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To what extent are digital health interventions targeting HIV care cascade among mobile populations feasible, acceptable, and effective? A mixed methods systematic review protocol

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Abstract

Introduction Human mobility is associated with an increased risk of HIV acquisition and disengagement from HIV care, leading to poorer health outcomes among highly mobile individuals compared to less mobile individuals. Mobile individuals, broadly defined as those who temporally, seasonally, or permanently move from one place to another for voluntary or involuntary reasons, face many challenges in accessing HIV care services. These challenges include logistical difficulties, interruptions in HIV care continuity, and limited access to services across different locations, which together hinder timely testing, treatment initiation, and viral suppression. Digital health interventions offer flexible approaches that can adjust to the mobile individual's location to improve HIV care engagement and health outcomes for this underserved and hard-to-reach population. However, evidence on the feasibility, acceptability, and efficacy of digital health interventions across the HIV care cascade among mobile populations has not yet been appraised.

Objectives We seek to synthesize empirical evidence on the feasibility, acceptability, and efficacy of digital health interventions targeting the HIV care cascade among mobile populations.

Methods We will conduct a mixed methods systematic review of peer reviewed studies published between 1 January 2010 and 31 July 2024 that evaluated digital health interventions targeting the HIV care cascade among mobile populations. We will search PubMed, Web of Science, and EBSCOhost (Academic Search Premier, Africa-Wide information, CINAHL, Health Source: Nursing/Academic Edition, APA PsycInfo, APA PsycArticles) electronic databases. Bibliographies of retrieved studies will also be reviewed for relevant citations. Only studies published in English language and involved a digital health intervention, report an outcome related to the HIV care cascade, and involve mobile populations either partially or completely will be included. Two reviewers will independently screen titles and abstracts against the inclusion criteria, followed by full text screening for eligible articles. In case of disagreements, consensus will be sought from a third reviewer. Data synthesis will follow the Joanne Briggs Institute's

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convergent segregated approach. If sufficient quantitative studies with comparable outcome measures are available, a meta-analysis will be performed.

Discussion This review will address a critical evidence gap by consolidating data on digital health interventions' feasibility, acceptability, and efficacy across the HIV care cascade among mobile populations. The results will inform the development of tailored digital health interventions to enhance HIV care delivery and health outcomes for this hard-to-reach population, supporting global HIV prevention and treatment goals.

Systematic review registration This protocol is registered on PROSPERO (CRD42024528122).

Keywords Digital health, Mobile populations, Migrants, HIV, HIV care cascade

Background

Human mobility and engagement in HIV care cascade

The UNAIDS "95–95-95" targets aim to end the HIV epidemic by ensuring that 95% of people with HIV know their status, 95% of those tested receive antiretroviral therapy (ART), and 95% of those on ART achieve viral suppression [1]. For this strategy to succeed, early diagnosis coupled with linkage to care, ART initiation, and ongoing retention in care, and ART adherence is required. These steps are usually referred to as the HIV care cascade. However, recent literature shows that human mobility, including internal and external migrations, are sustaining the HIV epidemic [2]. For example, the treatment as prevention trial in rural KwaZulu Natal showed that the circulation of newly HIV infected individuals in and out of the trial communities slowed down efforts to increase ART coverage and population viral load suppression which diminished any population level impact on new HIV infections [3]. Previous literature has shown that migration, including over short distances, increases the risk of acquiring HIV [4, 5] and is associated with behaviors such as multiple concurrent partners and substance use [6, 7] which increase the risk of HIV transmission. Once living with HIV, highly mobile individuals can experience delays in entering and remaining in HIV care and experience poorer HIV-related outcomes compared to less mobile individuals [8]. As such, mobile individuals are less likely to test for HIV, be retained in care, adhere to treatment, and achieve viral suppression compared to non-mobile individuals [9] which in turn hinders population-level HIV epidemic control goals.

