OPEN ACCESS
Global Journal of Research in Medical Sciences
ISSN: 2583-3960 (Online)
Volume 05 | Issue 03 | May-June | 2025
Journal homepage: https://gjrpublication.com/gjrms/

Research Article

Insights on Integrated Mobile Health Intervention on Socio-Demographic Characteristics in Relation to Medication Adherence

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DOI: 10.5281/zenodo.15391187 **Submission Date:** 10 April 2025 | **Published Date:** 13 May 2025

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Abstract

Background: *The fast spread of mobile health (mHealth) technologies in low- and middle-income countries (LMICs) has been praised for its potential to transform healthcare delivery, particularly among underserved groups. However, the efficacy of these tools is frequently moderated by complex socio-demographic factors that influence adoption, engagement, and health outcomes.* ***Aim:*** *This narrative review critically investigates how age, gender, education, poverty, and geographic location influence the adoption and effectiveness of mHealth interventions in Sub-Saharan Africa (SSA), with an emphasis on equitable access and program sustainability.*

Methodology: *A systematic narrative methodology influenced by Braun and Clarke's thematic analysis framework and CRD recommendations was used to synthesise peer-reviewed literature and grey sources. The study uses theoretical frameworks such as the Health Belief Model, the COM-B framework and Fisher & Fisher's IMB model to understand behavioural and systemic trends.*

Findings: *According to the findings, mHealth uptake is stratified by age and gender, with younger, urban, educated users benefiting the most. Key impediments include digital illiteracy, network restrictions, sociocultural norms, and economic inequalities, while facilitators include user-centred design, community-based interventions, and telecom collaborations.*

Conclusion: *The review finds that a one-size-fits-all mHealth design is insufficient and it advocates for intersectional, equity-informed solutions that take into account different user experiences, strong policy frameworks, long-term funding, and ethical data governance.*

Keywords: *Mhealth, Mobile Intervention, Digital Health Equity, Health Behaviour, Socio-Demographic Factors, Sub-Saharan Africa, Health System Integration.*

INTRODUCTION

Evidence demonstrate that human Immunodeficiency Virus (HIV) as a retrovirus that weakens the immune system, leaving the body vulnerable to opportunistic infections [1-6], particularly Tuberculosis (TB), which WHO [7] describes as a bacterial infection and the leading cause of death among HIV/AIDS patients. According to Kassaw et al. [8], HIV and tuberculosis constitute a syndemic, a co-occurring burden that affects the outcome of both diseases, notably in Sub-Saharan Africa, where Nigeria has the highest TB-HIV co-infection cases in West Africa. Medication adherence, the amount to which patients take medications as prescribed is considered critical in treating both infections, but it remains unsatisfactory [9]. Ndlangamandla [10] contends that the complexities of dual therapy regimens, combined with stigma, economic hardship, and weak health-care institutions, severely weaken adherence. To address these gaps, mobile health (mHealth)—defined by Free et al. [11] as the use of mobile devices to support medical and public health practices—has emerged as a viable solution, particularly in resource-constrained contexts. WHO [12] state that mHealth can increase treatment adherence, clinical monitoring, and health education, while opponents such as Holeman and Kane [13] argue that its impact is frequently mediated by socio-demographic differences such as age, gender, literacy, and location. However, these factors influence both access to mobile technologies and the ability to engage effectively with digital health solutions [14]. The goal of this research is to critically examine how such socio-demographic characteristics affect the efficacy of integrated mHealth treatments on medication adherence among HIV/TB co-infected patients in Imo State.

