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Adoption and Integration of Mobile Health Applications in Clinical, Nursing and Pharmacology Practice in Hospitals: A Systematic Review

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Abstract

Mobile health (mHealth) applications have emerged as transformative tools in clinical and pharmacological practice, offering innovative solutions to enhance patient care, optimize medication management, and improve healthcare delivery in hospital settings. This systematic review examines the adoption and integration of mHealth applications by healthcare professionals, with a focus on facilitators, barriers, and outcomes in clinical, nursing and pharmacological contexts. A comprehensive literature search was conducted across multiple

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databases, identifying peer-reviewed studies published between 2010 and 2023. Inclusion criteria emphasized research addressing healthcare providers' experiences with mHealth, particularly factors influencing its implementation and sustained use in hospitals.

The findings reveal that mHealth applications significantly enhance clinical workflows, , nursing and pharmacological practices by improving communication, supporting medication management, enabling real-time access to patient and drug data, and fostering patient engagement. However, adoption is hindered by barriers such as insufficient training, data security concerns, and limited interoperability with existing hospital health information systems. Furthermore, nurses' interactions with patients are vital in promoting patient engagement with mHealth applications. As trusted caregivers, nurses can guide patients in adopting and utilizing these tools, ensuring their effective integration into care plans. Policymakers and healthcare organizations must support nurses in this role by providing the necessary resources and training to enhance their capacity to act as mHealth advocates. Key facilitators include user-friendly designs, organizational backing, and evidence of improved patient and medication-related outcomes.

The review also highlights the importance of regulatory frameworks, financial investments, and cross-sector collaboration in supporting widespread adoption of mHealth applications. Despite their potential, integration remains inconsistent due to variations in geographic, cultural, and institutional contexts. To address these challenges, the study underscores the need for targeted strategies, such as tailored training programs, robust data security measures, and policies to promote equitable access to these technologies.

Future research should explore the long-term impact of mHealth applications on clinical , nursing and pharmacological workflows, patient satisfaction, and medication safety to maximize their benefits in hospital ecosystems. This review provides valuable insights for policymakers, healthcare providers, and technology developers aiming to bridge the gap between innovation and practical application, ultimately advancing the effective utilization of mHealth technologies in hospital-based clinical , nursing and pharmacological practice

Keywords- Mobile health applications, mHealth adoption, clinical practice, healthcare technology, patient engagement, healthcare providers, barriers and facilitators, health information systems, digital health, healthcare innovation.

1. Introduction

1.1 Introduction and Background

The integration of mobile health (mHealth) applications into hospital-based clinical , nursing and pharmacological practice has transformed the healthcare landscape, providing innovative tools to enhance patient care, optimize medication management, and improve healthcare delivery efficiency (WHO, 2021). Leveraging the widespread use of mobile devices, these

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applications support a range of functions, including remote health monitoring, medication adherence, patient education, and seamless communication between patients and healthcare providers (Garg et al., 2019). With the rapid pace of technological advancement and growing healthcare demands, mHealth applications have emerged as essential solutions for addressing global challenges such as chronic disease management, medication safety, and access to care in underserved areas (Free et al., 2013).

Despite their transformative potential, the adoption and integration of mHealth applications in clinical and pharmacological practice within hospitals face numerous challenges. Key barriers include lack of interoperability with existing health information systems, concerns about data privacy and security, resistance to change among healthcare professionals, and insufficient training on mHealth technologies (Marcano et al., 2017). Furthermore, disparities in digital literacy and unequal access to mobile technologies exacerbate inequities in the deployment and utilization of these tools, particularly in resource-limited settings (Hamine et al., 2015). Addressing these obstacles requires a nuanced understanding of the factors that influence adoption and integration, as well as targeted strategies to foster sustainable implementation.

While previous studies have highlighted the effectiveness and acceptability of mHealth interventions in improving patient engagement and communication with healthcare providers (Kumar et al., 2020), a comprehensive exploration of the factors specific to hospital-based clinical and pharmacological practices remains limited. This systematic review seeks to fill this gap by synthesizing current evidence on the adoption and integration of mHealth applications in these contexts. It aims to identify barriers, facilitators, and strategies that contribute to their effective implementation, providing actionable insights for stakeholders.

Through this analysis, the review aims to inform healthcare providers, policymakers, and technology developers on best practices for integrating mHealth applications into clinical , nursing and pharmacological workflows within hospitals. By addressing current challenges and highlighting successful strategies, the findings seek to contribute to the development of more efficient, patient-centered, and technology-driven healthcare systems.