Human mobility encompasses many dimensions with no consensus definition. For this paper, we will use the United Nations definition which defines mobile people broadly as those "who move from one place to another temporarily, seasonally, or permanently for a host of voluntary and/or involuntary reasons" [10]. Migrants, by extension, are mobile people who "take up residence in a foreign country" [11]. This paper will use mobile populations to refer to migrants and mobile people. In sub-Saharan Africa, mobility is very common, and internal migration is often an essential livelihood strategy. For example, in South Africa, internal migration rates are as high as 42% [12] with many individuals moving from rural areas to urban and industrial centers for employment and education opportunities [4].

While mobility is expected to bring new opportunities, it can also bring challenges for engagement in HIV care. Aspects of mobility that affect the HIV care cascade include temporality (duration, frequency or seasonality), individual level of control over travel, and travel destination [8]. For example, longer trips of over a month are associated with lower ART adherence compared to shorter trips [13]. Qualitative interviews with mobile men from Malawi revealed that travel was often unplanned and men were vulnerable to exploitative employment thus unable to access HIV care due to time and financial constraints [13]. Other research has shown how lack of patient record linkage [8] and additional administrative requirements such as transfer cards lead to interruptions in HIV treatment supply at travel destinations [14] as mobile people are refused HIV treatment at non-home facilities. Mobile people often live in shared accommodation in the first few months of relocation [15] which may lead to lack of privacy and reluctance to take HIV treatment in front of others [16]. In addition, migration is associated with loosened social support, yet social support is critical for adherence to HIV treatment and retention in HIV care [17]. These, coupled with lack of knowledge of patient rights and information on where to access HIV care services, particularly in unfamiliar destinations, serve as some of the reasons for delays in accessing HIV care and treatment interruptions in new destinations which ultimately results in poor treatment outcomes across the HIV care cascade.

Potential of digital health to improve HIV treatment outcomes across the HIV care cascade

Increasing use of digital technologies, such as mobile phones, computers, and Internet to support health [18, 19], also referred to as digital health [20], present opportunities to virtually support HIV testing, linkage to care, and retention in care, as well as adherence to HIV treatment across mobile populations' travel destinations.

For example, mobile phones with cameras and Internet connection can provide virtual support for HIV self-testing, deliver HIV counseling using informational or motivational videos or text, interpret test results, and initiate linkage to care [21]. Also, mobile phone location data can be used to detect when patients have traveled outside their usual health care settings and assist users locate HIV clinics and services in unfamiliar destinations [22]. Emerging research is also exploring the use of e-hailing services to deliver at-home HIV treatments [23], while other research leverage social media platforms to provide psychosocial support [24]. These interventions have a potential to address geographic barriers to care, such as travel costs, time constraints associated with attending facility-based services, and limited knowledge of the healthcare systems in new locations. However, their overall feasibility, acceptability, and efficacy has not yet been synthesized.

Existing reviews of digital health interventions targeting the HIV care cascade have primarily focused on general population living with HIV. Daher et al. conducted a systematic review of digital health innovations for HIV and other sexually transmitted infections and found them effective in improving clinic attendance and ART adherence and reducing the time between testing and treatment initiation [19]. Henny et al. reviewed electronic health interventions addressing the continuum of HIV care and highlighted that theory guided interventions had greater impact on improving linkage, retention, and treatment outcomes [25]. Moreover, people living with HIV perceived digital health interventions as more convenient and accessible as they can be accessed from any location addressing challenges such as transportation costs, waiting times, and stigma associated with facility-based HIV services [26]. Given the adaptability of digital health technologies to overcome barriers of geographic location and time, we hypothesized that these interventions could improve the HIV care cascade outcomes among mobile people.

Aims of the review

The primary aim of this systematic review is to synthesize existing evidence on the feasibility, acceptability, and efficacy of digital health interventions targeting the HIV care cascade among mobile populations. This evidence synthesis aims to inform the development and scale-up of effective digital health interventions within HIV programs for this hard-to-reach population. By integrating qualitative and quantitative research on patient experiences, intervention delivery, and effectiveness, we seek to understand whether and how digital health interventions can improve health outcomes across the HIV care cascade for mobile populations.