Conceptual and Theoretical Frameworks

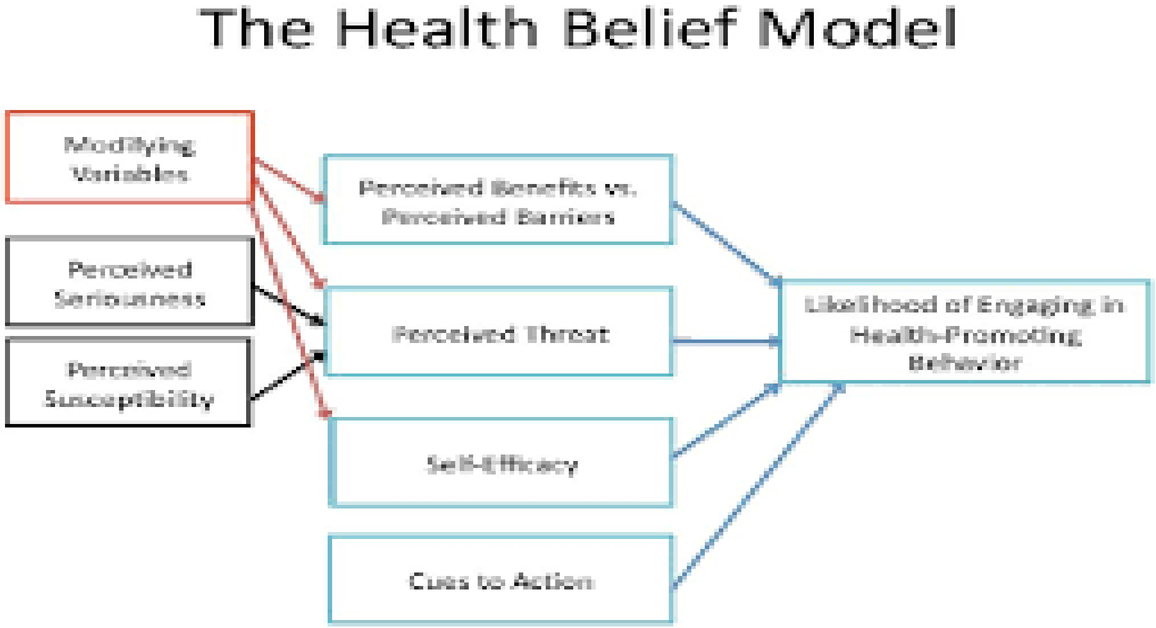

Figure 1: Health Believe Model [15]

Theoretical frameworks serve as the scaffolding for designing, interpreting, and evaluating behavioral health interventions (Figure 1). Rosenstock [15] proposed the Health Belief Model (HBM), which states that individuals' perceptions of threat (susceptibility and severity), benefits of action, and barriers to action influence their health-related behaviour. In line with this, Champion and Skinner [16] argue that medication adherence is more likely when people perceive themselves as at risk and believe that taking action (for example, mHealth reminders) will reduce that risk. However, detractors such as Janz and Becker [17] argue that HBM undervalues social and environmental effects, rendering it ineffective in explaining adherence in complex socio-demographic circumstances. In contrast, Michie et al. [2] developed the COM-B model, which includes capacity, opportunity, and motivation as core components that interact to generate behaviour and this model is more closely aligned with mHealth implementation because it considers not only internal readiness but also external factors such as access to mobile devices and health system support. West and Michie [18] emphasize that digital adherence tools must take into account both what motivates people and the external conditions that support them, which can be influenced by differences in social and economic backgrounds. Furthermore, Fisher and Fisher's [3] Information-Motivation-Behavioural Skills (IMB) model provides another perspective, arguing that people who are adequately informed, motivated, and behaviourally skilled will stick to their medication regimen. This paradigm has been widely employed in HIV interventions and, according to Rivet Amico [19] complements mHealth techniques by emphasizing material tailored to users' literacy and cultural context. On a larger scale, the socio-ecological model (SEM) organizes behaviour change at various levels, including individual, interpersonal, community, organizational, and policy and this concept is especially applicable in low- and middle-income countries, where adherence is influenced by systemic factors including health facilities and community norms [20]. DiClemente et al. [21] argue that only interventions that address multiple SEM layers can sustainably improve adherence, which is supported by mHealth projects that include community health workers and family engagement. Additionally, Van Dijk [22] discusses Digital Divide Theory, which investigates inequalities in digital technology access and use. Warschauer [23] thinks that this disparity is about more than simply access; it is also about digital literacy and the sociocultural capital required to use technologies effectively. Viswanath and Kreuter [24] argue that socio-demographic variables such as education, gender, age, and location have a direct impact on the uptake and outcomes of digital interventions in mHealth and while each framework is unique, they all contribute to a better understanding of how mHealth, adherence, and socio-demographic factors interact.

