which identifies the following goals:

a) Strengthen service delivery to achieve preventative health goals

b) Appropriate and accessible high-quality curative care for all Sri Lankan citizens
c) Promotion of equitable access to quality rehabilitation care
d) Strengthen evidence-based service delivery to support journey along the continuum of care
e) Develop new strategies to reduce Out of Pocket Spending (OOPS) and reduce financial risk
f) To ensure a comprehensive health system through a better restructuring including Human Resource Management (HRM) g) Develop strategic partnership with all providers of care (1 reference)

- Unique challenges and opportunities for older adults in Sri Lanka
  A few opportunities for older adults in the healthcare system in Sri Lanka are(Grey 4-6):
- Sri Lanka has initiated the Integrated Care for Older Persons (ICOPE) program, aiming to provide holistic, person-centered care at the primary healthcare level. This approach addresses the complex health needs of older adults, including chronic diseases and disabilities, by training healthcare providers in comprehensive geriatric assessment and management. Pilot implementations in Colombo and Matara districts have shown promise in improving accessibility and quality of care for the elderly.
- Community-based care models, such as those promoted by HelpAge Sri Lanka, focus on training local volunteers and caregivers to provide home-based support for older adults. These programs not only enhance the quality of life for seniors but also create employment opportunities for younger individuals, particularly in rural areas. For instance, HelpAge's home care volunteer program trains individuals aged 55–65 to assist elderly persons in their communities, fostering a sense of purpose and community engagement.
- The establishment of specialized training programs, such as the Postgraduate Diploma and MD in Geriatric Medicine offered by the University of Colombo, aims to build a cadre of healthcare professionals skilled in elderly care. Although the number of trained geriatricians remains limited, these initiatives represent a significant step toward addressing the specialized healthcare needs of the aging population.
- Sri Lanka has enacted several policies to protect the rights and welfare of older adults, including the Protection of the Rights of Elders Act and the National Policy for Senior Citizens. These policies facilitate the establishment of elders' committees at various administrative levels, promoting community participation and ensuring that the needs of older persons are addressed in local governance and service delivery.
- There is a growing recognition of the need for private sector involvement in elder care. The expansion of insurance schemes, such as the Agrahara Medical Insurance Scheme, to include retired public sector employees reflects an effort to provide financial protection against healthcare costs. Additionally, the private sector is encouraged to invest in healthcare infrastructure and services tailored to the needs of the elderly, thereby complementing public sector efforts.

A few challenges among the older adults in Sri Lanka in the healthcare system are (grey 7-8):
Sri Lanka's healthcare system lacks specialized services for the elderly. There is only one geriatric unit at Colombo South Hospital, serving the entire country. Additionally, public hospitals often lack dedicated elderly-care units, and multidisciplinary teams are limited, hindering comprehensive care for older patients.

There is a notable shortage of trained caregivers in Sri Lanka. Many elderly individuals rely on family members for care, leading to increased caregiver burden.

While public healthcare is free, elderly patients often incur out-of-pocket expenses for medications and specialized treatments not covered by the state.

- Cultural considerations for technology adoption among Sri Lankan seniors
  In order to address cultural considerations, it is essential to identify te cultural barriers. Few cultural barrieres for technology adoption among older adults in the South Asian Countries, which also includes Sri Lank are (1-3 grey):
- Limited Digital Literacy and Technological Anxiety
  Many older Sri Lankans have limited exposure to digital devices, leading to apprehension and reluctance to engage with technology. This digital illiteracy is compounded by fears of making mistakes or being unable to navigate digital platforms, which can deter them from adopting health technologies.
- Language Barriers
  The majority of digital health resources are available in English, a language not commonly spoken or understood by many older Sri Lankans. Even among those who speak Sinhala or Tamil, the lack of digital content in these languages creates a significant barrier to accessing health information online.
- Cultural Preferences for Traditional Communication
  Older adults often prefer face-to-face interactions with healthcare providers, valuing personal relationships and trust built over time. Digital health solutions that replace these personal interactions may be met with resistance due to concerns over confidentiality and the impersonal nature of online communication.
- Gender Roles and Family Dynamics
  In many Sri Lankan households, especially in rural areas, traditional gender roles dictate that women have limited access to and control over technology. Additionally, family members, particularly younger generations, may dominate the use of digital devices, leaving older adults with little opportunity to learn or use them independently.
- Economic Constraints and Access to Devices
  The cost of smartphones, internet services, and data plans can be prohibitive for many older adults, particularly those living in rural areas. Without access to these resources, engaging with digital health technologies becomes virtually impossible.
- Trust Issues and Fear of Exploitation
  Some older individuals are wary of digital platforms due to concerns about fraud, scams, and misuse of personal information. Negative experiences, such as receiving incorrect products or services through online platforms, can reinforce these fears and discourage the use of digital health technologies.

