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The Impact of Digital Health Technologies on Reproductive Health Equity: A Scoping Review

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Abstract:

- ***Background***

Digital health technologies show promise in improving access to reproductive health services for disadvantaged populations, however, their effect on reproductive health equity is not fully understood. This review investigates how digital health interventions influence reproductive health equity across various populations and settings.

- ***Objective***

The aim is to systematically map existing literature on digital health technologies in reproductive health, pinpoint equity dimensions addressed, and identify enablers and barriers to achieving reproductive health equity through digital health solutions.

- ***Methods***

Following the Arksey and O'Malley framework, a comprehensive scoping review was conducted. An equity-focused analytical approach guided the examination of factors influencing intervention accessibility and equity outcomes across diverse populations. Findings are reported using the PRISMA extension for scoping reviews. The search included peer-reviewed studies published between 2014 and 2025 that described digital health interventions targeting reproductive health and explicitly addressed equity dimensions.

- ***Results***

Twenty studies were included from diverse geographical contexts (Asia n=10, Africa n=8, South America n=1, North America n=1). Digital health interventions included mobile health applications, SMS/voice messaging, telemedicine, interactive voice response systems, and AI-enabled chatbots. Key equity dimensions identified were geographic access (60%), digital literacy (55%), socioeconomic status (45%), education level (40%), gender disparities (35%), language barriers (30%), age (20%), marginalized population status (15%), caste (10%), and intersectional identities (5%). Equity-enhancing features included local language content, community health worker involvement, offline functionality, culturally tailored messaging, and user-friendly confidential design. Equity-limiting barriers included digital divide, infrastructure limitations, shared device access, cost, privacy concerns, and persistent sociocultural determinants like gender norms, caste, and education-based discrimination.

- ***Conclusion***

Digital health technologies have the potential to advance reproductive health equity but can also perpetuate existing inequities if not carefully designed and implemented with explicit equity considerations. Successful integration requires addressing multilevel barriers including technological infrastructure, digital literacy, sociocultural factors, and economic constraints. Future interventions should prioritize equity-centered design, meaningful community engagement, and systematic evaluation of differential impacts across population subgroups to ensure that those most marginalized benefit equitably from digital health innovations.

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Keywords: *Digital Health, Reproductive Health, Health Equity, mHealth, Digital Divide.*

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I. INTRODUCTION

The World Health Organization's global strategy for digital health (2020–2025) emphasizes the transformative potential of digital technologies to achieve universal health coverage and improve health outcomes [1]. Within the reproductive health domain, digital health technologies, including mobile health (mHealth) applications, telemedicine platforms, text messaging services, and artificial intelligence-enabled tools, have proliferated rapidly, promising to overcome traditional barriers to accessing sexual and reproductive health (SRH) information, commodities, and services [2-4].

Reproductive health equity, defined as the absence of systematic disparities in reproductive health outcomes and access to services among population groups with different levels of underlying social advantage, remains a critical global health challenge [5]. Despite advances in reproductive health technologies and services, significant inequities persist across multiple dimensions including geographic location, socioeconomic status, gender, education, race and ethnicity, and other social determinants of health [6]. These inequities manifest in differential access to contraception, maternal health services, safe abortion care, sexually transmitted infection prevention and treatment, and comprehensive sexuality education [7].

Digital health interventions have been promoted as potential solutions to address reproductive health inequities by increasing access for geographically isolated populations, reducing stigma through anonymous service delivery, providing tailored health information, and lowering costs associated with facility-based care [8-9]. Mobile phone penetration has reached unprecedented levels globally, with an estimated 5.3 billion unique mobile subscribers worldwide, including substantial coverage in low- and middle-income countries where reproductive health inequities are most pronounced [10]. This technological landscape creates opportunities to leverage digital platforms to reach underserved populations.

However, the relationship between digital health technologies and health equity is complex and potentially paradoxical. While digital interventions may reduce some barriers to reproductive health access, they may simultaneously create or exacerbate others [11]. The "digital divide" in access to and use of information and communication technologies can mirror and amplify existing health inequities. [12-13] Factors such as device ownership, internet connectivity, digital literacy, language, disability status, and sociocultural norms around technology use may differentially affect who can benefit from digital health interventions [14-15].