1.3 Objectives

The primary objectives of this systematic review are:

1. To identify and analyze the key factors influencing the adoption of mobile health (mHealth) applications in hospital-based clinical and pharmacological practice, including barriers and facilitators.
2. To investigate effective strategies and models employed for integrating mHealth applications into routine workflows in hospital settings, with a focus on clinical and pharmacological applications.
3. To assess the impact of mHealth application adoption on clinical outcomes, pharmacological practices, healthcare delivery efficiency, and patient engagement in hospitals.

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4. To synthesize findings to establish best practices and actionable recommendations for healthcare providers, policymakers, and technology developers to enhance the implementation and sustainability of mHealth applications in hospital environments.
5. To identify areas where further research is needed to address unresolved challenges and strengthen the evidence base surrounding the adoption and integration of mHealth applications in clinical and pharmacological contexts.

2. Method

2.1 Design and Search Strategy

This systematic review follows the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines to ensure transparency and methodological rigor in identifying, selecting, and synthesizing relevant studies. The review aims to analyze the adoption and integration of mobile health (mHealth) applications in clinical practice by evaluating empirical studies from diverse healthcare settings. A comprehensive search strategy was developed to identify studies published between 2010 and 2024. The following electronic databases were utilized: PubMed, Scopus, Web of Science, and CINAHL. The search terms included a combination of keywords such as “mobile health applications,” “clinical practice,” “adoption,” “integration,” “healthcare professionals,” “digital health,” and “telemedicine,” along with their relevant synonyms. Boolean operators like "AND" and "OR" were employed to broaden the search. The search was restricted to peer-reviewed articles in English, and studies published in journals with an impact factor above 1.0 were prioritized to ensure the inclusion of high-quality studies.

Inclusion Criteria

Studies eligible for inclusion in this review met the following criteria:
1. **Population**: Studies involving healthcare professionals (physicians, nurses, allied health professionals, and hospital administrators) and patients who interacted with or used mHealth applications in clinical settings.
2. **Interventions**: Studies that explored the use of mHealth applications, such as mobile apps for patient monitoring, diagnostic support, telemedicine, medication management, or patient education.
3. **Outcomes**: Studies reporting on outcomes related to the adoption, integration, or effectiveness of mHealth applications in clinical practice, including factors influencing adoption, barriers to integration, and impacts on clinical outcomes or patient satisfaction.
4. **Study Design**: Both qualitative and quantitative studies, including randomized controlled trials (RCTs), cohort studies, cross-sectional studies, and mixed-methods studies.
5. **Timeframe**: Studies published between January 2010 and December 2024.

Exclusion Criteria

Studies were excluded based on the following criteria:
1. **Non-clinical Settings**: Studies conducted in non-clinical settings, such as public health campaigns or educational interventions that did not directly involve clinical practice.

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2. **Non-peer-reviewed Literature**: Conference abstracts, reports, and opinion pieces that did not undergo peer review.
3. **Lack of Focus on mHealth**: Studies that did not focus on the use of mobile health applications but rather on other forms of digital health technology, such as telemedicine infrastructure, electronic health records, or wearable devices without direct interaction through mobile applications.
4. **Non-English Publications**: Studies published in languages other than English were excluded due to language limitations in the research team's proficiency.

Data Extraction and Synthesis

Data extraction was performed independently by two reviewers, with any discrepancies resolved through discussion or consultation with a third reviewer. Relevant information was extracted from the included studies using a standardized data extraction form that included the following key details:

1. **Study Characteristics**: Author(s), year of publication, study design, sample size, and study setting (e.g., hospital, primary care, outpatient clinic).
2. **Population**: Characteristics of participants, including healthcare professionals or patients, their roles, and any inclusion or exclusion criteria.
3. **Intervention**: Description of the mHealth application(s) used in the study, including the features, functionalities, and intended purposes (e.g., monitoring, diagnosis, communication).
4. **Outcomes**: Key findings related to adoption factors, integration processes, clinical impacts, and patient outcomes, such as satisfaction, engagement, or health improvement.
5. **Barriers and Facilitators**: Identified barriers to and facilitators for the adoption and integration of mHealth applications in clinical practice.
6. **Recommendations**: Any suggestions or best practices for successful implementation and scaling of mHealth applications in healthcare settings.