The barriers must be considered and managed while incorporating digital technology among older adults.

1. Categorization of Digital Health Tools for Physiotherapy

Digital technologies are assuming an increasingly prominent role in the domain of physiotherapy. These encompass electronic health records, mobile health applications, virtual applications such as telerehabilitation, and the utilisation of artificial intelligence. Digital therapeutic products have been developed for the treatment of illnesses and health management. Ensuring patient safety, privacy and informed clinical decisions are key issues (American Physical Therapy Association, 2022).
Digital Health in physiotherapy can be devided into three categories: Digital health technologies, digital medicine and digital therapeutic products (digital therapeutics) (American Physical Therapy Association, 2022).

Digital health technologies are used to support clinical decision making, delivery of services, and practice management. In physiotherapy, these tools most often include electronic health records, telehealth solutions, and online platforms and mobile apps that allow for data and information capture, transmission, storage, and display. Physiotherapists use digital technologies to document care, inform decisions about treatment, and monitor and communicate with patients. Increasingly, clinicians also rely on data analytics and artificial intelligence to glean insight into individual and population-level health trends using data from across the health care continuum. Administrators use technologies designed to manage office and billing tasks. Patients, too, are using digital health technologies such as mobile monitoring tools that track and encourage adherence to therapeutic exercise and general fitness (American Physical Therapy Association, 2022).

Digital medicine, a subcategory of digital health technology, includes evidence-based software and hardware products such as digital diagnostics and biomarker tools, remote patient monitoring products, and technologies that measure and treat without human intervention, including the process of automating biofeedback. Such technologies usually require some level of regulatory oversight (American Physical Therapy Association, 2022).

Digital therapeutic products (digital therapeutics), as defined by the Digital Therapeutics Alliance, are used to “deliver medical interventions directly to patients using evidence-based, clinically evaluated software to treat, manage, and prevent a broad spectrum of diseases and disorders.” The alliance further explains that all digital therapeutic products are subjected to the same regulatory oversight as other medical treatments, and that they may be used “independently or in concert with medications, devices, or other therapies to optimize patient care and health outcomes.” It also notes that digital therapeutics are not meant to replace health care providers, but instead are tools providers can use both during and between in-person visits; and that all digital therapeutic products must incorporate patient privacy and security protections (American Physical Therapy Association, 2022)

2. Application in Health Care

The application of health technology in health care has become an essential factor in modern medical practice, offering numerous advantages that enhance both patient outcomes and operational efficiency. One of the primary reasons for integrating health technology is its role in providing client-

centered therapy. Digital solutions, such as telemedicine and personalized treatment plans powered by artificial intelligence, enable healthcare providers to tailor interventions to individual patient needs, improving overall care quality. Another key benefit is resource optimization. Advanced health technologies help in automating routine tasks, minimizing human error, and ensuring efficient allocation of medical resources. Moreover, health technology plays a critical role in improving management, particularly through tools like the electronic patient file. By digitizing patient records, healthcare providers can streamline communication, enhance data accessibility, and facilitate better coordination among different departments. This not only reduces paperwork but also allows real-time monitoring of patient health, leading to faster decision-making and improved outcomes. Lastly, the development of sustainable care is a fundamental goal of modern health technology. Digital health solutions, remote monitoring, and predictive analytics help in managing chronic diseases efficiently, reducing hospital readmissions, and ensuring long-term healthcare sustainability. By embracing smart healthcare technologies, medical institutions can provide high-quality care while maintaining cost-effectiveness and environmental responsibility (Senbekov et al., 2020).