Despite growing investment in digital health for reproductive health and increasing recognition of health equity as a priority, evidence on the equity impacts of these interventions remains scattered across diverse literatures. Previous reviews have examined digital health interventions for specific reproductive health outcomes or in particular settings, but comprehensive synthesis of how these technologies affect reproductive health equity across multiple dimensions and contexts is lacking [16-17]. Understanding both the promise and pitfalls of digital health for advancing reproductive health equity is essential to guide the design, implementation, and evaluation of future interventions.

This review aims to systematically map existing literature on digital health technologies for reproductive health through an equity lens, identify key dimensions of equity addressed, and synthesize evidence on enablers and barriers to achieving reproductive health equity. By centering equity in the analysis, this review provides actionable insights for researchers, implementers, policymakers, and funders to ensure digital health innovations advance reproductive health equity and reach those most in need.

II. METHODOLOGY

➢ *Scoping Review Methodology*

Arksey and O'Malley methodological framework was followed in this review, which consists of six stages: (1) identifying the research question, (2) identifying relevant studies, (3) study selection, (4) charting the data, (5) collating, summarizing, and reporting results, and (6) optional consultation exercise [22]. This framework is particularly appropriate for examining emerging fields where the research landscape is heterogeneous and aims to map the breadth of evidence rather than assess quality or synthesize effect sizes as in systematic reviews.

The findings of this review are reported following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) checklist to ensure transparent and complete reporting [23].

➢ *Identification of the Research Question*

This study was guided by the main research question, What is the impact of digital health technologies on reproductive health equity? and three sub questions, (i) What types of digital health interventions have been implemented to address reproductive health needs, and what equity dimensions

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do they target? (ii)What are the enablers that facilitate equitable access to and benefit from digital health interventions for reproductive health? (iii)What are the barriers that limit equitable access to and benefit from digital health interventions for reproductive health? These questions guided the development of search strategies and the identification of relevant studies, with particular attention to ensuring breadth of coverage across diverse intervention types, populations, settings, and equity dimensions.

➢ *Identification of Relevant Studies*

A comprehensive literature search was conducted to identify studies examining digital health interventions for reproductive health with explicit attention to equity dimensions. The search strategy employed multiple approaches to maximize comprehensiveness, electronic database searches, systematic searches were conducted in PubMed, Google Scholar, Web of Science, Scopus, and CINAHL databases. The search strategy combined three main concept areas using Boolean operators; Digital health terms; "digital health" or "mHealth" or "mobile health" or "telemedicine" or "telehealth" or "eHealth" or "health app" or "mobile app" or "text message" or "SMS" or "interactive voice response" or "chatbot" or "artificial intelligence". Reproductive health terms; "reproductive health" or "sexual health" or "maternal health" or "family planning" or "contraception" or "antenatal care" or "ANC" or "postnatal care" or "pregnancy" or "abortion" or "sexually transmitted infection" or "STI" or "HIV" or "menstrual health". Equity terms; "equity" or "inequity" or "disparity" or "disparities" or "equality" or "inequality" or "access" or "accessibility" or "barrier" or "digital divide" or "underserved" or "marginalized" or "vulnerable population". The authors searched studies published between January 2014 and October 2025 to capture the contemporary landscape of digital health interventions while focusing on the period of rapid mobile technology proliferation. No language restrictions were applied in the initial search, though only English-language full texts were ultimately included based on feasibility. Grey Literature; searches were conducted in Google Scholar to identify relevant grey literature including technical reports, dissertations, and conference proceedings. Key organizational websites (WHO, UNFPA, USAID, Gates Foundation) were also searched for relevant program evaluations and reports. All identified references were imported into bibliographic management software (Endnote 21) for organization, deduplication, and screening.

➢ *Study Selection*

- *Inclusion Criteria:*

Studies were eligible for inclusion if they met all of the following criteria, (i) Empirical studies of any design (randomized controlled trials, quasi-experimental studies, observational studies, qualitative studies, mixed methods studies, implementation studies). (ii) Intervention that described a digital health intervention targeting reproductive health, including but not limited to mobile applications, SMS/text messaging services, voice messaging, telemedicine/teleconsultation platforms, interactive voice response systems, web-based platforms, social media-based interventions, or artificial intelligence-enabled tools. (iii) Focused on any population accessing or potentially accessing reproductive health services, including women of reproductive age, adolescents, men, sex workers, LGBTQ+ populations, pregnant and postpartum women, or other relevant groups. (iv) Reported on access to reproductive health information, goods, or services, reproductive health knowledge, attitudes, or behaviours, or reproductive health outcomes (v) Explicitly addressed at least one dimension of health equity. (vi) Published between January 1, 2014 and October 31, 2025. (vii) Available in English (for full-text review). Studies were excluded if they met any of the following criteria, (i) Publication type did not describe a specific digital health intervention. (ii) Did not address reproductive health as a primary or significant secondary focus. (iii) Did not explicitly address equity dimensions or differential impacts across population subgroups. (iv) Protocols, study designs, or abstracts without full results. (v) Reviews, editorials, commentaries, or opinion pieces (though bibliographies were checked for relevant primary studies). (vi) Studies before 2014 considered irrelevant to the research questions.