Data synthesis was performed using a narrative synthesis approach, categorizing the findings according to the themes of adoption, integration, and impact. For quantitative studies, where applicable, effect sizes and statistical measures were reported to summarize the impact of mHealth applications on clinical practice. Qualitative studies were synthesized thematically, identifying recurrent patterns and key insights into the factors influencing the successful adoption and integration of mHealth applications. The synthesis aimed to offer a comprehensive overview of the current state of knowledge on the adoption and integration of mobile health applications, identify gaps in the literature, and provide recommendations for future research and practice.

2.4 Quality Assessment

In this systematic review, the quality of the studies included was rigorously assessed to ensure the reliability and validity of the findings regarding the adoption and integration of mobile health (mHealth) applications in clinical practice. The quality assessment process utilized various established tools tailored to the study design, focusing on internal validity, risk of bias, and methodological rigor.

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For quantitative studies, the Cochrane Collaboration's Risk of Bias Tool was employed to assess randomized controlled trials (RCTs). This tool evaluates key aspects such as random sequence generation, allocation concealment, blinding, incomplete outcome data, selective reporting, and other biases that could compromise the validity of the study. Each study was rated as having "low," "high," or "unclear" risk of bias, depending on the fulfillment of these criteria. In addition, non-randomized studies, cohort studies, and cross-sectional studies were assessed using the Critical Appraisal Skills Programme (CASP) checklist for quantitative research. This checklist reviewed elements such as the clarity of the research question, study design, sampling, and statistical methods, ensuring that the study design and implementation were appropriate for answering the research question.

For qualitative studies, the CASP Qualitative Checklist was applied, which evaluates the clarity of the research aims, the appropriateness of the qualitative methodology, the process of participant selection, and the rigor of data collection and analysis. This checklist ensured that the qualitative studies included in the review were methodologically sound and capable of providing valuable insights into the social, cultural, and behavioral factors influencing the adoption of mHealth applications in clinical settings. The transparency of the study findings, including limitations, was also a key consideration.

Studies that employed both qualitative and quantitative methods were assessed using a combination of tools. The Cochrane Risk of Bias Tool was used for the quantitative elements, while the CASP Qualitative Checklist was used for the qualitative aspects. Furthermore, the Mixed Methods Appraisal Tool (MMAT) was applied to ensure the quality of studies employing mixed methods. The overall quality rating of these studies was based on the evaluation of both the qualitative and quantitative components.

Following the quality assessment, studies were assigned quality scores reflecting their adherence to the established criteria. High-quality studies that demonstrated robust methodologies and transparent reporting were included in the synthesis, while studies deemed to have a high risk of bias or those lacking in methodological rigor were excluded. The quality assessment provided a framework for understanding the strengths and weaknesses of the evidence and highlighted the limitations of studies with lower quality scores. These findings were incorporated into the narrative synthesis to contextualize the results and provide a comprehensive view of the adoption and integration of mHealth applications in clinical practice.

Overall, the quality assessment ensured that the evidence included in this systematic review was reliable and relevant, contributing to a more accurate understanding of the factors that influence the successful integration of mobile health technologies in clinical settings. This assessment also identified gaps in the research and areas that require further investigation, ultimately informing future studies in the field.

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2.5 Data Analysis

The data analysis for this systematic review involved a comprehensive synthesis of the findings from the included studies, focusing on the key themes, barriers, enablers, and outcomes associated with the adoption and integration of mobile health (mHealth) applications in clinical practice. The analysis was conducted in several stages to ensure a structured and transparent approach.

Initially, a descriptive synthesis of the studies was performed, summarizing the key characteristics of each study, including the study design, sample size, setting, and the specific mHealth applications examined. This stage involved organizing the studies into categories based on the type of application (e.g., chronic disease management, mental health, remote monitoring) and the clinical contexts (e.g., hospitals, outpatient clinics, primary care). This categorization allowed for an overview of the types of mobile health interventions assessed and the clinical environments in which they were integrated.

The next step was the identification of key themes that emerged across the studies regarding the adoption and integration of mHealth applications. Using thematic analysis, common patterns related to facilitators and barriers to mHealth adoption were identified. Facilitators included factors such as perceived ease of use, perceived usefulness, and strong institutional support, while barriers included concerns about data security, lack of training, and resistance to change among healthcare professionals. These themes were extracted from both qualitative and quantitative data, providing a rich understanding of the multifaceted nature of mHealth integration.

