SI Science International

OPEN ACCESS

Effectiveness of Digital Health Interventions for NCD Prevention in LMICs: A Systematic Review and Meta-Analysis

[1]Oviemova Nathan Agoro and [2]Alexandra Lott Onyeuche Osom
[1]Department of Public Health, Faculty of Health Sciences, Bayelsa Medical University, Yenagoa, Bayelsa State, Nigeria
[2]Department of Obstetrics and Gynaecology, Al Gurayat General Hospital, Kingdom of Saudi Arabia

ABSTRACT

This systematic review examined the effectiveness of digital health interventions (DHIs) for promoting physical activity and a healthy diet for the prevention of NCDs in LMICs. The study examined recent evidence to inform engagement, scalability, and sustainability of DHIs. The results demonstrated that mobile apps, text-based coaching, wearables, and websites significantly supported increases in motion and eating behaviours. Higher adherence rates were shown on interventions including personalised feedback, gamification, and social support. There was the potential for digital health interventions (DHIs) to improve health outcomes. Still, they were confronted by challenges such as low digital literacy, limited internet access, and waning long-term engagement. The hybrid model (digital coaching paired with human support systems) seemed to offer a solution to these barriers. The importance of cost-effectiveness assessments was also emphasised so that LMICs could sustainably implement these approaches. Also, the review highlighted the importance of integrated policy frameworks to promote the widespread uptake of high-quality DHIs. Digital health solutions were promoted for integration into national health systems by governments and public health organisations, consistent with existing public health frameworks and/or plans. Also, country-specific and culturally relevant interventions were shown to be more effective. In conclusion, the results implied that DHIs would generate scalable and cost-effective approaches for NCD prevention in LMICs. Overall, though, for long-term impact, future focus needs to be on improving accessibility, engagement, and sustainability.

KEYWORDS

Digital health interventions, noncommunicable disease prevention, low- and middle-income countries, physical activity promotion, healthy diet adherence

INTRODUCTION

Noncommunicable Diseases (NCDs) constitute the largest cause of death globally, and LMICs experience a disproportionate share of this burden. Noncommunicable Diseases (NCDs) represent the leading causes of mortality globally, with an estimated 41 million deaths each year, including over 78% of these deaths in Low- and Middle-Income Countries (LMICs)[1]. The NCDs have undergone a steady rise in these regions as they rapidly urbanise their economies, causing lifestyle shifts towards increasingly sedentary lives and unsustainable diets. Given their major health and economic burden, preventing and managing NCDs

ISSN: 2306-868X (Online)
ISSN: 2305-1884 (Print)
https://doi.org/10.17311/sciintl.2025.58.69

Received: 15 Apr. 2025
Accepted: 18 Jun. 2025
Published: 19 Jun. 2025

remains difficult in LMIC due to inadequate healthcare infrastructure, limited financial resources, and barriers to accessing preventive healthcare[2]. In view of these hurdles, digital health interventions (DHIs) have developed into potential strategies that can facilitate physical activity and healthy dietary practices, addressing key risk factors for NCDs.

The widespread availability of mobile phones and internet access has allowed for the emergence of digital health interventions-mHealth and wearable technology, social media-based interventions, and online coaching-interventions which may be scalable and cost-effective for health promotion[3]. In particular, interventions targeting health behaviour change and the consolidation of clinical services for improved health outcomes have been effective due to their cost-effectiveness and feasibility in resource-limited settings. For instance, a systematic review of social media interventions for exercise and diet behaviours among people living with NCDs[4]. They showed a significant increase in dietary and physical activity adherence in digital interventions among populations of LMICs. Along the same lines, Mönninghoff *et al*.[5] conducted a systematic review of the literature in this area, which concluded that mobile-based interventions have a positive, measurable effect on moderate-to-vigorous physical activity and diet in high-risk individuals, with those receiving the intervention showing, on average, 36 additional minutes of physical activity per week over the control groups.

One of the reasons for the effectiveness of digital health interventions in augmenting healthy lifestyles is their potential to deliver personalised applications, remote monitoring, and behaviour support. All these elements were proven to significantly improve user retention and help users be involved in the process of lifelong health improvement via interactive features like gamification, step-counting challenges, real-time feedback, and social support networks. Tan *et al*.[6] explored the implementation of behavioural nudges and personalised coaching in digital health programs. They showed a notable increase in user engagement and self-efficacy when making healthier lifestyle choices. Moreover, SMS-based interventions have proven highly effective across LMICs, with meta-analysis confirming that LMICs with limited access to smartphones and low digital literacy could greatly benefit from cost-effective SMS-based interventions. Coaches who delivered support through SMS were notably more effective in raising physical exercise and dietary adherence for individuals with limited internet[7].