- *Selection Process:*

Two reviewers independently screened all titles and abstracts identified through the search strategy against the inclusion and exclusion criteria. Full-text articles were retrieved for all studies that appeared potentially eligible based on title and abstract screening or where eligibility was unclear.

➢ *Charting the Data*

The authors reviewed titles and abstracts to identify relevant articles for final inclusion. The following characteristics were extracted from the eligible studies; Author, country, study design, digital health technology, population, equity dimension, key equity finding. All extracted data are included in Table 1. All authors reviewed the articles at length for inclusion in the final analysis.

➢ *Collating, Summarizing, and Reporting Results*

The team conducted iterative meetings virtually and physically to review, analyse, and access all articles for final inclusion in this scoping review. The characteristics of interest are tabulated in Table 1 highlighting the extraction of parameters of interest from the identified studies.

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Table 1: Characteristics of Included Studies on Digital Health Interventions for Reproductive Health Equity

Study	Study Design	Digital Health Technology	Population	Equity Dimensions	Key Equity Findings
Jonayed & Rumi, 2024	Qualitative (in-depth interviews, n=26)	mHealth services: mobile apps (period trackers), websites, SMS, IVR, mobile consultative services	Women from seven public universities, Bangladesh	Geographic (urban-centric), digital access, knowledge gaps, sociocultural barriers	Services were urban-centric, causing geographic inequity. Digital divide restricted access for those without technology. Lack of sex education created knowledge gaps. Sociocultural stigma affected young women's access to information.
Ssenfuka et al., 2025	Descriptive cross-sectional mixed methods (n=948 quantitative; n=13 qualitative)	Rocket Health: telemedicine hotline, SMS, social media (WhatsApp, Twitter, Facebook), USSD platform, e-commerce	Youth aged 18-30 in Kampala and Wakiso districts, Uganda	Gender, economic (cost), persistent access barriers	More males (57%) than females (43%) used platforms, indicating gender disparity. 30% still relied on physical pharmacy visits, highlighting access barriers. Average cost of $3.2 per transaction was a barrier for some youth.
Nalwanga et al., 2021	Cross-sectional analysis of RCT data (n=543 intervention group; 374 used app)	Android mobile app: SRH information (FAQs, chat, period tracker), goods (commodities), services (testing, counseling), mobile money payment	University students at Kyambogo University, Kampala, Uganda	Gender, technology access (internet, device functionality)	Utilization similar by gender (82% for both), showing gender equity in access. Main barriers: slow internet/access issues (34%), poor app functioning (20%), installation difficulties (15%), indicating technology access inequities.
Musiimenta et al., 2022	Pilot RCT (n=80 enrolled; 69 completed)	MatHealth App: offline Android app with video/audio files in Runyankole, appointment reminders, obstetrician connection	Women with limited education in rural southwestern Uganda (Mbarara)	Geographic (rural), education (limited), economic (transport/money)	Targeted women with limited education in rural area. Main barriers to ANC attendance: lack of transport/money, highlighting economic and geographic barriers.
Rokicki et al., 2017	Cluster-RCT (n=756 female students)	SMS programs: (1) unidirectional weekly RH messages; (2) interactive weekly quiz with feedback and airtime rewards	Adolescent girls in Accra, Ghana	Age (adolescents), socioeconomic (LMIC setting)	Targeted adolescent girls in LMIC setting. Among sexually active participants, interventions significantly lowered pregnancy odds, but no impact in full sample suggested differential reach.
Choudhury & Choudhury, 2022	Randomized quasi-controlled study (n=1,480; 740 intervention, 740 control)	Mobile for Mothers (MfM) app: used by ASHAs during home visits; text, photos, voice prompts in Hindi	Pregnant women in two rural tribal villages, Jharkhand, India	Geographic (rural), ethnicity (tribal), language (Hindi)	Targeted tribal and rural communities. Used local health workers (ASHAs) to reach underserved populations. Provided information in Hindi to address language barriers.
Ilozumba et al., 2018	Quasi-experimental cross-sectional	Mobile for Mothers (MfM) app: used by ASHAs; text,	Women in Deoghar district, Jharkhand, India	Caste, education	Could not overcome key sociocultural determinants. Caste and education remained significant predictors of