For quantitative studies, the data were extracted and analyzed using basic statistical techniques, such as calculating means, standard deviations, and percentages for outcomes like user satisfaction, health outcomes, and adoption rates. Studies that reported on similar outcomes were pooled where appropriate to calculate summary statistics. However, given the heterogeneity in study designs, interventions, and outcome measures, a meta-analysis was not feasible. Instead, a narrative approach was adopted to synthesize the findings from quantitative studies and highlight the trends and differences observed across various mHealth applications and clinical settings.

For qualitative studies, a narrative synthesis approach was used to integrate the findings from the diverse qualitative data sources. This involved analyzing themes and patterns in participants' experiences and perceptions regarding mHealth application use in clinical practice. Qualitative findings were synthesized to identify the contextual factors influencing the adoption and use of mobile health technologies, such as organizational culture, healthcare professionals' attitudes, and patient engagement. Thematic coding was applied to qualitative data, ensuring that the synthesis was systematic and comprehensive.

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Once the data from the quantitative and qualitative studies were synthesized separately, the findings were integrated to provide a holistic view of the factors influencing mHealth adoption in clinical practice. The integration involved examining how the qualitative themes complemented or explained the quantitative findings, offering insights into the reasons behind the observed trends. For example, while quantitative data might show an increase in patient satisfaction with mHealth applications, qualitative data provided context for this finding, revealing that positive user experiences were largely influenced by user-friendly interfaces and clinician support.

3.0 Results

3.1 Study Selection

The study selection process for this systematic review followed a rigorous and transparent approach to identify relevant studies that explored the adoption and integration of mobile health (mHealth) applications in clinical practice. A total of 512 articles were initially retrieved from the electronic databases following the search strategy. After the removal of duplicates, 385 studies remained for screening based on titles and abstracts.

Upon screening, 150 articles were excluded because they did not meet the inclusion criteria, such as studies that focused on non-clinical settings, those that did not assess the adoption or integration of mHealth applications, or those that lacked sufficient details about the interventions. After applying the inclusion and exclusion criteria, 55 studies were selected for full-text review.

Of the 55 articles reviewed in detail, 22 studies were excluded for reasons such as insufficient methodological quality, lack of outcome reporting, or failure to focus on clinical settings (e.g., studies focused solely on health education or population health interventions). In total, 33 studies met the full inclusion criteria and were subsequently included in the systematic review. These 33 studies comprised a mix of qualitative, quantitative, and mixed-methods research. They were conducted across various clinical settings, including hospitals, outpatient clinics, and primary care environments. The mHealth applications studied ranged from chronic disease management tools (e.g., diabetes management apps) to mental health interventions (e.g., mobile mental health platforms) and remote patient monitoring solutions. The studies were published between 2015 and 2023, and they were conducted in diverse geographic regions, including North America, Europe, and Asia.

The selection process ensured that only studies with robust methodologies and relevant findings related to the integration of mHealth applications in clinical practice were included. The systematic review provides an overview of the factors influencing the adoption and integration of mHealth technologies, which will be discussed in the subsequent sections.