METHODOLOGY

A narrative review is a type of evidence synthesis that gives a thorough, descriptive, and interpretive summary of available literature on a specific issue without adhering to strict systematic review standards [25]. Unlike systematic reviews, which follow precise guidelines and focus on merging data, narrative reviews are better suited to complex themes where discrepancies in treatments, study techniques, and locations make it difficult to assess the data together. This review used a narrative synthesis approach to investigate the impact of integrated mobile health (mHealth) interventions on medication adherence among individuals co-infected with HIV and tuberculosis (TB), with a particular emphasis on the role of sociodemographic characteristics within care centers in Imo State, Nigeria. This strategy was chosen due to the variety of mHealth interventions available (such as SMS reminders, app tools, and phone services), as well as variances in the people engaged (such as age, gender, and income) and the health systems in which they operate. Such diversity makes statistical synthesis less helpful, emphasizing the necessity for a qualitative, thematically driven analysis to understand how and why individual factors influence intervention outcomes [26]. The literature search was undertaken using numerous databases, including PubMed, Scopus, Web of Science, African Journals Online (AJOL), and Google Scholar, to ensure that both global and regional studies were included. Boolean operators were used to create search phrases, which comprised a combination of free-text and Medical Subject Headings (MeSH) terms such "mHealth," "HIV," "Tuberculosis," "Adherence," "Nigeria," "Socio-demographic Factors," and "Mobile Interventions." To ensure that many relevant research as possible between 2005 and 2025 was found, focus was directed on the rise of mobile health technology in Sub-Saharan Africa [12]. The inclusion criteria included peer-reviewed journal articles, qualitative and quantitative empirical studies, mixed-methods research, and relevant grey literature such as government reports, policy briefs, and WHO publications. All selected studies examined HIV/TB co-infection and mHealth interventions in low- and middle-income countries (LMICs), with a focus on Nigeria and similar socio-demographic contexts in Sub-Saharan Africa [6], Editorials, opinion articles, and research that were not published in English or did not provide adequate methodological detail were excluded. Given the nature of this review, we prioritized studies that investigated the relationship between sociodemographic characteristics (such as age, gender, literacy, economic level, and urban-rural domicile) and adherence behaviours in the context of mHealth-supported HIV/TB treatment. Instead of employing a structured systematic coding framework for data extraction, a thematic analysis method was used. According to Braun and Clarke [1], thematic analysis provides flexibility in detecting, interpreting, and reporting patterns (themes) throughout a data set, making it ideal for synthesizing heterogeneous and contextually rich studies. Titles and abstracts were used to evaluate studies for relevance before conducting a full-text review. Key data gathered included research location, demographic characteristics, intervention kind, and adherence results. The studies were then categorized and compared based on common themes such as digital access, technology skills, health system involvement, and social support, allowing us to better understand how social and demographic aspects influence the success of mHealth.

FINDINGS

According to Vaportzis, Clausen, and Gow [27] older persons frequently have lesser digital literacy and are more skeptical of mobile technologies due to generational differences, which impedes mHealth uptake agreeing that age, as a sociodemographic characteristic, has a major impact on digital involvement in healthcare interventions. Wagner et al. [28] agree, stating that younger people are more likely to use smartphones consistently, which improves adherence to reminders and health information. Choi and DiNitto [29] on the other hand, contradict this age-based distinction, claiming that when provided sufficient training, older persons display comparable digital engagement, underlining the importance of age-tailored mHealth design. According to GSMA [30], women in Sub-Saharan Africa use mobile internet 37% less than men, owing to differences in access, literacy, and social autonomy. Barro et al. [31] argue that cultural conventions and gender roles limit women's ability to make independent decisions, with many seeking marital approval to buy or use a phone. This is consistent with Hardon et al. [32] who argue that gendered power dynamics further limit women's privacy in managing HIV/TB-related mHealth communication, raising the risk of stigma and nonadherence. Jenkins [33] contends that inclusive, community-based mHealth programs can increase female engagement when created with gender-sensitive techniques and the ability to understand and respond to mHealth interventions is determined by one's educational level, which is directly related to health literacy. Nutbeam [34] defines health literacy as the ability to obtain, interpret, and act on health information, rather than simply reading it. Glick et al. [35] discovered that users with higher education levels correctly interpreted mHealth messaging and interacted effectively with app features. Jones-Esan et al. [36] find that persons with inadequate literacy frequently misread SMS information, jeopardising treatment adherence, underlining the need for simplified, visual, or voice-based communication forms. Van Heerden et al. [37] posited that income and socioeconomic level (SES) also influence access to mobile devices, data plans, and consistent involvement, as well contending that poverty limits digital health engagement by reducing phone ownership and constant connectivity. According to WHO [12], low socioeconomic status is both a barrier to adherence and a confounder in digital uptake, since economic stressors may deprioritize health-related behaviours. Poushter [38] reveals that the affordability of airtime and power remains a recurrent issue in rural and peri-urban areas. Location, whether urban or rural, has a significant impact on mHealth integration. Oyeyemi and [39] metropolitan inhabitants benefit from greater infrastructure, stronger mobile networks, and more modern health systems, all of which facilitate seamless mHealth integration. In contrast, Owusu-Ansah et al. [40] indicate that rural residents frequently confront poor network signals, a lack of digital literacy training, and overworked clinics that are unprepared to manage tech-based therapies. Furthermore, marital status, occupation, religion, stigma, and language influence individual responses to mHealth interventions and Bogart et al. [41] claim that the stigma associated with HIV and tuberculosis can dissuade people from using mobile tools that may mistakenly reveal their medical condition. According to Krah et al. [42], linguistic mismatches between mHealth content and user dialects alienate users even more, increasing isolation and nonadherence (Figure 2).