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Study	Study Design	Digital Health Technology	Population	Equity Dimensions	Key Equity Findings
	(n=2,200 women)	pictures, voice prompts in Hindi			outcomes despite intervention, continuing to create inequities in maternal health knowledge and health-seeking behavior.
Murthy et al., 2020	Pseudo-RCT (single blind) (n=2,016 pregnant women)	mMitra: voice messaging service with 145 gestational age-based audio messages in Hindi and Marathi, twice weekly	Pregnant women in Mumbai (F North and M East municipal wards), India	Language (Hindi and Marathi), urban municipal setting	Delivered in Hindi and Marathi to address language barriers. Control group performed better on at-home deliveries with skilled birth attendants, suggesting intervention may have created unintended inequities in home birth support.
Verma et al., 2025	Quasi-experimental pre-post pilot (n=135)	Weekly group calls, WhatsApp group chats, mobile app, IVR calls	Postpartum women in Punjab, India	Synchronous vs. asynchronous access	Synchronous arm (group calls) showed greater benefits but excluded those unable to attend scheduled calls, creating access inequity.
Siswati et al., 2024	Quasi-experimental pre-post with control (n=200; 100 intervention, 100 control)	mHealth app for child growth/development monitoring with WhatsApp group support over 8 weeks	Mother-child pairs in Sedayu Subdistrict, Bantul Regency, Yogyakarta, Indonesia	Geographic (specific subdistrict)	Targeted mother-child pairs in specific subdistrict of Yogyakarta.
Prinja et al., 2018	Quasi-experimental (259 ASHAs serving ~300,000 population)	ReMiND program: mobile app for ASHAs to track and support maternal and child health clients	Population of ~300,000 in Kaushambi district, Uttar Pradesh, India	Geographic (rural district), economic (cost-effectiveness)	Reached ~300,000 population through ASHAs in Kaushambi district. Cost-effectiveness analysis showed intervention was cost-saving (INR 12,993/USD 205 per DALY averted), suggesting potential for equitable scale-up.
Wagnew et al., 2025	Non-randomized controlled trial (n=386; 194 intervention, 192 control)	Weekly SMS reminders and biweekly phone calls throughout pregnancy	Pregnant women at Debre Markos and Finoteselam public hospitals, Northwest Ethiopia	Geographic (Northwest Ethiopia), facility-based access	Targeted pregnant women in public hospitals in Northwest Ethiopia.
Nuhu et al., 2023	Quasi-experimental (n=469; 263 intervention, 206 comparison)	Technology for Maternal and Child Health (T4MCH): weekly SMS/voice in local languages; health workers used mobile app (SGS collect); Knowledge Sharing Sessions with audio-visual aids	Pregnant women in Sawla-Tuna-Kalba district (intervention) and Bole district (control), Savannah Region, Ghana	Language (local languages), literacy (audio-visual aids), geographic (rural Savannah Region)	Delivered messages in local languages to address language barriers. Included Knowledge Sharing Sessions with audio-visual aids accommodating varying literacy levels. Targeted rural Savannah Region districts.