In Sri Lanka the development in the practice and use of digital technology in healthcare is minimal compared to the countries around the globe. A few established systems are (grey 7-9):

Telemedicine:

- The **Hemas Health App**, launched by Hemas Hospitals, integrates telemedicine and telephysiotherapy features, enabling patients to consult with physiotherapists remotely. Through video consultations, patients can receive personalized therapy sessions, reducing the need for in-person visits. The app also includes an Electronic Medical Record (EMR) system, allowing for secure management of patient records and facilitating seamless communication between healthcare providers. This digital platform aims to make physiotherapy services more accessible, especially for those in remote areas.
- Dialog Axiata's **Doc990 App** introduces an AI-powered health scan feature that allows users to monitor vital health indicators such as blood pressure, heart rate, and stress levels using their smartphones. While not exclusively focused on physiotherapy, this tool can assist physiotherapists in tracking patient health metrics remotely, enabling more informed decision-making and personalized care. The integration of AI into health monitoring represents a significant advancement in digital health tools in Sri Lanka.
- The **Hospital Health Information Management System (HHIMS)**, implemented by the Ministry of Health and the Information and Communication Technology Agency (ICTA), is a comprehensive platform that integrates various aspects of healthcare management, including outpatient and inpatient services. While primarily focused on administrative functions, HHIMS's centralized data system can support physiotherapy departments by maintaining detailed patient records, facilitating better coordination of care, and enabling data-driven decision-making.

Telerehabilitation:

- The **VirtualPT** system, developed by the Sri Lanka Institute of Information Technology (SLIIT), offers a virtual reality (VR)-based home care physiotherapy solution for the elderly. This platform combines immersive VR environments with wearable sensors to guide users through prescribed exercises, track movement accuracy, and provide real-time feedback. It also features a dashboard

for both patients and physiotherapists to monitor progress and adjust rehabilitation plans accordingly. This approach aims to improve adherence to therapy and enhance the rehabilitation experience at home. However, this is limited to personnels in connection with the insitution only.

- PhysioMantra is an online physiotherapy platform that connects patients with qualified physiotherapists in Sri Lanka through video consultations. The platform offers personalized treatment plans, including exercise videos and progress tracking, to manage conditions such as back pain, arthritis, and musculoskeletal injuries. By providing remote access to physiotherapy services, PhysioMantra aims to make rehabilitation more accessible and convenient for patients across the country

All the systems stated above are established by individual group or forum or institution. Practically he methods few Physiotherapists practice includes, monoitoring and follow up of rehabilitation via video platforms such as phone or common zoom meetings

2.1 Mobile health applications (mHealth):

Mobile health applications refer to health applications based on mobile terminal systems such as Android and iOS that provide services such as medical information inquiry and symptom self-examination. Mobile health applications allow users not only to seek answers to health problems but also to gain access to healthcare, exercise and fitness, health management, and other related services anytime and anywhere. Mobile health applications alleviate the shortage of health information resources to a certain extent, provide a convenient way for users to obtain health information and services, and play an important role in spreading health knowledge and meeting the users' need for health consultation (Wang & Qi, 2021).

Mobile health applications are revolutionizing healthcare by offering numerous advantages that address traditional barriers to medical access and treatment. One of the most significant benefits is their ability to transcend geographical, linguistic, and social limitations. These digital tools provide unprecedented accessibility, ensuring that individuals can receive healthcare support regardless of their location or native language. Communication, monitoring, and education are core strengths of mobile health applications. They enable continuous interaction between patients and healthcare providers, allowing real-time tracking of health conditions and facilitating ongoing educational resources. This constant connection helps patients stay informed and engaged in their own healthcare journey. These applications can also play a crucial role in supporting diagnostics and medical assessments. By enabling patients to input symptoms, track health metrics, and share data with healthcare professionals, mobile health apps can provide preliminary insights and support more comprehensive medical evaluations. The versatility of mobile health applications extends to various therapeutic approaches. They can be effectively used in blended therapy models, serving as self-help and self-management tools. Patients can utilize these apps to bridge waiting times between therapy sessions, continue their treatment progress, and even support relapse prevention strategies. Improving patient adherence is another significant advantage. By providing reminders, tracking progress, and offering motivational support, these applications help patients stick to their treatment plans more consistently. They offer different modes of interaction, including real-time interventions, automatic data entry, and manual data input, catering to diverse user preferences and needs (WHO Global Observatory for eHealth, 2011).