Implementation Science and Mhealth

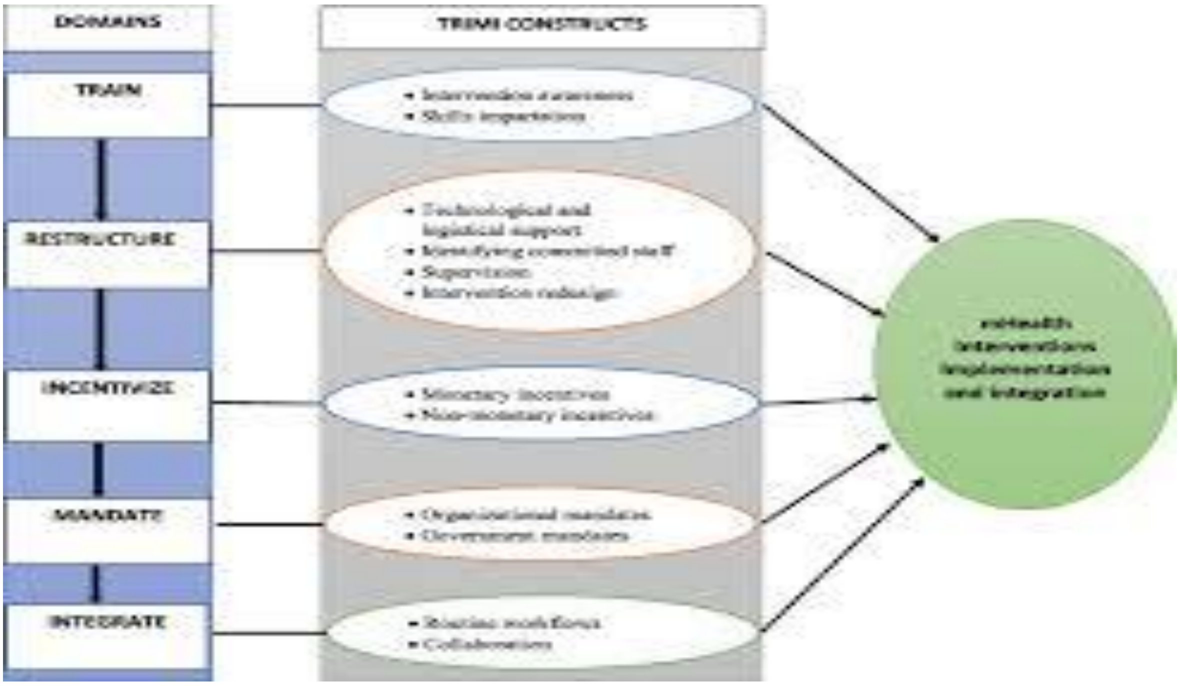

Figure 2: Implementation Science

Implementation science in the context of mobile health (mHealth) refers to the systematic study of techniques to enhance the uptake, integration, and sustained use of evidence-based digital health innovations inside real-world health systems [41]. According to Damschroder et al. [44], the Consolidated Framework for Implementation Research (CFIR) includes multiple factors spanning from intervention characteristics to outer setting elements that influence whether an innovation, such as mHealth, is successfully implemented. The World Health Organisation (WHO) supports this viewpoint, arguing for a systems-thinking approach that includes policy, workforce, and digital architecture as essential domains in implementation [12]. In mHealth, implementation science must include not just clinical efficacy, but also sociocultural acceptance, technological feasibility, and scalability across multiple geographies. Aranda-Jan et al. [45], many mHealth projects in Africa fail due to fragmented policy landscapes and poor intersectoral collaboration, which erode institutional buy-in and jeopardise program continuation and thorough assessment demonstrates that, despite technical soundness, several treatments failed in the absence of unified governance frameworks. Mechael et al. [14] agree that a recurring issue is a lack of technical support after implementation, particularly in remote areas with inadequate infrastructure. Barro et al. [31] note that infrastructural deficiencies, such as unpredictable power supply and network inconsistencies, undermine mHealth effectiveness, particularly in distant locations where referral mechanisms are frequently non-functional. According to Holeman and Kane [13] human-centered design (HCD), which includes end users at all stages of the development process, significantly enhances adoption and long-term use, and the work in global health equality reveals that mHealth solutions built on community-based participatory design are more likely to succeed because they represent users' lived experiences and digital capacities. Furthermore, Agarwal et al. [46] emphasise the necessity of empowering frontline health professionals through ongoing training and supportive supervision, claiming that digital literacy among health workers not only improves tool use but also builds client trust, which is crucial in culturally sensitive areas such as reproductive health. Kassaw et al. [8] report mixed results in Ethiopia, where early adoption of mHealth in tuberculosis management showed promise but was hampered by limited resources and a lack of interoperable platforms. In contrast, Kenya provides a more optimistic scenario; Lester et al.,[47] show that SMS-based reminders for HIV treatment adherence considerably improved health outcomes, thanks to reasonably solid mobile infrastructure and donor support. Jones-Esan et al. [36] argue that even within LMICs, differences in digital penetration, governance structures, and sociocultural attitudes necessitate contextual tailoring of mHealth initiatives, criticising the tendency to generalise findings from urban pilot programs to the national level while ignoring rural-specific difficulties. According to Hall et al. [48], "pilot-itis" occurs when there is an overemphasis on innovation metrics and proof-of-concept trials, resulting in a glut of uncoordinated ventures that seldom integrate into national health systems, advocating for fewer, more strategic interventions guided by strong implementation science frameworks. This critique interacts with the issue of donor dependence addressed by Mechael et al. [14] study, which warns that without local ownership and long-term planning, mHealth risks becoming another fleeting health craze and the long-term viability of mHealth is thus dependent not only on its technological soundness, but also on political will, community engagement, and adaptive learning mechanisms.