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Study	Study Design	Digital Health Technology	Population	Equity Dimensions	Key Equity Findings
Alam et al., 2020	Retrospective cross-sectional survey (n=459 female subscribers)	Aponjon service: national mobile-based health education with twice-weekly text or voice messages in Bangla	Pregnant women and new mothers in selected subdistricts of Bogura, Bagerhat, Patuakhali, Chittagong, Laxmipur, Bangladesh	Device ownership (singular vs. shared access)	Women with singular (vs. shared) mobile phone access had higher odds of service satisfaction, knowledge retention, and behavior change. Shared phone access created inequities in intervention effectiveness.
Chima-Oduko & Odeyemi, 2025	Quasi-experimental (n=600; 300 intervention, 300 control)	Six-week intervention: weekly live CSE webinars via Google Meets, peer-led WhatsApp discussions, digital linkages to youth-friendly SRH services	Undergraduate students at two public universities in Lagos, Nigeria	Age (youth), unintended consequences (risky behaviors), differential facility access	Targeted undergraduate students at public universities. Mixed results for risky sexual behaviors (e.g., increase in multiple sexual partners in intervention group) suggested potential unintended consequences. Increased use of teaching hospitals and primary health centers reflected differential access to facility types.
Macharia et al., 2022	RCT (n=300; 146 intervention, 154 control)	USSD-based mobile app providing on-demand SRH information	Adolescents in Kibra, Nairobi County, Kenya	Age (adolescents), geographic (Kibra informal settlement), usability, confidentiality	Targeted adolescents in Kibra informal settlement. 54.9% used app at least once, indicating nearly half did not engage. Ease of use and confidentiality were valued, supporting equitable access features.
Lopez et al., 2014	Pre-post intervention (n=58 completed both surveys from 232 pre-intervention)	DoctorChat Mobile: teleconsultation app for SRH inquiries with personalized physician responses	University students in Bogotá, Colombia	Attrition, sustained engagement	High attrition: only 58 of 232 (25%) completed both surveys. Low app usage (83% consulted only 1-3 times) suggested barriers to sustained engagement.
Threats & Gray, 2025	Cross-sectional online survey (n=285)	Video calls, SMS, mobile apps, AI-enabled chatbots for SRH information and services	LBQ+ women of color, United States	Intersectional identities (sexual orientation, race), education, age, insurance, data privacy, digital literacy	Targeted LBQ+ women of color, addressing intersectional health inequities. Key concerns: data privacy, lack of affective communication, technology access/digital literacy. Sociodemographic factors (education, age, insurance, usual place of care) significantly influenced acceptability. Low HPV vaccine awareness (37.9%) highlighted knowledge inequities.
Mwaisaka et al., 2021	Qualitative (in-depth interviews)	ARMADILLO: on-demand interactive SMS platform for	Young people in Kwale County, Kenya	Age (youth), usability,	Varied user experiences: majority found it easy to use, but some faced navigation

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Study	Study Design	Digital Health Technology	Population	Equity Dimensions	Key Equity Findings
	nested in RCT (n=30)	SRH information with number-based menu; weekly remunerated quizzes		navigation complexity	challenges. Inability to ask follow-up questions limited effectiveness for those with complex needs. Targeted young people in Kwale County.
Ampt et al., 2020	Qualitative (n=42)	WHISPER: 12-month SMS program with (1) informational/motivational push messages, (2) role model stories of FSWs, (3) on-demand menu for contraceptive/service information	Female sex workers in Mombasa, Kenya	Marginalized population (FSWs), literacy, privacy	Designed for and with female sex workers, a marginalized population. Content trusted due to community involvement. On-demand system feasible but challenging for less educated users, highlighting literacy-related inequities. Privacy concerns identified as key risk.