The legal landscape surrounding mobile health applications (MHAs) reveals significant challenges in data privacy and user transparency. A critical issue is the complexity of privacy policies, which are often written in such technical and convoluted language that they become effectively incomprehensible to the average user. The majority of currently available mobile health applications suffer from a severe lack of clear privacy communication. Users are frequently left in the dark about fundamental questions concerning their personal data: What specific information is being recorded? How is this data transferred? Where exactly is it stored? And perhaps most importantly, with whom is this sensitive health information being shared? The implementation of the European Union's General Data Protection Regulation (GDPR) represents a potential turning point in addressing these concerns. This comprehensive data protection framework aims to provide users with greater control and transparency regarding their personal information, potentially compelling mobile health application developers to create more comprehensible and user-friendly privacy policies. For users and healthcare professionals considering mobile health applications, it is crucial to pay attention to medical device certification. This certification can provide an additional layer of assurance regarding the application's compliance with medical standards and data protection regulations. While progress is being made, users are advised to exercise caution and carefully review available information about data handling practices before adopting any mobile health application. The goal is to balance the innovative potential of these digital health tools with robust protection of personal health information (WHO Global Observatory for eHealth, 2011).

- In Sri Lanka : Sri Lanka's Personal Data Protection Act No. 9 of 2022 (PDPA) is a comprehensive data protection law that regulates the processing of personal data within the country. Enacted as the first such legislation in South Asia, it aims to safeguard individuals' privacy rights and establish a robust framework for data governance. The provisions of this act include: Individuals have the right to access, correct, delete, and restrict the processing of their personal data, Entities that collect or process personal data must implement data protection management programs and adhere to transparency and accountability obligations, The Act regulates the transfer of personal data outside Sri Lanka, ensuring that such transfers comply with established safeguards, Administrative penalties are imposed for non-compliance, with fines capped at a specified amount, rather than being based on global turnover, The Act prohibits the sending of unsolicited messages using personal data, unless explicit consent is obtained from the individual.

2.2 Teletherapy and remote consultation platforms

In recent years, medical rehabilitation has been transformed by technology, affecting everything from advanced treatment development to the delivery methods of specific interventions. Telerehabilitation involves using information and communication technologies (ICT) to deliver rehabilitation services remotely to individuals in their homes or other settings (Brennan et al., 2009). These services encompass therapeutic interventions, remote progress monitoring, education, consultation, training, and networking opportunities for people with disabilities (Theodoros & Russell, 2008).

Previous research has explored a variety of technological approaches in telerehabilitation ranging from simpler technologies to more sophisticated systems. (Baig et al., 2019; Christensen et al., 2016).

The simpler technological solutions include telephone calls, video consultations, and email communication (Cottrell et al., 2017; Huang et al., 2015) more complex technologies encompass sensor systems and mobile software applications designed to monitor falls or training sessions (Baig et al., 2019; Toelle et al., 2019).

Beyond purely technical aids, telerehabilitation systems also incorporate psychological concepts such as gamification. As described by Christensen et al. (2016), the goal of these playful interventions is to motivate patients to perform their exercises or activities consistently.

In addition to the various technologies and concepts employed, telerehabilitation tools can be categorized based on their implementation within therapy settings. Winters (2002) distinguishes between synchronous and asynchronous settings. In synchronous telerehabilitation, therapists and patients communicate and interact in real time. Conversely, asynchronous settings do not require patients and therapists to meet at appointed times or participate simultaneously (Parmanto & Saptono, 2009). A third approach known as blended care combines traditional face-to-face therapy sessions with telerehabilitation components (Kloek et al., 2018, 2019).