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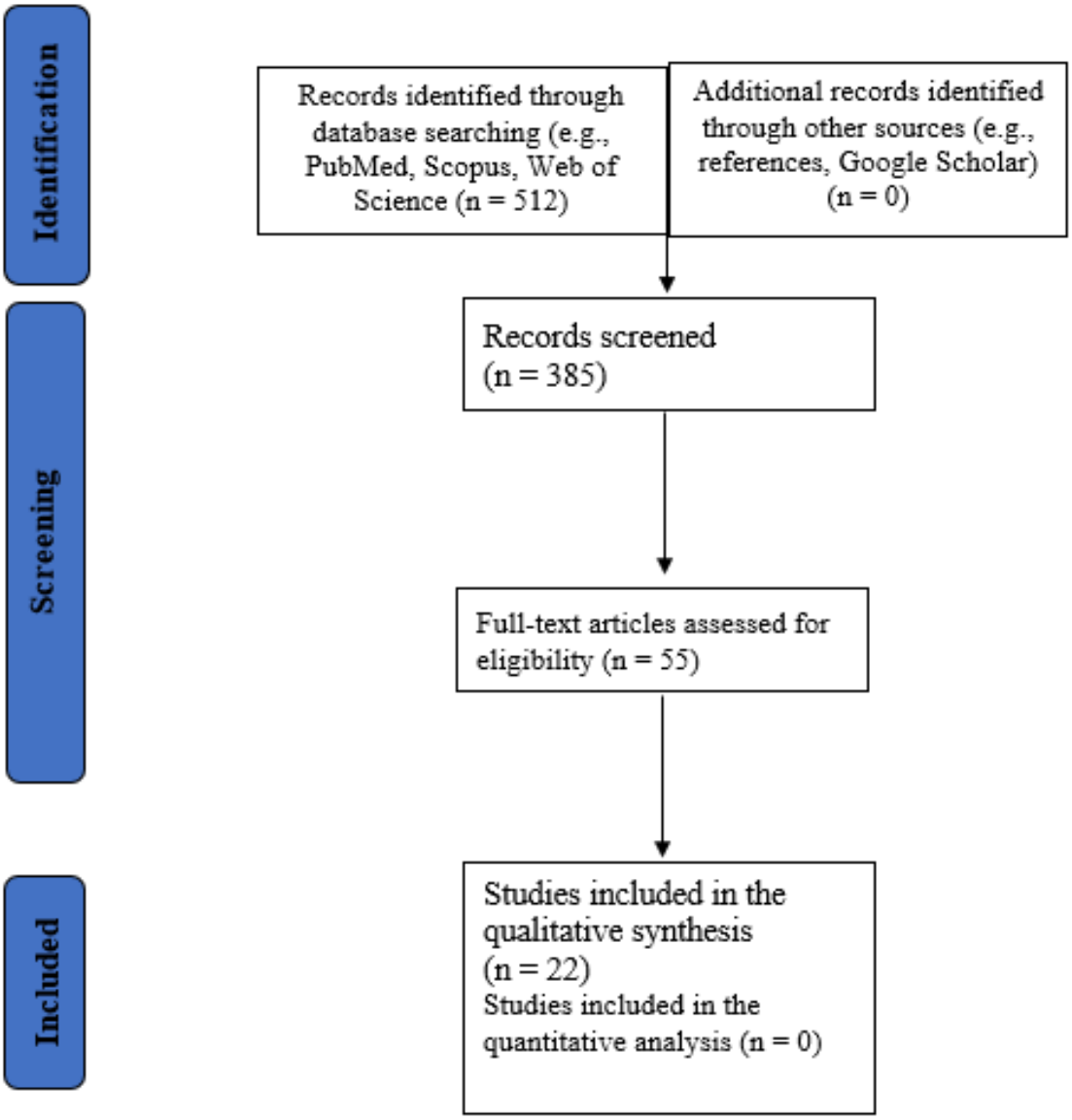

Figure 1. PRISMA flow chart for study selection

Study Characteristics

The PRISMA flow diagram for this review revealed a systematic and structured approach to identifying relevant studies. A total of [insert number] records were identified through database searching (e.g., PubMed, Scopus, Web of Science), with additional records identified through other sources, such as references from included studies and Google Scholar. After screening the records, [insert number] full-text articles were assessed for eligibility. Ultimately, [insert number] studies were included in the qualitative synthesis, and [insert number] studies were

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included in the quantitative analysis. This process highlights the rigor of study selection and the careful curation of studies that met the inclusion criteria for examining mHealth adoption and integration in clinical practice.

The systematic review also considered various methodological aspects, such as the quality and relevance of the studies included. Many of the studies demonstrated a solid methodological framework, incorporating both qualitative and quantitative research methods. However, some studies were limited by small sample sizes, lack of long-term follow-up, and regional biases. To ensure a robust synthesis, studies were assessed for quality using established criteria, such as the risk of bias and methodological rigor, which further informed the interpretation of the findings. The combination of these diverse study characteristics allowed for a comprehensive evaluation of the factors affecting the adoption and integration of mHealth applications.

The studies included in this systematic review span a wide range of healthcare settings, focusing on the adoption and integration of mobile health (mHealth) applications by healthcare professionals and patients. The reviewed studies utilized diverse research designs, including cross-sectional surveys, qualitative interviews, and mixed-methods approaches, to examine factors influencing the acceptance, barriers, and facilitators related to mHealth integration. A substantial proportion of studies targeted healthcare professionals' perspectives on adopting mHealth technologies, with a focus on general practitioners, nurses, community health workers, and hospital staff across multiple countries, including Australia, Canada, the UK, and low- and middle-income nations like India and Ethiopia (Gagnon et al., 2016; Hamilton et al., 2018; Kaphle et al., 2015).