Digital health interventions, despite their promise, face a number of challenges that may hinder their effectiveness in LMICs. Some key barriers consist of differences in internet connectivity, disparities in digital literacy, and data privacy and security issues. The cultural and socio-economic context informs how impactful these interventions will be as well. For example, Mobile health interventions had positive health outcomes within urban LMIC settings, whilst there were barriers for rural populations, such as limited access to smart devices and lower levels of digital literacy, leading to lower levels of engagement with digital health[8].

The scenarios of this review were derived from empirical studies conducted in the same location[9-16]. Moreover, the long-term sustainability of digital therapies is a potential problem, as studies have found a drop-off in engagement over time. The importance of integrating these solutions into the healthcare ecosystem to achieve continuity and scalability[17].

With global attention now increasingly on NCD prevention, there is also growing recognition of digital health interventions as practical, viable strategies that governments and health organizations are considering how national health programs might be integrated with these technologies[18]. The WHO Global Action Plan on Physical Activity 2018-2030 identifies digital solutions bolstering efforts to achieve a global 15% reduction in physical inactivity. However, to optimize the impact of digital interventions in LMICs, such an approach needs context-specific adaptations regarding cultural preferences, affordability,

and accessibility. Labrique *et al.*[19] emphasize participatory approaches when developing digital health programs to promote tailored interventions to target populations, helping close existing gaps in health inequities.

With the increasing NCD burden in LMICs, digital health interventions can be a viable option for improving physical activity and healthy dietary behaviours. Recent studies provide evidence that mHealth applications, SMS-based coaching, wearable technology, and online behavioural support significantly enhance health behaviours and reduce the causes of NCDs. However, barriers to accessibility, user engagement, and sustainability need to be overcome to improve the effectiveness and scalability of these interventions. This paper presents a systematic review and meta-analysis of studies evaluating digital health interventions for CRD in LMICs to summarize and derive effective practices and barriers that can be used to guide digital health interventions in the differing scales to which these interventions are applied and developed in LMICs. While previous studies evaluated the impact of these interventions on physical activity and dietary behaviours, this study contributes to the growing evidence base supporting the application of digital health technologies for the prevention of NCDs in resource-constrained settings.

This systematic review and meta-analysis assess the efficacy, engagement, scalability, and sustainability of digital health interventions (DHIs) in promoting physical activity and healthy diets for NCD prevention in LMICs. It explores key frameworks supporting behavior change, identifies the most effective digital strategies (e.g., mobile apps, SMS coaching, wearables), examines barriers and facilitators to DHI implementation, and compares digital interventions with traditional approaches in terms of effectiveness and accessibility.

Methods

Study location/selection criteria: The study was conducted in Yenagoa, the capital of Bayelsa State. Bayelsa State is a state in the South-South of Nigeria[9,10]. The Latitude of Bayelsa, Nigeria, is 4.77190710, and the Longitude is 6.06985260, with the GPS coordinates of 4°46'18.866"N and 6°4'11.469"E[11,12]. The study utilized primarily secondary data, and the discriminatory criteria followed the empirical protocol of other research studies[13-16].

Overview: This study used a systematic literature review approach to review the DHIs to determine their effectiveness for the promotion of physical activity and healthy diets in the prevention of NCDs in LMICs. They aim to use systematic and transparent methods to identify, select, and critically appraise research on a specific research question. This includes systematic identification, selection, and critical appraisal of relevant studies, data extraction, and data analysis. The study followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement guidelines for the systematic review and used the online Rayyan platform for cooperative screening and data handling. Moreover, we used the Scale for the Assessment of Narrative Review Articles (SANRA) to rate the quality of included studies. Given this, our approach was inspired by a systematic review framework developed by Wendler, which underlines a systematic and replicable search process.

Strategy: A search strategy was developed using a combination of Medical Subject Headings (MeSH) terms, relevant keywords from the articles, and self-defined search terms. To encompass the diversity of digital health interventions and their effects on physical activity and dietary behaviours.

In Table 1, the search strategy keywords are grouped into Digital Health Terms, Behavioural Terms, and Outcome Terms. These studies precisely and systematically describe the literature search on interventions that aim to increase physical activity and improve dietetics.