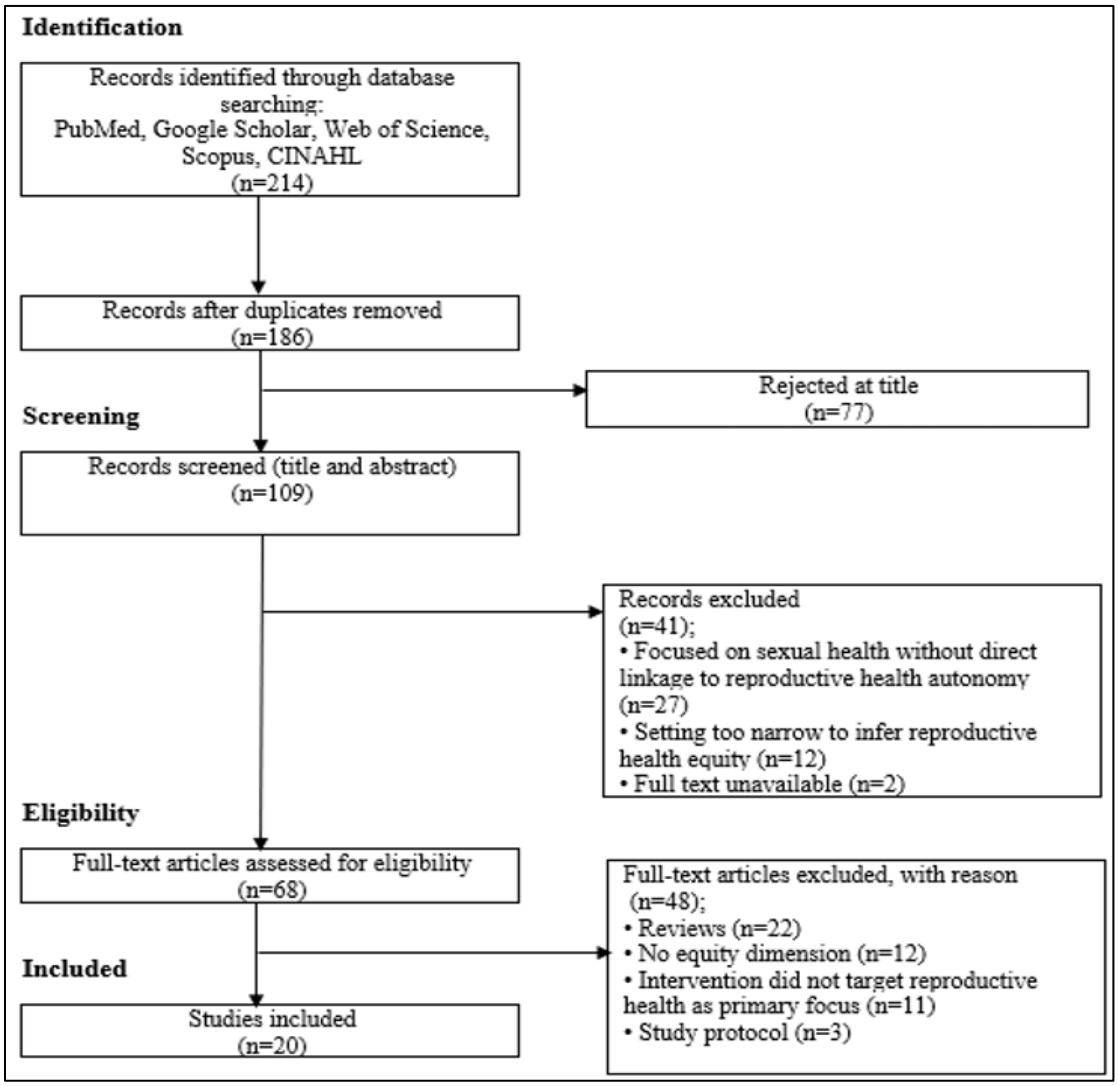

Fig 1 Flow Diagram for Selected Studies

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III. RESULTS

Our initial database search identified 214 articles, 28 of which were duplicates, 77 articles were eliminated at title, and an additional 41 articles were removed from the abstracts. Out of 68 full-text articles assessed for eligibility, 20 studies met all inclusion criteria and were included in this scoping review as shown Fig 1. The 20 included studies were published between 2014 and 2025, with 70% (n=14) published since 2020, indicating a recent acceleration in digital health interventions for reproductive health with explicit equity considerations.

Studies were conducted across diverse geographic contexts namely, Asia (n=10, 50%), Africa (n=8, 40%), South America (n=1, 5%), and North America (n=1, 5%). Study designs included randomized controlled trials (RCTs) (n=4, 20%), cluster-randomized controlled trials (n=1, 5%), quasi-experimental studies (n=8, 40%), cross-sectional studies (n=4, 20%), and qualitative studies (n=3, 15%). Sample sizes ranged from 30 participants in a qualitative study to 2,016 participants in a pseudo-randomized controlled trial, with a median sample size of 386 participants.

Digital health interventions employed diverse technologies namely, mobile applications (n=9, 45%), SMS/text messaging services (n=8, 40%), voice messaging services (n=4, 20%), telemedicine/teleconsultation platforms (n=3, 15%), interactive voice response (IVR) systems (n=2, 10%), USSD platforms (n=2, 10%), social media platforms including WhatsApp (n=4, 20%), and artificial intelligence-enabled chatbots (n=1, 5%). Many interventions employed multiple technologies in combination.

Reproductive health domains addressed included; maternal health/antenatal and postnatal care (n=9, 45%), family planning and contraception (n=7, 35%), comprehensive sexual and reproductive health information (n=11, 55%), sexually transmitted infections including HIV (n=6, 30%), and menstrual health (n=2, 10%).

Target populations included pregnant and postpartum women (n=9, 45%), adolescents and youth (n=7, 35%), university students (n=3, 15%), female sex workers (n=1, 5%), and LBQ+ women of color (n=1, 5%). Eight studies (40%) specifically targeted rural or geographically isolated populations, and six studies (30%) explicitly focused on low-income or economically disadvantaged populations.