Methods

Study design

We will conduct a mixed methods systematic review to synthesis data from studies with diverse research designs. This approach will allow for a comprehensive understanding of complex issues by integrating both qualitative and quantitative evidence on digital health intervention experiences and outcomes. The review will adhere to the Joanna Biggs Institute (JBI) methodological guidance for conducting mixed methods reviews [27] and follow the Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA 2020) guidelines [28] to ensure transparency, rigor, and replicability. This systematic review protocol is registered on PROSPERO (CRD 42024528122), the International Database of Prospective Register of Systematic Reviews, and is reported according to the PRISMA-P 2015 checklist [29] (see Supplementary File 1).

Eligibility criteria

A summary of the eligibility and exclusion criteria is presented in Table 1. Studies will be eligible for inclusion in the review if they meet the criteria outlined under study characteristics, populations, interventions, comparators and outcomes.

Study characteristics

This review will include peer reviewed publications that include primary data with no geographic restriction. We will include qualitative, quantitative, and mixed method designs and exclude literature reviews, commentaries, case reports and case series, and conference and conceptual papers that do not report outcomes specific to feasibility, acceptability, and efficacy of the intervention. Studies published in English language between 1 January 2010 and 31 July 2024 will be included. This period is marked by rapid advancements in digital health and use of technology to support HIV care programs [30] and significant updates in HIV care guidelines. Since 2010, the global penetration of mobile wireless technologies, particularly smartphones with advanced computing capabilities and Internet access, has expanded rapidly with the rollout of 3G networks [31] facilitating their integration into healthcare and supporting the adoption of digital health interventions. Also, notable changes in HIV care protocols and standards, including the "test and treat" guidelines and approval of HIV self-testing [32], have redefined best practices, making it challenging to reliably compare findings from studies conducted before 2010.

Population

Studies must include mobile populations aged 15 years and older either partially or completely. We have defined mobile populations broadly as individuals that relocate frequently or for extended periods and these include migrants, transients, immigrants, refugees, asylum seekers, mobile sex workers, and truck drivers. Migrants are sometimes defined on grounds of ethnicity or citizenship (foreigners or non-nationals). The age restriction is in line with the legal eligibility of HIV care services without a guardian/parent in most regions.

Interventions

Included studies must use a digital health intervention targeting one or more stages of the HIV care cascade (HIV testing, linkage to care, ART initiation, retention in care HIV treatment adherence and viral suppression). Digital health interventions include the use of digital technology, e.g., electronic health (eHealth), mobile health (mHealth), telemedicine and telehealth, either as a component or standalone strategy for delivering the intervention to mobile populations.

Comparators/control

Studies will be included regardless of whether they have a control group or not. Comparators may include standard of care or an alternative intervention.

Outcomes

Studies included must report a feasibility, acceptability, or effectiveness outcome of the digital health intervention. Definitions of these outcomes vary widely in the literature, and we have considered broad definitions for this review. Feasibility can be measured by attrition, attendance, adherence, and retention in the intervention and qualitative feedback on intervention delivery [33]. Acceptability includes participant experiences and views on using digital technology such as usefulness and ease of use as well as perceptions on whether the intervention is satisfactory or agreeable [34, 35]. Efficacy is the intended effects and effect size estimations of the intervention and will include behavioral and biomedical metrics related to the HIV care cascade: (1) HIV testing uptake, (2) linkage to care, (3) ART initiation, (4) retention in care (clinic attendance, ART adherence, pill count, loss to follow up), and (5) viral suppression (viral load or other markers of treatment success including CD4 count and HIV related mortality or morbidity).