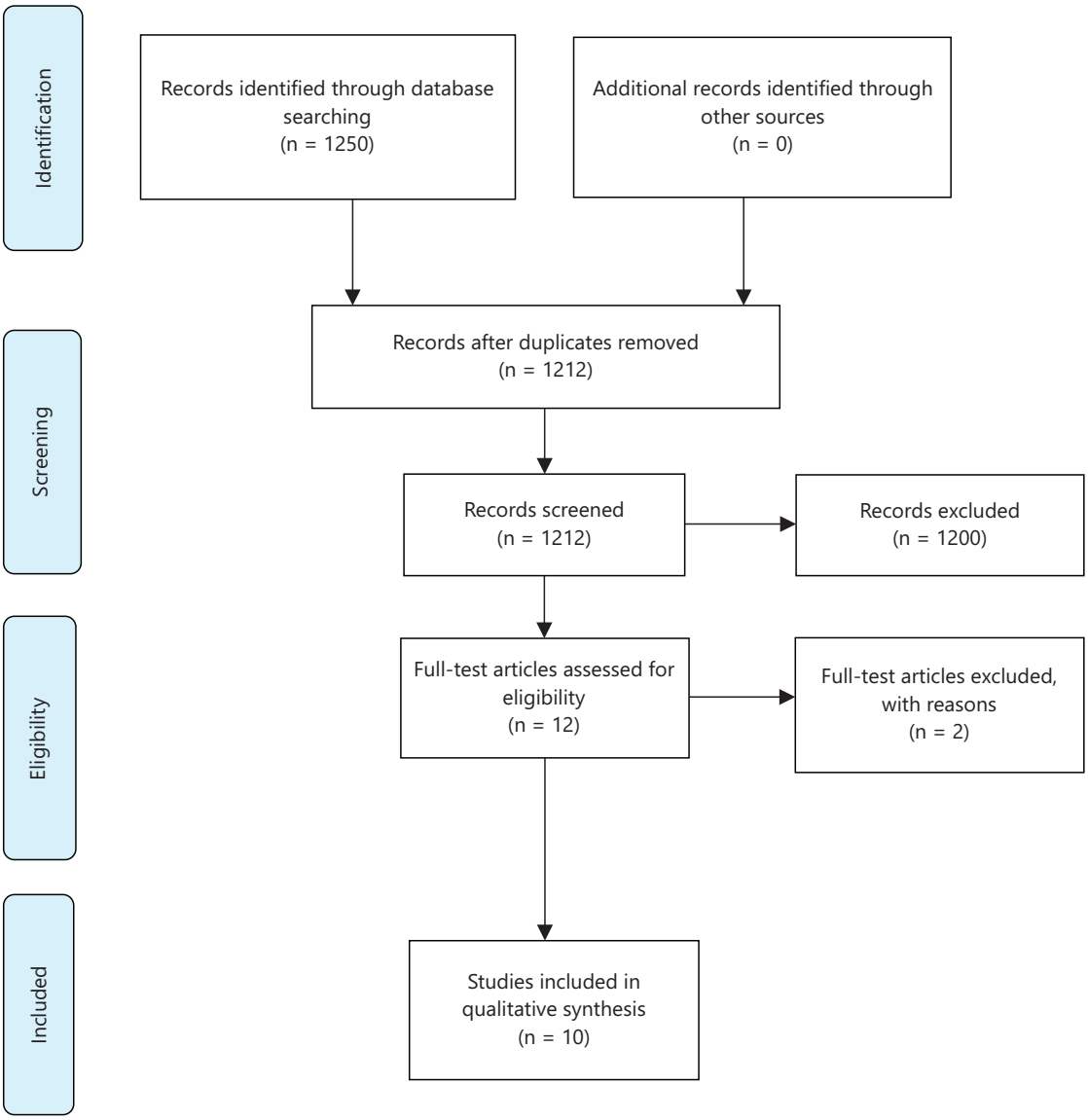

Fig. 1: Article selection process (PRISMA 2009)

Table 1: Structure of search string

Search component	Keywords
Digital health terms	eHealth, mHealth, digital health, mobile health, smartphone, app, digital intervention
Behavioral terms	Physical activity, exercise, sedentary behavior, nutrition, diet, healthy eating
Outcome terms	Effectiveness, engagement, behavior change, prevention, obesity, overweight, NCDs

The search was performed through five electronic databases, including PubMed, Elsevier, SpringerLink, Nature, and IEEE Xplore. These databases were chosen for their broad coverage of the health and technology literature. To include recent and relevant studies, the search was restricted to peer-reviewed articles published in English between January 1, 2020, and January, 2025.

Study selection and screening: The study selection comprised four stages (identification, screening, eligibility, and inclusion) as per the PRISMA flowchart (Fig. 1).

The selection criteria for the studies used were based on the comprehensive approach with which they were included. A total of 1,250 articles were initially identified from five electronic databases: PubMed, Elsevier, SpringerLink, Nature, and IEEE Xplore. These databases were selected because of their breadth of coverage in health and technology literature.