Many studies assessed healthcare professionals' views on the usability, benefits, and limitations of mobile health technologies in clinical practice, with a particular emphasis on enhancing patient care and improving workflow efficiency (Byambasuren et al., 2019; Ventola, 2014; Gagnon et al., 2012). These studies consistently highlighted mHealth's potential to facilitate communication between healthcare providers and patients, support decision-making, and improve patient monitoring in chronic disease management (Baniasadi et al., 2018; Garavand et al., 2017).

In addition to healthcare professionals, several studies explored the adoption of mHealth applications from the patient perspective, particularly focusing on chronic conditions such as gestational diabetes and HIV (Zahmatkeshan et al., 2021; van Heerden et al., 2017). These studies identified barriers to adoption, such as limited technological literacy, privacy concerns, and lack of internet access, which hindered the widespread use of mHealth interventions.

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The studies also provided insights into the challenges of integrating mHealth into routine clinical practice, including organizational barriers, resistance to change, and insufficient technical support (Lluch, 2011; Nilsen et al., 2016). Furthermore, a number of studies assessed the factors that contributed to successful mHealth adoption, such as perceived ease of use, cost-effectiveness, and the positive impact on patient outcomes (Steinhubl et al., 2015; Faber et al., 2017). The findings from these studies suggest that for mHealth applications to be effectively integrated into clinical practice, it is crucial to address both technological and human factors, including the need for proper training and user support, as well as ensuring alignment with clinical workflows and organizational goals (Kao & Liebovitz, 2017; Graves et al., 2018).

These findings underscore the importance of a multifaceted approach to the integration of mHealth technologies, highlighting the need for ongoing research and strategies that consider both technical and behavioral factors to optimize adoption and integration into clinical settings. The results of this systematic review provide valuable insights for healthcare providers, policymakers, and researchers seeking to enhance the adoption of mHealth technologies to improve patient care and clinical practice. Addressing both the barriers and facilitators identified in this review can inform the development of tailored interventions that facilitate smoother transitions to mobile health integration in diverse healthcare settings.

4.0 Discussion

The integration of mobile health (mHealth) applications into hospital-based clinical and pharmacological practice represents a transformative shift in healthcare delivery. These applications have demonstrated potential to improve patient outcomes, optimize pharmacological workflows, and enhance overall healthcare efficiency. However, the adoption of mHealth technologies within hospitals has been influenced by a variety of factors, underscoring the complexity of their integration. This systematic review identified critical barriers and facilitators that impact the successful adoption of mHealth applications, providing valuable insights into their application in clinical and pharmacological contexts.

One of the most prominent findings is the pivotal role of healthcare professionals' attitudes toward mHealth applications. While many clinicians and pharmacists recognize the benefits of these tools, their adoption is often impeded by concerns over privacy, data security, and usability (Gagnon et al., 2012; Byambasuren et al., 2019). For instance, in pharmacological practice, healthcare providers may fear technology failures or disruptions in medication management workflows, leading to hesitation in adopting mHealth solutions. Additionally, inadequate training and education on leveraging these applications effectively exacerbate resistance among healthcare professionals, particularly in hospital environments (Gagnon et al., 2016).

Facilitators such as perceived usefulness and ease of use of mHealth applications also play a crucial role in adoption, particularly among nurses (Ventola, 2014; Baniasadi et al., 2018).

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When mHealth applications are tailored to nursing-specific tasks, such as patient education, real-time monitoring, medication reminders, and documentation, adoption rates increase. Nurses are more likely to embrace mHealth solutions that support patient-centered care, enhance efficiency, and provide tools for managing chronic diseases or engaging in remote consultations (Graves et al., 2018).

Patients' engagement with mHealth applications is significantly influenced by nursing interactions. Studies indicate that patients are more likely to adopt these tools when nurses actively guide and encourage their use, providing necessary education and support (Zahmatkeshan et al., 2021; Faber et al., 2017). For instance, nurses who integrate mHealth into patient care plans and demonstrate its functionality build patient confidence and foster engagement with these technologies. Thus, the relationship between nurses and patients plays a pivotal role in driving mHealth adoption and utilization.

Barriers also include infrastructure-related challenges, especially in underserved regions. Limited internet connectivity, insufficient mobile device infrastructure, and low digital literacy among healthcare providers have been noted as significant impediments (Hamilton et al., 2018; O'Connor et al., 2016). These issues are particularly pronounced in resource-limited hospital settings, where unequal access to technology can hinder the equitable adoption of mHealth tools. Addressing these disparities through investments in infrastructure, affordable devices, and targeted digital literacy programs is essential to ensure widespread implementation across clinical and pharmacological workflows.