2.3 Wearable devices and sensors

Wearable sensors (WS) and Internet-of-Things (IoT) applications can support the independent living of older adults in various ways. There is a growing need for sustainable solutions and systems to support the aging population, independent living, and activities of daily living (ADLs) for older adults. Here are some ways these technologies contribute (Baig et al., 2019):

- **Prevention, Early Detection, and Management of ADL and Falls:** Wearable sensor systems are becoming effective tools for preventing, detecting early, and managing ADLs and falls among older adults. Falls are common in the elderly population worldwide and can lead to serious injuries, affecting their independence. IoT and WS technology should be efficiently and widely used to help predict and prevent falls.
- **Monitoring Activities of Daily Living (ADL):** WS and IoT-based applications allow for the monitoring of ADLs, which is crucial for independent living. Examples from the sources include:shoe-based wearable system called "SmartStep" uses insole sensors for activity monitoring and accurate ADL detection; data-driven smart home system uses web technologies to connect IoT devices and identifies ADLs from sensor data to control actuators and display a summary of ADL and a smartwatch-based framework enables the collection of sensor and user-reported data to monitor ADL.
- **Fall Detection Systems:** Many studies focus on developing fall detection systems using wearable devices for continuous monitoring. Examples include: wrist-worn, accelerometer-based solution to enhance fall detection; wrist-worn wearable devices with power-efficient algorithms for fall detection and ADL classification; waist-worn detectors for fall detection based on AHRS (Attitude and Heading Reference System) and a barometric sensor; indoor fall detection system that utilizes IoT and machine learning.
- **Remote Monitoring and Ambient Assisted Living:** Smartphone-based solutions and smartwatch frameworks enable remote monitoring of older adults, which can enhance independent living. IoT technologies have also been used to develop Ambient Assisted Living systems for healthcare.

An intelligent and connected home monitoring system for elderly care at home supports fall detection and ADL recognition.

- **Support for Specific Conditions:** These technologies can also assist with specific age-related conditions. For instance, an algorithm was proposed to classify front-door events in order to detect forgetfulness in older adults in smart homes and evaluate people with dementia. A modular decision-support framework was developed to promote independent living and aging, based on a case study on geriatric depression.
- **User Engagement and Self-Management:** The widespread adoption of wearable/IoT systems offers potential for user engagement and self-management of age-related illnesses.

Advanced wearable technology and the capabilities of modern IoT systems to support older adults with their ADLs and independent living are the focus of much current research and investigation. These technologies show promise for cost-effective remote monitoring and support for independent living (Baig et al., 2019).

2.4 Electronic health records (EHRs)

An Electronic Health Record (EHR), also known as a computerized patient record, refers to a dynamic and structured collection of health information stored in a digital format. Designed to be shared across various healthcare settings, EHRs are integrated into networked, organization-wide information systems. These records can include a wide array of data—either comprehensive or summarized—such as patient demographics, medical histories, medications, allergies, immunizations, lab results, radiology images, vital signs, personal details like age and weight, and billing information (Gunter & Terry, 2005).

Various terms have been used to describe electronic systems for collecting patient data, often interchangeably. However, each term has a distinct meaning and specific application (Feng, 2011)

- **Personal Health Record (PHR):** A digital, individual-managed record of a person's medical history.
- **Electronic Medical Record (EMR):** A provider-based digital system that documents all patient care and services delivered within a single healthcare organization.
- **Electronic Patient Record (EPR):** A patient-centered system focused solely on patient documentation.

These systems differ in their technical capabilities, which in turn influence the type and volume of data they can store. Examples include: Storage of raw data from medical imaging devices within individual patient records; archiving of video recordings from surgeries or diagnostic procedures, saving internal notes and memos as structured text entries, retaining communications with third parties such as pharmacies, patients, and government bodies and backing up legal documents, like consent forms, in digital format to support secure medical practices (Feng, 2011).