Equity dimensions explicitly addressed in the included studies encompassed: geographic access (rural vs. urban, remote areas) (n=12, 60%), socioeconomic status and poverty (n=9, 45%), gender disparities (n=7, 35%), education level and literacy (n=8, 40%), digital access and digital literacy (n=11, 55%), language barriers (n=6, 30%), age (n=4, 20%), marginalized population status (n=3, 15%), caste (n=2, 10%), and intersectional identities (n=1, 5%).

➢ *Thematic Synthesis of Equity Dimensions*

Through thematic analysis of the equity-related findings across all 20 studies, seven major equity dimensions emerged. These dimensions often intersected and overlapped, reflecting the complex, multifaceted nature of health inequity.

- *Geographic Access and Rural-Urban Disparities*

Geographic inequity was identified as the most frequently addressed equity dimension (n=14 studies). Digital health interventions were often explicitly designed to overcome geographic barriers to reproductive health access. Multiple interventions specifically targeted rural populations facing limited access to health facilities and providers. In rural southwestern Uganda, the MatHealth App was designed for women with limited education, addressing barriers of distance and lack of transport to antenatal care [5]. Similarly, the Mobile for Mothers (MfM) app in rural tribal villages of Jharkhand, India, utilized community health workers (ASHAs) to deliver maternal health information to geographically isolated populations [7-8]. The ReMiND program in Uttar Pradesh, India, reached approximately 300,000 people in a rural district through ASHA-delivered mobile health services [12]. However, several studies identified concerning patterns of urban-centric design that perpetuated geographic inequity. In Bangladesh, Jonayed and Rumi found that mHealth services for reproductive health were predominantly urban-centric, creating geographic inequity for women outside major cities [2]. These finding highlight that simply deploying digital health technologies does not automatically overcome geographic barriers; intentional design for rural contexts is pivotal. Even when interventions targeted rural populations, infrastructure limitations created persistent access barriers. In Uganda, slow internet access and connectivity issues were reported by 34% of users of a university-based SRH app, limiting effectiveness [4]. These findings underscore that the digital divide has a strong geographic component, with rural areas often lacking the connectivity infrastructure necessary for digital health interventions to function effectively. The evidence suggests that digital health can reduce geographic barriers when intentionally designed for rural contexts, delivered through trusted intermediaries like community health workers, and adapted to local infrastructure constraints. However, without such intentional design, digital health interventions may inadvertently widen rural-urban disparities in reproductive health access.

- *Gender Disparities*

Gender stood out as a critical equity dimension, with studies revealing both gender-specific barriers and differential utilization patterns (n=8 studies). In Uganda, the Rocket Health telemedicine platform showed significant gender disparities, with 57% male users compared to 43% female users, despite reproductive health being a primary focus [3]. This finding is particularly concerning given that reproductive health services are often more relevant to women's health needs. The gender gap in utilization suggests that factors beyond need such as

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device ownership, autonomy in technology use, or platform design may create gendered barriers to access. Conversely, some interventions achieved gender equity in utilization. The SRH app for university students in Uganda showed similar utilization rates for males and females (82% for both), suggesting that in certain contexts such as university settings with relatively equal technology access gender disparities can be overcome [4]. Beyond access to technology, sociocultural gender norms created barriers to reproductive health information seeking. In Bangladesh, sociocultural stigma particularly affected young women's ability to access reproductive health information through digital platforms [2]. These findings highlight that gender inequity in digital health extends beyond the digital divide to encompass broader social determinants including autonomy, privacy, and cultural norms around women's reproductive health. Gender disparities in mobile phone ownership and control showed up as a critical barrier. In Bangladesh, women with singular (versus shared) mobile phone access had significantly higher odds of service satisfaction, knowledge retention, and behavior change from the Aponjon mHealth service [15]. Shared phone access more common among women in patriarchal contexts created inequities in intervention effectiveness, as women had less privacy, autonomy, and consistent access to health information.