Data sources

To ensure comprehensive coverage of relevant literature from clinical, social, and technological perspectives, we will search PubMed, Web of Science, and EBSCOhost (Academic Search Premier, Africa-Wide information, CINAHL, Health Source: Nursing/Academic Edition, APA PsycInfo, APA PsycArticles). We will also review the bibliographies of retrieved studies for relevant citations. Using this approach will allow us to balance methodological rigor with feasibility by minimizing redundant results and maximizing the relevance and manageability of the review.

Search strategy

Supplementary Table 1 details a pilot search strategy for one of the databases (Web of Science) developed and tested after consultations with a digital health specialist (BM) and librarian (PM). Medical subject heading terms (MeSH) will be used where appropriate, and the primary search strategy will be modified to meet the specific syntax in each database.

Study selection

Following the search, all identified records will be downloaded to Endnote 20 (Clarivate Analytics) to manage citations and remove duplicates. The deduplicated list of citations will then be imported to Rayyan software [36] for screening. Screening will be conducted in two stages. The first stage will be done on Rayyan where two reviewers will independently screen the titles and abstracts against the predefined inclusion criteria. Studies that meet all criteria will be included in the second stage where full texts will be retrieved for more

Table 1 Inclusion and exclusion criteria

Inclusion criteria
• Population: focused on mobile populations aged 15 years and older either partially or completely (e.g., includes mobile and non-mobile, but sub analyses specific to migrants will be required)
• Intervention: use digital technology to address one or more stages of the HIV care cascade (HIV testing, linkage to care, ART initiation, retention in care, treatment adherence or viral suppression)
• Outcomes: report feasibility, acceptability, or impact outcomes of the digital intervention on HIV care cascade
Exclusion
• Population: does not include sub-analyses of mobile populations aged 15 years and above
• Intervention: does not use digital technology to enhance the HIV care cascade
• Outcomes: does not report feasibility, acceptability, and impact outcomes
• Other: published before 2010 and after July 31, 204; not written in English; literature reviews, commentaries, case reports, case series, conference abstracts, or conceptual papers

Table 2 Summary of data that will be extracted to Microsoft excel form

Primary item	Secondary item
Basic information of the study	1) Title 2) Author 3) Publication year 4) Study country
Characteristics of the design	1) Sample size 2) Study type 3) Study length
Population	1) Target group 2) Sex 3) Age 4) Control group 5) Number of participants
Intervention	1) Type of technology used 2) Intervention name 3) Intervention description 4) Time and duration of intervention 5) Stage of the HIV care cascade
Outcomes	1) Feasibility 2) Acceptability 3) Impact

comprehensive review. These full texts will also be independently assessed by the two reviewers to confirm eligibility for inclusion in the final review. Reasons for exclusion of full texts that do not meet the inclusion criteria will be recorded and reported in the final review. To ensure consistency and rigor, any disagreements regarding study eligibility will be resolved through discussions between the reviewers. If consensus cannot be reached, a third reviewer (senior author) will be consulted to make a final determination. The results of the search will be presented in a PRISMA flow diagram to show the stages of identification, screening, eligibility and inclusion.

Data extraction

Two reviewers will independently extract data from studies included in the final review using a structured Microsoft excel form that will capture key details about each study as presented in Table 2. For quantitative studies, outcome data comprise of descriptive and/or inferential statistical results, while for qualitative studies, data comprise of themes or sub-themes.

Assessment of methodological quality

Studies included in the final review will be assessed for methodological quality by two independent reviewers using the JBI critical appraisal instruments [37] (Supplementary File 2). JBI has appraisal checklists tailored to each study design and each checklist contains specific domains that assess quality, such as clarity of research questions, appropriateness of study design, recruitment strategy, data collection methods, reliability and validity of outcome measures, confounding factors, and adequacy of statistical or thematic analyses. Included studies will be scored on each domain to determine whether they meet the criterion or not and categorized into low, medium, and high quality. Any incongruities in appraisal that arise between reviewers will be discussed and resolved with the senior author. Regardless of the methodological quality, all included studies will undergo extraction and synthesis.