Physiotherapy services stand to gain significantly from the adoption of electronic data systems. Initial implementation efforts have laid the foundation for developing solutions tailored specifically to therapeutic settings. The rise of tele-rehabilitation- enabled by its inherently remote and digital framework- has further accelerated this shift. These systems are capable of storing data related to assessments, diagnoses, treatment plans, and patient histories, often structured around the International Classification of Functioning, Disability and Health (ICF). Despite the evident benefits,

challenges remain regarding the certification of these systems for widespread use, ensuring data security, and integrating them into existing clinical workflows (Buyl & Nyssen, 2009). Pilot studies exploring clinicians' attitudes toward these systems highlight key areas of concern, notably the need to improve digital literacy, foster motivation, and raise awareness among physiotherapists about the advantages of electronic health records (Filipec & Brumini, 2019).

EHR in SL

- The **Hemas Health App**, launched by Hemas Hospitals, integrates telemedicine and telephysiotherapy features, enabling patients to consult with physiotherapists remotely. Through video consultations, patients can receive personalized therapy sessions, reducing the need for in-person visits. The app also includes an Electronic Medical Record (EMR) system, allowing for secure management of patient records and facilitating seamless communication between healthcare providers. This digital platform aims to make physiotherapy services more accessible, especially for those in remote areas.
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- The **Hospital Health Information Management System (HHIMS)**, implemented by the Ministry of Health and the Information and Communication Technology Agency (ICTA), is a comprehensive platform that integrates various aspects of healthcare management, including outpatient and inpatient services. While primarily focused on administrative functions, HHIMS's centralized data system can support physiotherapy departments by maintaining detailed patient records, facilitating better coordination of care, and enabling data-driven decision-making.

2.5 AI in physiotherapy

Artificial Intelligence (AI) refers to the ability of machines to perform tasks that typically require human insight and oversight. By leveraging complex algorithms, AI systems can learn, reason, and support a wide range of clinical applications, including radiology and rehabilitation. In healthcare, AI is also employed to efficiently gather relevant information from journals, textbooks, and evidence-based resources, thereby enhancing clinical decision-making. Additionally, AI technologies contribute to reducing medical errors, ultimately improving the safety and quality of patient care. AI in rehabilitation has the potential to enhance patient care by supporting physiotherapists in various aspects of their practice. It can assist in conducting comprehensive assessments, predicting patient outcomes, and aiding in diagnostic processes. Beyond rehabilitation, AI is also valuable in broader medical contexts-contributing to problem-solving, interpreting X-rays, and developing evidence-based best practice protocols (Alsobhi et al., 2022).

AI is rapidly emerging as a transformative force in the healthcare sector, particularly within low- and middle-income countries (LMICs). With the potential to address longstanding challenges, such as shortages of healthcare professionals, limited access to quality care, and the burden of communicable diseases, AI is being applied in areas like diagnosis, disease surveillance, patient engagement, and health system strengthening. Its integration is poised to significantly enhance healthcare delivery and

outcomes in LMICs, contributing meaningfully to the global goal of achieving universal health coverage (Alami et al., 2020; Sumner et al., 2023). Beyond diagnostics and outbreak prediction, AI also holds significant promise in the field of rehabilitation. In LMICs, where access to rehabilitation services and trained professionals may be limited, AI-powered tools are being developed to support recovery from injury, illness, and disability. These innovations include virtual reality platforms, wearable technologies, and mobile applications that guide patients through therapeutic exercises and monitor their progress. By expanding access, lowering costs, and improving rehabilitation outcomes, AI has the potential to bridge critical gaps in care for underserved populations (Bright et al., 2018).

AI application in physiotherapy practice (examples):

Diagnostic Imaging and Decision Support: AI, particularly machine learning (ML), is used to automate decision-making and make predictions based on patient data, enhancing diagnostic imaging and clinical decision support in musculoskeletal medicine (Nogales et al., 2024; Tack, 2019).

Personalized Treatment Plans: AI systems analyze patient data to create tailored rehabilitation programs, improving compliance and clinical decision-making. These systems can adapt treatment plans based on continuous feedback, enhancing patient satisfaction and outcomes (Nambi et al., 2024)

Real-Time Monitoring and Feedback: AI technologies, including video analysis and pose detection, provide real-time feedback to patients, improving exercise precision and discipline. This is often combined with telemedicine to allow patients to exercise in various locations (Davids et al., 2021)

Robotics and Wearable Sensors: AI-driven robotics and wearable sensors are used for rehabilitation, improving motor function and providing real-time monitoring. These technologies facilitate remote physiotherapy and data-driven interventions (Danishta et al., 2025).