HUMAN CENTERED DESIGN AND USER ENGAGEMENT

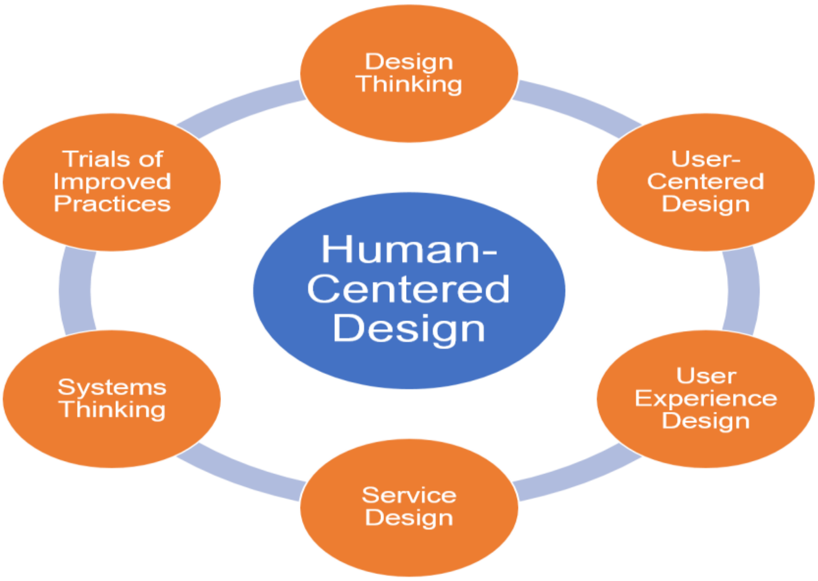

Figure 3: Human Centered Design

Human-Centered Design (HCD) has arisen not only as a design choice but as a methodological need for attaining fairness in digital health interventions, particularly in low- and middle-income situations [48]. Holeman and Kane [13] suggest that HCD pushes digital health design away from technocentric ideologies and toward participatory paradigms that understand the embeddedness of health behaviors within specific cultural, social, and infrastructural settings (Figure 3). While HCD theoretically provides relevance and adaptability, in practice, it is frequently diluted by donor-driven timetables and bureaucratic implementation cultures that value scalability over contextual [14]. Free et al. [11], express serious worries about how bad interface design and usability deficiencies harm user experience and, as a result, the usefulness of mHealth platforms. Identifying multiple initiatives where high attrition rates were clearly linked to non-intuitive design characteristics, which not only confuse users but also undermine faith in digital health solutions. Lewis and Wyatt [49] broaden this critique by emphasising the safety risks inherent in poorly regulated app ecosystems, pointing out that literacy mismatches between platform complexity and user capability frequently result in misinformation or dangerous self-treatment practices. The GSMA [30] estimates a persisting mobile gender gap in Sub-Saharan Africa, with women 19% less likely than males to use mobile internet, owing to affordability constraints, literacy gaps, and social conventions that limit phone use. Glick et al. [35] supplement this with findings from paediatric settings, where carers, mainly older women, struggle to interact with digital tools due to inadequate health literacy, resulting in poor health outcomes for children, and these findings suggest that the design of mHealth platforms cannot be separated from systemic inequities and must actively remove them through intentional inclusion measures. Integrating models such as Fisher and Fisher's [3] Information-Motivation-Behavioral Skills (IMB) model and Michie et al. [2] COM-B model provides a systematic approach to embedding behaviour change science into platform architecture and the IMB model emphasises that knowledgeable and motivated users with the necessary behavioural skills are more likely to participate in and benefit from digital health interventions. Similarly, the COM-B model (capability, opportunity, motivation behavior) enables designers to align technological interventions with users' psychological and contextual realities, elevating personalisation from a luxury to a design imperative and the dominating logic of digital health scaling, which prioritises uniformity and cost-efficiency, frequently contradicts this personalisation approach [14]. Aranda-Jan et al. [45] warn that design frameworks that ignore the diversity of user contexts urban vs. rural, literate vs. preliterate, young vs. elderly risk exacerbating digital disempowerment. Jenkins [33] underlines this issue by demonstrating how a mobile-based family planning campaign in Uganda failed among adolescent girls because users were assumed to have equal educational backgrounds and phone access levels and the failure of such initiatives demonstrates the risks of using one-size-fits-all templates on complex, diverse groups. Human-centered design should not be reduced to superficial user testing or aesthetic refinement but must be founded in structural realism acknowledging the economic, sociocultural, and infrastructural limitations that mediate access and engagement.