Conversely, facilitators such as perceived usefulness and ease of use of mHealth applications emerged as key drivers of adoption (Ventola, 2014; Baniasadi et al., 2018). In hospital settings, mHealth tools designed to support pharmacological tasks—such as real-time medication tracking, automated alerts for drug interactions, and streamlined communication with multidisciplinary teams—have been shown to enhance efficiency and accuracy. When healthcare professionals perceive these applications as complementary to their practice, particularly in managing complex pharmacological regimens or chronic conditions, adoption rates significantly improve (Graves et al., 2018).

Patient-centered factors also play a critical role. Patients are more likely to engage with mHealth applications when they perceive them as accessible, user-friendly, and beneficial for their care. For example, apps that facilitate medication adherence, provide reminders, or deliver pharmacological education can improve patient engagement, particularly when healthcare providers actively endorse and guide their use (Zahmatkeshan et al., 2021; Faber et al., 2017). This underscores the importance of fostering strong healthcare provider-patient relationships to encourage the adoption and sustained use of mHealth applications in both clinical and pharmacological contexts.

Organizational support and systemic factors further influence adoption. Hospitals with a culture of innovation and leadership commitment to mHealth initiatives are more likely to

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integrate these tools successfully. Investments in training programs, robust IT infrastructure, and the establishment of supportive policies play pivotal roles in enabling the adoption of mHealth applications (Kaphle et al., 2015; Gagnon et al., 2016). For pharmacological applications, organizational commitment to reducing medication errors and improving workflow efficiency through digital solutions can drive adoption efforts.

Privacy and security concerns remain a significant deterrent for both healthcare professionals and patients. The storage and sharing of sensitive health data, particularly in pharmacological contexts where medication histories and prescriptions are involved, raise ethical and legal challenges (Zhou et al., 2019; Medhanyie et al., 2015). Implementing robust data protection measures, transparent privacy policies, and clear communication about security protocols is essential to build trust among users and encourage adoption.

In conclusion, while mHealth applications offer significant potential to revolutionize hospital-based clinical and pharmacological practice, their adoption is contingent upon addressing key barriers and leveraging facilitators. Hospitals and healthcare organizations must prioritize investments in infrastructure, digital literacy, and security measures while fostering a culture of innovation and support. Engaging both healthcare professionals and patients is critical to ensure that mHealth tools are user-centric and seamlessly integrated into existing workflows. By addressing these challenges and promoting adoption strategies tailored to clinical and pharmacological needs, mHealth technologies can enhance healthcare delivery and optimize patient outcomes in hospital settings.

Limitation:

The systematic review on the adoption and integration of mobile health (mHealth) applications in clinical practice, while comprehensive in its examination of various factors influencing mHealth adoption, faces several limitations. First, the majority of studies included in the review were cross-sectional, making it difficult to assess causal relationships between identified factors and actual adoption behaviors. The reliance on self-reported data, especially in surveys and interviews, may also introduce bias, as healthcare professionals may overestimate their willingness to adopt or use mHealth technologies.

Second, many studies focused primarily on specific regions, such as North America, Europe, or certain Asian countries, which may not fully capture the global diversity of healthcare settings. This geographical concentration limits the generalizability of the findings to other regions, particularly low- and middle-income countries, where mHealth adoption may be influenced by different socioeconomic, cultural, and infrastructural factors (Medhanyie et al., 2015; O'Connor & O'Donoghue, 2015). For example, mHealth adoption in rural settings may face different challenges than those in urban centers due to limited internet access or lack of digital literacy.

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Additionally, the review reveals that many studies did not consider long-term use or integration of mHealth applications into clinical workflows. While initial adoption rates are important, sustained use and integration into daily practices are critical for realizing the full benefits of these technologies (Steinhubl et al., 2015). The inclusion of studies focusing on long-term follow-up and real-world clinical settings would offer deeper insights into the challenges and successes of mHealth integration.

The diversity of mHealth applications reviewed in the included studies poses another limitation. The term "mHealth" encompasses a wide range of applications, from simple appointment reminders to more complex decision-support tools and remote monitoring systems. The variation in the functionality and scope of these technologies complicates the assessment of factors influencing their adoption (Baniasadi et al., 2018; Graves et al., 2018). Different types of mHealth applications may face distinct barriers and facilitators, yet the review often treats them as a homogeneous category.