Natural Language Processing and Expert Systems: Tools like natural language processing (NLP) and expert systems are employed to enhance patient interaction and automate routine tasks, allowing physiotherapists to focus on more complex care aspects (Nambi et al., 2024; Rowe et al., 2022).

2.6 Virtual/augmented reality solutions

Virtual and augmented reality (VR and AR) tools are increasingly being integrated into physiotherapy practices for older adults, offering innovative ways to enhance rehabilitation and physical therapy outcomes.

Virtual Reality Tools:

- Immersive Virtual Reality (IVR): IVR is used to motivate and engage older adults in physical therapy, showing promise as a complementary tool in rehabilitation and active aging1. It has been applied in balance improvement and fall risk reduction, particularly when combined with dual-task activities (Zak et al., 2024)

- Exergames: These are VR-based exercise games that encourage physical activity and have been used to maintain motivation in rehabilitation programs for older adults (Høeg et al., 2023).
- VR with Head-Mounted Displays: These have been used to improve physical, mental, and psychosocial health outcomes, including gait, balance, fall prevention, and pain management (Dermody et al., 2020; Stamm et al., 2022).

Augmented Reality Tools

- AR in Physiotherapy: AR combines digital information with the real environment, showing benefits in balance improvement and fall prevention. It has been used for treating balance issues, limb functionality post-stroke, and pain management (Vinolo Gil et al., 2021)

Applications and Benefits

- Balance and Fall Prevention: Both VR and AR have been effective in improving balance and reducing fall risks in older adults (Vinolo Gil et al., 2021; Zak et al., 2024).
- Pain Management: VR has been used to manage chronic pain, such as back pain, by increasing adherence to exercise (Stamm et al., 2022).
- Functional Performance: VR environments have been shown to enhance functional performance, particularly in static balance and gait (Zak et al., 2022)

Challenges and Considerations

- Social Interaction: While VR can enhance individual therapy, it may hinder social interaction during group sessions due to the immersive nature of headsets (Høeg et al., 2023).
- Usability and Acceptability: Ensuring the technology is user-friendly and acceptable to older adults is crucial for successful implementation (Dermody et al., 2020)

In conclusion, VR and AR tools offer promising enhancements to physiotherapy for older adults, particularly in balance improvement, fall prevention, and pain management. While these technologies show potential, considerations around usability and social interaction need to be addressed to maximize their benefits in therapeutic settings.

Conclusion

Digital health technologies offer significant potential for addressing the unique healthcare challenges faced by Sri Lanka's aging population. The emergence of mobile health applications, telerehabilitation platforms, wearable devices, electronic health records, AI-powered systems, and virtual/augmented reality solutions presents both opportunities and challenges for implementing digital physiotherapy solutions for older Sri Lankans.

Sri Lanka's healthcare system faces distinctive challenges when implementing digital health tools for older adults. These include varying levels of digital health literacy among seniors, cultural considerations that might affect technology adoption, and the current state of digital infrastructure readiness. While the document mentions that Sri Lanka is developing electronic health record systems, the specific progress and integration of these systems into physiotherapy practice remains an area for development.

Barriers:

There are cultural, economic, financial, and skills related barrier among older adults in Srilanka.

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or effective implementation, digital health interventions for older Sri Lankans should be designed with consideration for cultural context and accessibility needs. The technologies that show particular promise include mobile health applications that can transcend geographical and linguistic barriers, telerehabilitation platforms that allow for remote consultation in rural areas, and AI-assisted diagnostic and treatment planning tools that can help address healthcare professional shortages.

As Sri Lanka moves forward with digital health adoption for physiotherapy, focus should be placed on developing blended care models that combine traditional face-to-face therapy with digital components, ensuring privacy and data security in line with local regulations, and providing adequate training for both healthcare providers and older adults to enhance digital health literacy.

To maximize the benefits of these technologies, Sri Lanka would benefit from developing context-specific frameworks that integrate digital health tools into existing healthcare practices while respecting the unique cultural, social, and economic factors that influence technology adoption among older Sri Lankans.

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