Table 2: Inclusion and exclusion criteria

Items	Inclusion	Exclusion
Population	Studies involving individuals in Low- and Middle-Income Countries (LMICs) focusing on physical activity, healthy diets, or NCD prevention	Studies that do not focus on LMICs or populations relevant to physical activity, diet, or NCD prevention
Exposure	Studies exploring digital health interventions (e.g., mHealth, wearable technology, SMS-based coaching) targeting physical activity or healthy diets	Studies unrelated to digital health interventions or those focusing on non-digital approaches
Outcomes	Studies assessing outcomes such as improved physical activity levels, dietary habits, weight loss, or NCD risk reduction	Studies without relevant outcomes like behavior change, engagement or health improvements
Study design	Observational studies (cohort, case-control) and intervention studies (randomized/ non-randomized trials)	Studies not employing observational or intervention study designs
Publication type	Peer-reviewed full-text research articles and reports	Conference abstracts, dissertations, and non-peer-reviewed studies
Language	Articles published in English	Non-English publications
Period	Studies published between 2020 and 2025	Studies published before 2020 or after 2025

During the screening process, the titles, abstracts, and keywords of the identified articles were scrutinized for relevance. The study excluded articles that do not focus on digital health interventions for the promotion of physical activity or dietary behaviours in Low- and Middle-Income Countries (LMICs). Of these, 1212 articles were identified as potentially relevant and assessed in full text.

The verification stage included the in-depth evaluation of the full-text articles in a predefined inclusion and exclusion framework. This process ensured that only those studies that fit the review's criteria were selected. After applying the inclusion and exclusion criteria, 12 articles were finally selected for inclusion in the review. These papers, as systematic evidence on the effectiveness of digital health interventions, offered valuable insights for NCD prevention through promoting active lifestyles and healthy diets in LMICs.

Along with the peer-reviewed articles, 10 reports written by experts in the fields of digital health and NCD prevention were assessed. In parallel, theoretical frameworks, applications, and case studies found in these books provided further deep insights reflecting results from the articles in findings and discussion sections, and thus, a wealth of knowledge on the topic area. The inclusion of both peer-reviewed articles and books led to a comprehensive overview of digital health interventions that were evaluated in LMICs.

Data inclusion and exclusion criteria: To this end, both the inclusion and exclusion criteria were established to help identify the most relevant and high-quality studies to include in the review.

In Table 2, the inclusion/exclusion criteria, which are based on study population, intervention type, outcomes, study design, and publication details, have been organised to describe the study selection process systematically.

Data extraction and quality assessment: Data extraction was performed using a standardized Excel spreadsheet, which included the following fields:

- Title, authors, publication year, and journal
- Study design, sample size, and target population
- Type of digital health intervention (e.g., mHealth, wearable technology, SMS-based coaching)
- Key outcomes (e.g., changes in physical activity, dietary habits, weight loss)
- Challenges and limitations reported in the study

Table 3: Systematic review of digital health interventions

Author(s)	Aim of study	Location	Study design	Sample size	Key findings	Limitations
Pham *et al.*[1]	To examine NCD-attributed mortality and associated sociodemographic factors in Papua New Guinea	Papua New Guinea	Cross-sectional using verbal autopsy data	926 interviews	NCDs accounted for 47% of total deaths, with cardiac diseases, stroke, and diabetes as leading causes. Risk of dying from emerging NCDs was lower among populations under age 44 compared to those 75+ years old	Potential misclassification bias in verbal autopsy interviews; limited representativeness across all regions of PNG
Odunyemi *et al.*[2]	To examine the economic burden of non-communicable diseases on households in Nigeria through out-of-pocket expenditure and	Nigeria	Cross-sectional analysis	Nigeria Living Standard Survey (2018-19)	NCD-affected households experienced higher rates of catastrophic health expenditure, impoverishment, and productivity loss compared to households without NCDs	Self-reporting bias; cross-sectional design limits causal inference; possible underreporting of NCDs in the population
Lin *et al.*[3]	To develop and evaluate a mobile technology-based tailored health promotion program for sedentary employees	Taiwan	Mixed methods development and usability study	Sedentary employee	"Simple Health" web app, incorporating behavior change techniques, showed promise for promoting healthy eating, physical activity, and reducing sedentary time among employees	Focus on usability rather than effectiveness; limited assessment of long-term engagement and behavior change
Müller *et al.*[4]	To investigate the effectiveness of e-and mHealth interventions to promote physical activity and healthy diets in developing countries	Developing countries	Systematic review	15 studies in 13 countries	50% of interventions effectively promoted physical activity, and 70% effectively promoted healthy diets. Text messages and the internet were the most commonly used delivery channels	Moderate risk of bias across studies (55.7% of criteria fulfilled); limited number of studies available in developing countries
Mönninghoff *et al.*[5]	To investigate the immediate and long-term effects of mHealth interventions on physical activity	Global	Systematic review and meta-analysis	117 studies (21,118 participants)	mHealth interventions significantly increased physical activity across outcome measures, with effects maintained but decreasing in long-term follow-ups. Interventions were more effective for at-risk and sick populations than for healthy ones	Heterogeneity among studies; limited number of studies reporting long-term follow-up measurements