SUSTAINABLE AND EQUITABLE SCALE-UP

Sustainability in digital health, particularly in mHealth ecosystems, goes beyond technological resilience and focusses on long-term systemic integration, institutional ownership, and enduring impact within public health frameworks [14]. According to Labrique et al. [50], long-term mHealth tactics must be aligned with broader health system strengthening goals, rather than operating as isolated innovations. Mechael et al. [14] argue that many mHealth projects fail to attain long-term viability due to their reliance on donor cycles, lack of integration with current health management information systems (HMIS), and low institutional buy-in. As a result, the ability of digital treatments to evolve within and contribute meaningfully to dynamic health systems over time, rather than short-term functioning or reach, determines sustainability [48]. However, Fadlallah et al. [51] emphasise that, while narrative-driven research effectively captures lived experiences and frontline realities, its impact on formal policy-making is still limited, and it uncovers a structural gap between qualitative research and policy making, with emotionally charged insights frequently overlooked in favour of bureaucratic slowness or politically palatable goals. The Centre for Reviews and Dissemination [5] shares this concern, describing how health policy is frequently shaped by evidence hierarchies that undervalue context-specific narratives and implementation learnings, ignoring the complexities of digital health deployment in diverse sociopolitical contexts. This policy myopia is exacerbated by a lack of conscious coordination among stakeholders, making the potential of public-private partnerships (PPPs) even more important. The GSMA [30] emphasises how collaborations among mobile network operators (MNOs), governments, and non-governmental organisations (NGOs) can bridge affordability gaps and develop digital infrastructure, particularly for marginalised populations like rural women who face economic and sociocultural access barriers. However, such partnerships must go beyond mere coordination to include clear accountability mechanisms, equitable resource sharing, and alignment with community needs and without this, public-private partnerships risk becoming another layer of fragmented intervention rather than a catalyst for inclusive access [14]. Furthermore, while PPPs are frequently lauded for their ability to mobilise resources and scale innovation, they raise serious questions about data protection and ethical management [48]. Lewis and Wyatt [49] contend that the growth of digital health applications in the absence of standardised regulatory frameworks exposes users to exploitation, surveillance, and breach of confidentiality and these dangers are especially high in situations where users lack the digital literacy to comprehend consent mechanisms or fight data usage and the monetisation of health data by both private actors and governments often disguised as "innovation" undermines trust, which is essential for any public health action. As a result, the data architecture of mHealth systems must include high ethical standards, transparent governance, and community supervision in order to scale up sustainably, and looking ahead, the future of digital health must be redefined using hybrid models that combine emerging technologies with grounded, community-based approaches [14]. Holeman and Kane [13] propose merging telemedicine platforms with wearable sensors and frontline health worker networks, supported by machine learning algorithms that personalise care delivery based on user data, contextual variables, and behaviour patterns. However, the promise of such technological fusion must be balanced with a commitment to equity, ensuring that personalisation does not become a vehicle for exclusion or algorithmic bias. DiClemente et al., [21] support this by saying that behaviour change initiatives in digital health must take into consideration structural determinants of health, acknowledging that no amount of technological accuracy can compensate for social injustice or institutional neglect. Thus, future digital health frameworks must strike a balance between technology innovation, ethical design, policy responsiveness, and participatory governance and the emphasis should not be on how quickly digital health tools can grow, but rather on how properly and sustainably they can be integrated into the health rights of all people.