Data synthesis and analysis

Data synthesis and analysis will follow the convergent segregated approach based on the JBI methodology for mixed methods systematic reviews [27]. This method involves synthesizing qualitative and quantitative findings separately before integrating them to provide an enriched understanding of digital health interventions' feasibility, acceptability, and efficacy in the context of HIV care for mobile populations.

Quantitative data

Based on our initial preliminary searches, we anticipate significant heterogeneity in the study design, population characteristics, and intervention types across included studies. This variability may limit the feasibility of conducting a meta-analysis. If meta-analysis is not possible, we will conduct a narrative synthesis to systematically analyze and present the quantitative data. We will organize the data by outcome and provide a structured summary to capture and convey insights of the feasibility, acceptability, and impact of digital interventions across different stages of the HIV care cascade. The narrative synthesis will follow the steps outlined in Fig. 1.

If sufficient studies with comparable outcome measures are identified, a meta-analysis will be conducted to assess the feasibility, acceptability, and effectiveness of digital health intervention at each stage of the HIV care cascade (e.g., testing, linkage to care, treatment initiation, retention, and adherence). The meta-analytic approach will follow the steps presented in Table 3.

Qualitative data

We will categorize qualitative data into broad themes related to feasibility, acceptability, and factors influencing the implementation of digital health interventions, such as common barriers and facilitators. These themes will be further divided into sub-categories based on emerging patterns. For example, within the theme of acceptability, sub-categories might include "ease of use," while "network stability" could emerge under feasibility. The qualitative data will then be pooled through the process of meta-aggregation [38], which involves grouping the findings into overarching themes that capture common