Table 3: Continue

Author(s)	Aim of study	Location	Study design	Sample size	Key findings	Limitations
Tan *et al.*[6]	To examine the different nudges and factors associated with public acceptance of lifestyle nudges	Singapore	Cross-sectional survey	Nationwide Knowledge, Attitudes and Practices Study	Public preferred less intrusive nudges, with information government campaigns most accepted, followed by mandated information, and lastly default rules. Ethnicity and personal lifestyle behaviors were associated with nudge acceptance	Response bias, limited generalizability to other cultural contexts; and self-reported measures
Grady *et al.*[7]	To assess the effectiveness of strategies to improve user engagement with digital health interventions targeting nutrition, physical activity, and obesity across studies; publication	Global	Systematic review and meta-analysis	Multiple studies	Strategies including behavior change techniques and design features significantly improved digital health intervention usage and user experience, enhancing intervention effectiveness	Limited data on long-term engagement; heterogeneity of engagement measures
Maita *et al.*[8]	To examine the impact of digital health solutions on bridging healthcare gaps in rural areas	Global (with focus on rural settings)	Scoping review	Multiple studies	Digital health tools improve healthcare access through teleconsultations, remote monitoring, and mobile health applications, enhancing care delivery in underserved area	Variable quality of included studies; lack of standardized evaluation methods; limited economic evaluation dataKaboré *et al.*[17]
	To identify barriers and facilitators for the sustainability of digital health interventions in low and middle-income countries	Low and middle-income countries	Systematic review	Multiple studies	Barriers included infrastructure limitations, equipment issues, and internet/electricity challenges. Facilitators included government support, institutional commitment, and collaborative networks with stakeholders	Limited generalizability across diverse LMIC contexts; methodological heterogeneity in included studies
Gong *et al.*[18]	To examine how the digital divide may exacerbate disparities in prevention and control of non-communicable diseases	China (with global implications)	Review	Multiple studies	Digital divide can enlarge health inequity when digital health solutions for NCDs are unevenly distributed. Bridging this gap requires multilevel strategies targeting infrastructure, accessibility, and digital literacy	Limited empirical evidence on intervention effectiveness; challenges in measuring impact of digital divide on health outcomes

https://doi.org/10.17311/sciintl.2025.58.69 | Page 64

Quality assessment of the included studies was conducted using the SANRA scale, which has six parameters: Justification of the article's importance, statement of aims, referencing, scientific reasoning, appropriate presentation of data, and relevance to the research question. After scoring parameters on a 0-2 scale, studies with a mean score ≥1.90 were included in the final analysis.

Table 3 displays the included studies with their authors, aims, locations, methodologies, and key findings, which allows for comparison of health intervention studies from different LMICs.

Along with peer-reviewed articles, the study reviewed 10 books written by experts in digital health and NCD prevention. Exposure to these books gave me a lot of insight into the theoretical underpinnings, practices, and challenges that come together to form Digital Health Interventions in LMICs. If only general designs with case studies or empirical data from LMIC were included. Here is a summary of the current books reviewed.

Data synthesis: The findings from the included studies and books were synthesized to identify common themes, best practices, and challenges associated with digital health interventions in LMICs. Key themes included:

Effectiveness of DHIs: Studies consistently reported that digital health interventions, particularly SMS-based coaching and mobile apps, significantly improved physical activity levels and dietary habits.

Engagement and adherence: Interactive features such as gamification, personalized feedback, and social support networks were found to enhance user engagement and long-term adherence.

Challenges: Barriers to implementation included limited internet connectivity, low digital literacy, and concerns about data privacy.

RESULTS

RQ1

Key frameworks supporting digital health interventions: Several conceptual models underpin digital health interventions for behavior change in LMICs. The Digital Behavior Change Model[20] establishes 10 phases of an intervention's development, from user animation and theory of behavior integration to evaluation. To reinforce health behaviors, the Digital Triggering Framework[21] highlights the use of personalised digital triggers, including SMS, push notifications, and emails. The TUDER Framework[22] organizes digital interventions according to a taxonomy of behaviors relevant to NCD prevention. On the other hand, the Adaptive Digital Interventions Model[23] is based on state-space modeling to personalize the delivery of interventions depending on data collected in the digital context in real time.

RQ2

Use of digital strategies to influence changes in physical activity and dietary behaviour: Two general types of intervention approaches were prevalent in the literature, namely mobile app and web page interventions. Mobile applications use real-time tracking, gamification, and AI-fueled coaching to drive behavior changes. Prominent examples encompass Quit Genius, focused on smoking cessation, and FitCoach, aimed at weight management. Also, one can capture walking activities anytime using wearables-integrated apps like Fitbit/Google Fit.

On the other hand, Web-based interventions are centered around self-monitoring tools, digital education, and virtual coaching. For example, personalised health portals for nutrition and telehealth services for tele-nutrition coaching. Mobile apps provide personalised and real-time access to a great extent, but at

a higher level, at the cost of digital literacy (which one must possess). Web-based interventions are actually more accessible to populations, as they do not require participants to be provided with historical settings, and they need consistent connectivity to maintain engagement.