MHEALTH INTEGRATION WITH SOCIO-DEMOGRAPHIC FACTORS

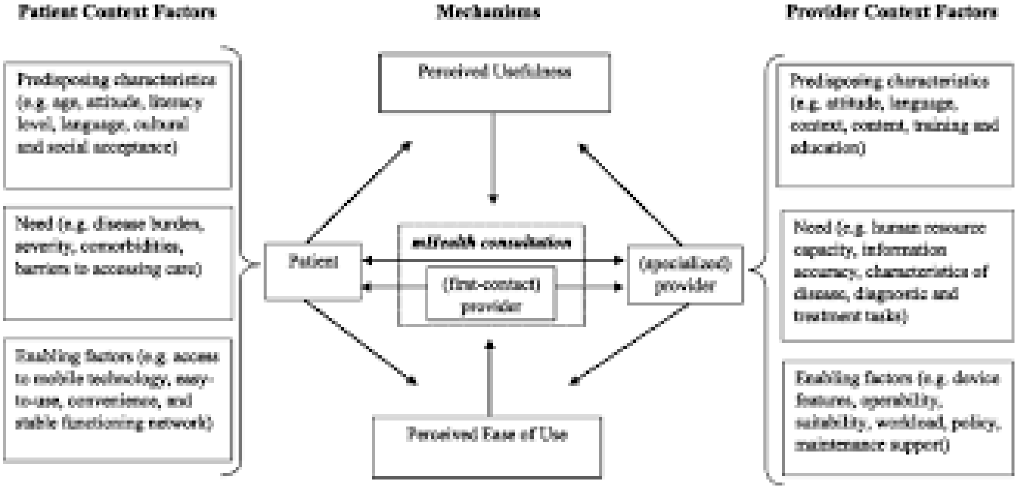

Figure 4: mHealth integration

The integration of mobile health (mHealth) interventions with socio-demographic diversity has sparked intense debate about their efficacy in medication adherence, particularly among persons living with HIV/AIDS (PLWHA) who are also infected with tuberculosis [52]. WHO [12] defines mHealth as the use of mobile and wireless technology to achieve health goals. Labrique et al. [50] also claim that mHealth is a scalable approach for improving health outcomes in low-resource settings, but concede that its success is varied among demographics. According to this review, the effectiveness of mHealth is heavily influenced by factors such as age, gender, education, income, and geography. Aranda-Jan, Mohutsiwa-Dibe, and Loukanova [45] contend that, while mHealth promotes appointment attendance and treatment adherence, its performance is frequently dependent on users' digital competence, which is stratified by socio-demographics. According to Hall et al. [48] younger, urban, and more educated users are more likely to use mHealth, but older persons and rural residents are frequently digitally excluded owing to a lack of literacy, infrastructure, or affordability. This is consistent with the Digital Divide Theory, which holds that socioeconomic gaps in digital access exacerbate pre-existing health inequalities [22]. Oyeyemi and Wynn [39] found that rural Nigerians are much less likely to use smartphone reminders due to weak signal strength, power interruptions, and low mobile penetration. The GSMA [30] forecasts a 30% gender disparity in mobile internet adoption in Sub-Saharan Africa, attributed to socio-cultural hurdles and economical constraints and these inequalities demonstrate how one-size-fits-all mHealth strategies frequently fail when used without contextual tailoring. According to Vaughan et al. [53], effective mHealth treatments require socio-demographic profiling during the design and implementation phases. Agarwal et al. [46], for example, recommend including culturally sensitive user feedback loops to ensure congruence with community values and build trust. Programmatic solutions must address structural inequities Jones-Esan et al. [36] argue that digital literacy training for older individuals and women boosts confidence and usability. Barro et al. [31] also call for public-private collaborations with telecom companies to give subsidized data plans and devices to low-income individuals. Jenkins [33] suggests that gender-sensitive mHealth programming take into account privacy concerns, gendered power dynamics, and the societal stigma associated with HIV and tuberculosis. Similarly, to avoid inadvertent exposure, SMS reminders must be discreet and linguistically suitable, the Socio-Ecological Model suggested by McLeroy et al. [20] calls for interventions at various levels individual, interpersonal, institutional, and community to effectively address the complex challenges to mHealth adoption and adherence. Lester et al. [47] and Glick et al.