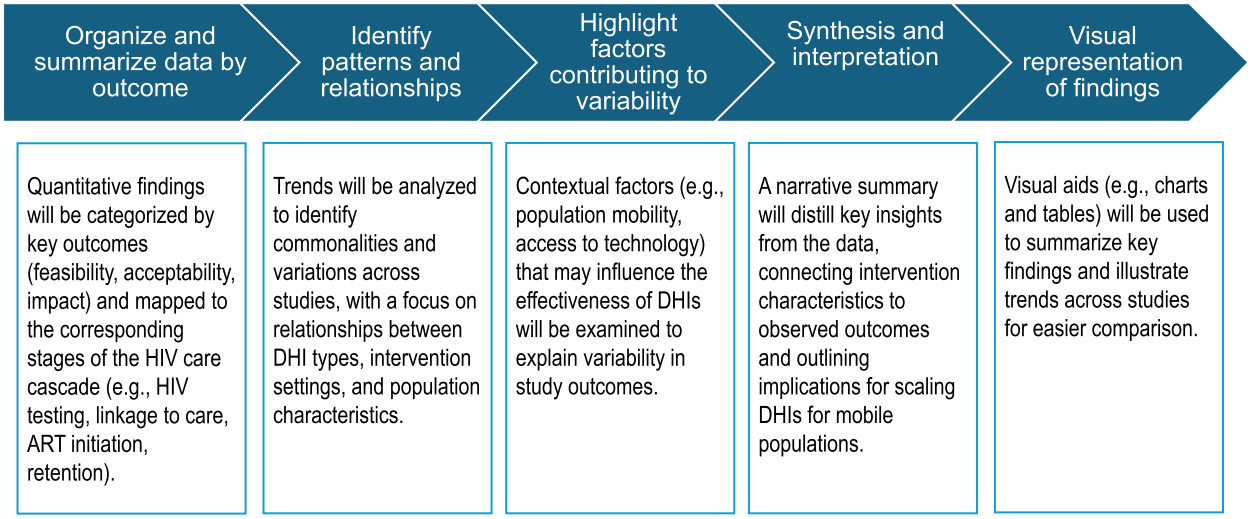

Fig. 1 Narrative synthesis steps fir the quantitative data

Table 3 Steps of the meta-analysis approach

Step	Description
Effect size estimation	Calculate risk ratios (RR) or odds ratios (OR) for binary outcomes (e.g., adherence, linkage to care) and mean differences (MD) for continuous outcomes (e.g., viral load reduction or adherence rates)
Statistical model	Use a random-effects model to account for variability across studies, assuming intervention effects may vary due to differences in populations and intervention characteristics
Heterogeneity assessment	Assess heterogeneity with the I^2 statistic and Cochran's Q test. $I^2 > 50\%$ indicates substantial heterogeneity, guiding further investigation
Subgroup and sensitivity analyses	Conduct subgroup analyses by variables like intervention type, population demographics, and HIV care cascade stage. Perform sensitivity analyses by excluding studies with high risk of bias
Publication bias assessment	For meta-analyses with > 10 studies, assess publication bias with funnel plots and Egger's test to detect asymmetry, indicating potential bias
Data presentation	Summarize pooled effect estimates with 95% confidence intervals (CIs) using forest plots to display effect sizes and heterogeneity visually

patterns related to feasibility, acceptability, and impact. These findings will be summarized into key statements that represent collective insights across studies (e.g., privacy concerns). If meta-aggregation is not feasible, a narrative synthesis will be employed to summarize individual studies' thematic findings, focusing on feasibility, acceptability, and implementation challenges such as barriers, facilitators, and user experiences with digital health interventions.

Mixed methods studies

The quantitative and qualitative components will be synthesized separately as listed above for quantitative and qualitative components.

Integrating quantitative and qualitative data

Once the quantitative and qualitative data are synthesized, they will be integrated based on their thematic similarities to produce a set of integrated findings. These findings will be presented in the form of action statements that align with the review questions [27]. The integration process will involve juxtaposing the quantitative and qualitative findings in a matrix:

- One side of the matrix will contain findings from the qualitative synthesis (e.g., intervention components linked to acceptability or feasibility)
- The other side will present findings on intervention effects (e.g., whether the intervention improved outcomes, had no effect).

The matrix will allow us to identify patterns and correlations, using qualitative data to explain variations observed in quantitative study findings.

Discussion

Mobile populations face unique challenges in accessing consistent HIV care and treatment services due to relocation, which disrupts continuity of care and access to services. Digital technologies provide promising, adaptable solutions to address these barriers. However, the feasibility, acceptability, and efficacy of digital intervention in improving outcomes across the HIV care cascade for this underserved population requires careful evaluation and synthesis.

This review will provide a comprehensive overview of available evidence on digital interventions leveraging technology to address the HIV care cascade among mobile populations. It will offer useful insights into the design and functionality of digital health interventions that have demonstrated feasibility, acceptability, and efficacy in both real world and controlled settings. By systematically analyzing intervention components, such as text message reminders, mobile applications, or other digital tools, this review will identify key features associated with successful outcomes, guiding the optimization of digital solutions tailored to the unique needs of this hard-to-reach population. Furthermore, the findings from this evidence synthesis will provide essential guidance for researchers and practitioners developing or adapting digital health interventions for mobile populations.

Abbreviations

ART	Antiretroviral therapy
JBI	Joanna Biggs Institute
MeSH	Medical Subject Heading
PICO	Population Intervention Comparison and Outcomes
PRISMA-P	Preferred Reporting Items for Systematic Review and Meta-Analysis Protocols

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s13643-024-02747-2.

Supplementary Material 1. PRISMA-P 2015 Checklist.

Supplementary Material 2. JBI critical appraisal instruments.

Supplementary Material 3: Supplementary Table 1. Pilot search strategy for Web of 214 Science database.

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Authors' contributions

TM developed the study protocol in collaboration with TP, BM, LK, and FT. PM, BM, and TM formulated the draft search strategy. All authors read and approved the final manuscript.

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Data availability

Not applicable.

Declarations

Ethics approval and consent to participate

Not applicable.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

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