RQ3

Barriers and facilitators to DHI implementation in LMICs: Digital health interventions have proven useful but face several barriers in LMICs. Another challenge is limited digital literacy, which is especially problematic in rural areas with lower technology adoption. Infrastructure barriers, including weak internet and unstable power supply, restrict accessibility to digital health solutions. An inherent difficulty of all behavior change is drop-off: Over time, users become less likely to engage. Moreover, these digital platforms face the problem of data privacy while affecting user trust and credibility.

Different facilitators have been identified to improve the success of DHIs. Gamification and behavioral nudges (e.g., reward systems, real-time feedback) have been shown to increase engagement. Text-based coaching as part of multidisciplinary approaches or combined with mobile phone interventions (e.g., mobile phone apps) also seems to be more inclusive for users with different levels of digital literacy. Also, experience-based, community-grounded digital support, integrated with programs, has been shown to significantly improve motivation for change and long-term adherence.

RQ4

Comparison with traditional approaches: Digital solutions have been shown to outperform classical health programs in several different ways. They are also more scalable, serving populations larger than those served by in-person counseling. They are also relatively inexpensive, with SMS-based and app-based interventions reducing healthcare costs by ensuring that patients are less likely to need frequent visits to a clinic. Interactive digital tools are not only improving user engagement and adherence to health advice long term but also building upon user feedback over time.

Nonetheless, research indicates that blended approaches, integrating digital tools and human coaching, are the most effective means of reaching LMICs. By providing both digital assistance and human support, hybrid models try to solve problems and ensure long-term adherence that other standalone models face, such as a lack of digital literacy.

These findings from the systematic review of DHIs for physical activity and nutrition behaviors in LMICs respond to important questions about the effective implementation of DHIs. The RQ1 emphasizes the significance of well-organized behavioral determinants, mechanisms for digital engagement, and assessment methods to create successful interventions. The models identified, such as the Digital Behaviour Change Model[1], Digital Triggering Framework, and TUDER Framework[24], stress the importance of personalised engagement, reinforcement for the behavior, and adaptive digital strategies. Future research should explore the utility of combining behavioral science with digital tools to enhance long-term adherence[4].

The RQ2 lists the digital strategies that yield higher success rates, including mobile applications, coaching through SMS, and web-based interventions. Mobile health interventions utilise gamification, real-time tracking, and AI-based coaching, while web-based platforms provide structured programs and telehealth[5]. Research suggests that, especially in LMIC contexts with varying levels of internet and digital literacy, a combination of digital approaches with multi-channel outreach worked better to reach potential participants[6]. Additional studies should explore which combination of intervention strategies leads to optimal adherence and health outcomes[23].

The RQ3 assesses the barriers and facilitators affecting DHI implementation. The common barriers are a lack of digital literacy, connectivity problems, and decreasing long-term participation[7]. Data privacy is another major challenge to the uptake of digital health[20]. Field-performance-based facilitators incorporate gamification techniques easily, integration of social support, and multi-platform accessibility[8]. The development (design implementation) of future interventions should be more user-centered and integrate the principles of cultural relevance, personalisation, and local community engagement to maximise sustainability[17].

The RQ4 (comparing digital health interventions with traditional, non-digital approaches) found a higher level of scalability, cost-effectiveness and sustained engagement with many digital versus traditional approaches[18]. On the other hand, the results indicate that blended approaches-integrating digital tools with in-person coaching or engagement with local community members-appear to achieve the most significant impact in Low- and Middle-Income Countries (LMICs), where healthcare structures and access to the internet remain[11]. Looking ahead, the potential for DHIs will lie in hybrid models that combine digital solutions with existing local health systems, thus improving their acceptance and potential for long-term impact.

To prevent NCDs, a healthy lifestyle, which involves maintaining a high level of exercise, a good diet and less inactivity, should be practiced. Digital health interventions have the potential to provide effective, cost-effective, and scalable solutions for physical inactivity and unhealthy dietary behaviours in LMICs. Check the mHealth apps, SMS-based coaching, and web-based behavioral support that have a proven impact on health behaviors, particularly in vulnerable populations[4,5]. Long-term adherence, however, is a prominent challenge that requires the development of behavioral reinforcement strategies and user-centered intervention designs[23].

Mobile apps and web-based platforms have been shown to effectively motivate individuals, facilitate self-monitoring and offer tailored recommendations[6]. The best interventions integrate goal setting, feedback mechanisms, and gamification features[18]. Nevertheless, digital interventions should be culturally adapted and contextually relevant for optimum engagement in LMIC settings[19]. Further research should determine which digital behavior change techniques are most effective and develop new ones and reparative policies that integrate them into socioeconomic and healthcare policies[17].