[35] bemoan the scarcity of long-term studies investigating the impact of mHealth technologies after initial trials, as well positive outcomes are frequently reported, but failure cases such as; app desertion, platform misuse, or negative effects are rarely documented. Furthermore, Owusu-Ansah et al. [40] note the underrepresentation of rural and linguistically varied people in most studies, which skews findings and reduces generalisability.

CONCLUSION

This analysis thoroughly analyzed the socioeconomic and demographic aspects that influence how successfully integrated mobile health (mHealth) initiatives assist persons with HIV/AIDS and tuberculosis in Nigeria adhere to their medication regimens. The findings indicate that age, gender, education, income, and location all have a significant impact on how people use mHealth and the results they receive. According to the literature, while mHealth programs have potential, they are influenced by significant social disparities that affect access, ease of use, and long-term success. Crucially, this analysis highlights intersectionality the overlapping and compounding character of social factors such as gender, poverty, and rural residency as a means of mediating access to digital health technology. For example, older persons in remote locations with inadequate literacy risk numerous layers of exclusion, regardless of the technological solution's merits. Similarly, women frequently face access barriers due to patriarchal rules and privacy concerns, while income differences limit their capacity to afford mobile data, maintain devices, and successfully interpret mHealth messaging and these findings highlight the importance of contextual understanding when implementing digital health solutions.

Authors Contribution

All authors contributed to the review process.

Final Approval of Manuscript

All authors

Ethics Approval and consent to Participate

Not Applicable

Consent to Publish

Not applicable

Availability of Data and Materials

N/A

Competing Interests

Authors have declared that they have no competing interests

Funding
No funds were received for this study

Acknowledgements
Not Applicable

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CITATION

Osuoha C.B., Njoku-Obi, T. N., David C. I., & Igiri V. C. (2025). Insights on Integrated Mobile Health Intervention on Socio-Demographic Characteristics in Relation to Medication Adherence. In Global Journal of Research in Medical Sciences (Vol. 5, Number 3, pp. 20–29).

https://doi.org/10.5281/zenodo.15391187