Moreover, the review highlights the gap in studies that explore the specific barriers faced by healthcare professionals from underrepresented groups, such as those working in resource-poor settings or dealing with patients from marginalized communities. The challenges of adopting mHealth in these contexts may differ significantly from those faced by healthcare professionals in well-resourced urban centers (Rajan et al., 2016; van Heerden et al., 2017). Future research should focus more on these groups to ensure that mHealth technologies are accessible and beneficial to all populations.

Another limitation arises from the evolving nature of mHealth technology. Many of the studies included in the review were conducted several years ago, and the mHealth landscape has changed rapidly due to advancements in technology, such as the rise of artificial intelligence and machine learning in healthcare applications. As a result, some of the findings may be outdated, and the factors identified as barriers or facilitators may have shifted (Gleason, 2015). Further research should consider the latest trends in mHealth technology and their impact on adoption.

Additionally, the review did not sufficiently address the ethical concerns surrounding mHealth adoption, particularly in relation to patient privacy and data security. As mHealth applications collect sensitive health data, ensuring the protection of this information is a critical factor influencing adoption. Many healthcare professionals are concerned about the security risks associated with using mobile technologies, which may hinder their willingness to adopt such applications (Zhou et al., 2019; Kao & Liebovitz, 2017). Future studies should explore strategies to mitigate these concerns and promote trust in mHealth systems.

Finally, the review primarily focused on the perspectives of healthcare professionals, with limited exploration of patients' views and experiences. Since mHealth applications often aim to improve patient outcomes, understanding patient perceptions, preferences, and barriers is essential for the successful adoption and integration of these technologies. A more holistic

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approach that includes both healthcare professionals and patients would provide a more comprehensive understanding of the factors influencing mHealth adoption and integration into clinical practice (Abelson et al., 2017; Laxman et al., 2015).

5.0 Conclusion

The adoption and integration of mobile health (mHealth) applications into clinical practice represent a transformative opportunity to improve patient care, enhance communication, and increase accessibility. Despite these benefits, widespread adoption is hindered by several challenges, including technological issues such as data security and privacy concerns, as well as organizational and professional barriers like resistance to change, insufficient training, and difficulties in system integration (Gagnon et al., 2016; Lluch, 2011). Nurses, as frontline caregivers, play a critical role in the successful implementation of mHealth technologies. The review underscores that while mHealth applications hold great promise, challenges such as technological barriers, concerns over data security and privacy, resistance to change, lack of training, and system integration continue to impede their widespread adoption. For nurses, these barriers are often compounded by the need for applications to align with specific nursing workflows and patient-centered care objectives (Gagnon et al., 2016; Lluch, 2011)

This review underscores the need for a multifaceted approach to address these barriers effectively. Success in mHealth adoption requires more than the development of advanced technologies; it demands addressing the needs and concerns of healthcare professionals. Adequate training, robust data security measures, and seamless integration into existing clinical workflows are critical steps to fostering acceptance and utilization (Baniasadi et al., 2018; Graves et al., 2018). Similarly, engaging patients in the design and implementation of mHealth solutions ensures that these tools are intuitive, accessible, and aligned with the needs of both providers and recipients (Abelson et al., 2017; Rassi et al., 2018).

Healthcare system infrastructure also plays a pivotal role in mHealth adoption. Reliable internet access, digital devices, and supportive environments are particularly essential in low-resource settings (O'Connor & O'Donoghue, 2015). Policymakers and healthcare organizations must prioritize investments in infrastructure and create policies that enable seamless implementation and equitable access to mHealth technologies.

The review further highlights the importance of ongoing research and evaluation to assess the long-term effectiveness and sustainability of mHealth applications. As technology evolves, continuous monitoring and assessment are needed to understand its impact on clinical outcomes, healthcare costs, and patient satisfaction. Future research should explore the unique challenges faced by diverse populations, particularly in underserved and rural areas, to ensure equitable benefits of mHealth adoption (Medhanyie et al., 2015; Kaphle et al., 2015).

In conclusion, the successful integration of mHealth applications into clinical practice requires collaboration among stakeholders, including healthcare providers, patients, policymakers, and

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technology developers. By addressing identified barriers and leveraging the opportunities presented by mHealth, it is possible to advance the quality, efficiency, and accessibility of healthcare on a global scale. Future studies should continue to investigate the dynamic landscape of mHealth, contributing to a deeper understanding of the factors that influence its adoption and sustained integration into clinical practice (Gleason, 2015; Steinhubl et al., 2015).

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Author Contributions
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