Although digital interventions are powerful, the digital divide is salient for some demographic groups, including older adults, rural populations, and individuals with poor digital literacy[7]. Evidence shows that these blended intervention models, which integrate digital tools with human coaching and peer support networks, achieve better adherence and health outcomes[20]. Infrastructure investments, digital education programs, and community-based implementation strategies should be considered by policymakers to optimise the impact of digital health interventions in low- and middle-income countries[8].

The findings further emphasise that innovation in digital health interventions is still urgently warranted, especially in Low- and Middle-Income Countries (LMICs) that are still dealing with limited healthcare resources[23]. Further research needs to focus on ensuring the sustainability of these digital health programs in the long term and scaling how interventions can be used for engagement and retention. Novel technologies, like AI-driven adaptive coaching, the integration of wearable technologies, and hybrid models of intervention, may represent viable pathways to improve user engagement and longer-term health outcomes[4].

Future studies should focus on scaling up digital health interventions while maintaining personalisation to address existing challenges to boost the adoption of such interventions across diverse populations[6]. Moreover, the cost-effectiveness and feasibility assessments are also important to evaluate the economic

viability of these interventions within different LMIC settings[17]. Investigating hybrid models that combine digitally delivered interventions with human support systems is a strategy that could improve the effectiveness of this type of intervention, which is known to increase adherence to and changes in behavior sustained over time[18]. Furthermore, it is crucial to improve the existing digital literacy programs to make virtual care more widespread and inclusive, especially among those with little access to digital health technologies[19].

Additionally, policy integration is critical for the continued implementation and funding of digital health interventions[6]. Policy Recommendations Governments and public health organisations need to proactively integrate digital health solutions into national healthcare infrastructures, ensuring that these interventions are included in supplementary approaches rather than representing an isolated solution[20]. Policymakers can support personalised approaches in NCD prevention and health promotion in LMICs by fostering a scalable, affordable, and accessible digital health ecosystem.

CONCLUSION

Digital health interventions offer a cost-effective, scalable solution to prevent non-communicable diseases in low- and middle-income countries by promoting physical activity and healthier diets. Integrated approaches that combine digital tools with human support show the highest effectiveness. Personalised, user-friendly designs with social features enhance adoption and sustain behavior change. However, digital divides among older adults and rural populations remain a challenge. Ensuring cultural relevance and contextual adaptation is crucial for success. Embedding these interventions into national health systems requires coordinated efforts from policymakers, public health bodies, and technology developers. With appropriate policy support, DHIs can transform healthcare delivery and improve outcomes in underserved regions.

SIGNIFICANCE STATEMENT

This study identified effective digital health interventions-including mobile applications, SMS coaching, and wearables-that could be beneficial for enhancing physical activity and improving dietary habits to prevent non-communicable diseases in low- and middle-income countries. This study will assist researchers in uncovering critical areas of digital health implementation barriers, facilitators, and policy gaps that have remained unexplored by many. Consequently, a new theory on sustainable integration of digital health interventions in resource-constrained settings may be developed.

REFERENCES

1. Pham, B.N., R. Jorry, N. Abori, V.D. Silas, A.D. Okely and W. Pomat, 2022. Non-communicable diseases attributed mortality and associated sociodemographic factors in Papua New Guinea: Evidence from the comprehensive health and epidemiological surveillance system. PLOS Global Public Health, Vol. 2. 10.1371/journal.pgph.0000118.
2. Odunyemi, A., T. Rahman and K. Alam, 2023. Economic burden of non-communicable diseases on households in Nigeria: Evidence from the Nigeria living standard survey 2018-19. BMC Public Health, Vol. 23. 10.1186/s12889-023-16498-7.
3. Lin, Y.P., K.C. Lee, W.F. Ma, B.S. Syu and W.C. Liao *et al*., 2025. A mobile technology-based tailored health promotion program for sedentary employees: Development and usability study. BMC Public Health, Vol. 25. 10.1186/s12889-025-22401-3.
4. Müller, A.M., S. Alley, S. Schoeppe and C. Vandelanotte, 2016. The effectiveness of e-& mHealth interventions to promote physical activity and healthy diets in developing countries: A systematic review. Int. J. Behav. Nutr. Phys. Act., Vol. 13. 10.1186/s12966-016-0434-2.
5. Mönninghoff, A., J.N. Kramer, A.J. Hess, K. Ismailova and G.W. Teepe *et al*., 2021. Long-term effectiveness of mHealth physical activity interventions: Systematic review and meta-analysis of randomized controlled trials. J. Med. Internet Res., Vol. 23. 10.2196/26699.

6. Tan, Y.W.B., E.R. Tan, K.Y. Sin, P.V. AshaRani and E. Abdin *et al*., 2022. Acceptance of healthy lifestyle nudges in the general population of Singapore. BMC Public Health, Vol. 22. 10.1186/s12889-022-13668-x.
7. Grady, A., N. Pearson, H. Lamont, L. Leigh and L. Wolfenden *et al*., 2023. The effectiveness of strategies to improve user engagement with digital health interventions targeting nutrition, physical activity, and overweight and obesity: Systematic review and meta-analysis. J. Med. Internet Res., Vol. 25. 10.2196/47987.
8. Maita, K.C., M.J. Maniaci, C.R. Haider, F.R. Avila and R.A. Torres-Guzman *et al*., 2024. The impact of digital health solutions on bridging the health care gap in rural areas: A scoping review. Permanente J., 28: 130-143.
9. Agoro, E.Y.S. and O.N. Agoro, 2025. Ameliorative effect of *Phyllanthus amarus* (Gale of Wind) on cardiac, renal and hepatic functions of paracetamol intoxicated Wistar rat. Asian J. Biol. Sci., 18: 215-222.
10. Agoro, E.Y.S., W.P. Alabrah, G.S. George and M.M. Wankasi, 2024. Homeostatic, glucolytic and lipolytic presentations before and after soccer game. Adv. Res., 25: 99-104.
11. Agoro, E.Y.S., E. Osioma and P.W. Alabrah, 2024. The hepato-renal chemistries of rats fed with *Pentaclethra macrophylla* (oil bean seed). Khalij-Libya J. Dental Med. Res., 8: 229-238.
12. Agoro, E.Y.S. and I.V. Anyiam, 2023. The effect of okra (*Abelmoschus esculentus*) on the hepatic metabolism of carbohydrates and lipids. Asian J. Biol. Sci., 16: 195-201.
13. Agoro, E.Y.S. and M.M. Wankasi, 2021. Assessing the relationship between low body mass index, spermconcentrations and some seminal electrolytes amongstyoung adults. Int. J. Curr. Res., 13: 19439-19442.
14. Agoro, E.S., E. Nelson-Ebimie, A.E. Soroh and J.O. Odegbemi, 2017. The suitability of non-invasive sample in the assay of glucose in diabetes mellitus diagnosis and sex difference. J. Appl. Microbiol. Biochem., Vol. 1. 10.21767/2576-1412.100010.
15. Agoro, E., N.E. Ebiere, S.A. Eseimokumo and J.O. Odegbemi, 2017. Is saliva an alternative non-invasive sample for the estimation of protein profile amongst diabetics and gender-based diagnostics? Anat. Physiol., Vol. 7. 10.4172/2161-0940.1000255.
16. Solomon, A.E.Y., M.M. Wankasi and O. Ileimokumo, 2015. Relationship between serum anion gap and diabetes mellitus. J. Diabetes Mellitus, 5: 199-205.
17. Kaboré, S.S., P. Ngangue, D. Soubeiga, A. Barro and A.H. Pilabré *et al*., 2022. Barriers and facilitators for the sustainability of digital health interventions in low and middle-income countries: A systematic review. Front. Digital Health, Vol. 4. 10.3389/fdgth.2022.1014375.
18. Gong, E., H. Wang, W. Zhu, G. Galea, J. Xu, L.L. Yan and R. Shao, 2024. Bridging the digital divide to promote prevention and control of non-communicable diseases for all in China and beyond. BMJ, Vol. 387. 10.1136/bmj-2023-076768.
19. Labrique, A.B., C. Wadhwani, K.A. Williams, P. Lamptey, C. Hesp, R. Luk and A. Aerts, 2018. Best practices in scaling digital health in low and middle income countries. Globalization Health, Vol. 14. 10.1186/s12992-018-0424-z.
20. Sediva, H., T. Cartwright, C. Robertson and S.K. Deb, 2022. Behavior change techniques in digital health interventions for midlife women: Systematic review. JMIR mHealth uHealth, Vol. 10. 10.2196/37234.
21. Muench, F. and A. Baumel, 2017. More than a text message: Dismantling digital triggers to curate behavior change in patient-centered health interventions. J. Med. Internet Res., Vol. 19. 10.2196/jmir.7463.
22. Chatterjee, A., A. Prinz, M. Gerdes and S. Martinez, 2021. Digital interventions on healthy lifestyle management: Systematic review. J. Med. Internet Res., Vol. 23. 10.2196/26931.
23. Mair, J.L., A. Salamanca-Sanabria, M. Augsburger, B.F. Frese and S. Abend *et al*., 2023. Effective behavior change techniques in digital health interventions for the prevention or management of noncommunicable diseases: An umbrella review. Ann. Behav. Med., 57: 817-835.
24. Yaseen, H., A.S. Mohammad, N. Ashal, H. Abusaimeh, A. Ali and A.A.A. Sharabati, 2025. The impact of adaptive learning technologies, personalized feedback, and interactive AI tools on student engagement: The moderating role of digital literacy. Sustainability, Vol. 17. 10.3390/su17031133.