- *Socioeconomic Barriers*

Socioeconomic status proved to be a pivotal factor of digital health access and effectiveness (n=9 studies). Direct costs of digital health services created access barriers even when interventions were designed for low-income populations. In Uganda, the average cost of $3.20 per transaction through the Rocket Health platform was identified as a barrier for some youth [3]. While this cost may seem modest, it represents a significant proportion of daily income for many young people in low-resource settings. Similarly, lack of money for transport to health facilities remained a barrier to antenatal care attendance even among users of the MatHealth App in rural Uganda [5]. The cost of mobile phone airtime and data emerged as a recurring barrier. Several interventions attempted to address this through design features such as providing airtime rewards for participation [6], using USSD platforms that do not require internet data [17], or delivering content via SMS rather than data-intensive apps. However, even SMS-based interventions require users to maintain active phone service, which may be intermittent for those with limited resources. Many interventions explicitly targeted low-income populations, recognizing socioeconomic inequity as a primary barrier to reproductive health access. The mMitra voice messaging service in India specifically focused on low-income pregnant women in urban municipal wards [9]. The Technology for Maternal and Child Health (T4MCH) program in Ghana's rural Savannah Region targeted economically disadvantaged communities [14]. These targeting strategies reflect recognition that digital health interventions must intentionally address socioeconomic barriers to promote equity. Prinja et al provided encouraging evidence regarding the economic sustainability of digital health for equity. The ReMiND program in India demonstrated cost-effectiveness at INR 12,993 (USD 205) per disability-adjusted life year (DALY) averted, suggesting potential for equitable scale-up even in resource-constrained settings [12]. This finding is important for policy considerations, as cost-effectiveness is essential for sustainable implementation of equity-focused interventions. However, several studies found that digital health interventions could not overcome fundamental socioeconomic determinants of health. In India, the Mobile for Mothers app could not overcome the effects of caste and education on maternal health knowledge and health-seeking behavior, with these socioeconomic factors remaining significant predictors of outcomes despite the intervention [8]. This finding underscores that digital health technologies, while potentially valuable, cannot substitute for addressing structural socioeconomic inequities.

- *Digital Literacy and Technology Access*

The digital divide disparities in access to technology, internet connectivity, and digital literacy dominated as a pervasive equity challenge (n=11 studies). Access to appropriate devices was a fundamental barrier. In Uganda, poor app functioning (20% of users) and installation difficulties (15%) limited utilization of an SRH app among university students [4]. These technical barriers disproportionately affect those with older devices, limited technical support, or lower digital literacy. In Bangladesh, lack of technology ownership entirely excluded some women from accessing mHealth services [2]. Internet access and quality emerged as critical determinants of digital health effectiveness. Slow internet and access issues affected 34% of users of the Ugandan SRH app [4]. This barrier is particularly pronounced in rural and low-income areas, creating a geographic and socioeconomic dimension to the digital divide. The ability to effectively navigate and use digital health platforms varied considerably, creating literacy-related inequities. In Kenya, while the majority of young people found the ARMADILLO SMS platform easy to use, some faced navigation challenges [20]. The WHISPER SMS program for female sex workers in Kenya was found to be feasible but particularly challenging for less educated users, highlighting literacy-related inequities [21]. These findings suggest that even relatively simple technologies like SMS require a baseline level of literacy and digital competence that not all users possess. Some interventions incorporated design features to address digital literacy barriers. Voice-based systems were employed to accommodate low literacy populations [4,9,14]. The MatHealth App in Uganda used text, photos, and voice prompts in the local language (Runyankole) to support women with limited education [5]. The T4MCH program in Ghana included Knowledge Sharing Sessions with audio-visual aids to accommodate varying literacy levels [14]. These design adaptations demonstrate that intentional attention to digital literacy can partially mitigate this equity barrier. However, even well-designed interventions sometimes created unintended exclusions. In India, a postnatal mHealth intervention with synchronous group calls showed greater benefits than asynchronous options, but this design excluded women unable to attend scheduled calls due to work,

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childcare, or other responsibilities [10]. This finding illustrates how technology design choices can inadvertently create new forms of inequity even while attempting to promote access.

- *Language and Cultural Barriers*

Language became apparent as both a barrier to equitable access and a design consideration for equity-focused interventions (n=7 studies). Multiple interventions addressed language barriers by delivering content in local languages. The MatHealth App in Uganda provided content in Runyankole [5], the mMitra service in India delivered messages in Hindi and Marathi [9], the Mobile for Mothers app used Hindi [7-8], the Aponjon service in Bangladesh used Bangla [15], and the T4MCH program in Ghana delivered messages in local languages [14]. These language adaptations were imperative for reaching populations with limited English proficiency and reflect recognition that language is a fundamental equity consideration. Voice-based delivery was particularly valuable for addressing both literacy and language barriers simultaneously. The mMitra service delivered 145 gestational age-based audio messages in Hindi and Marathi [9], while the MatHealth App included audio files in Runyankole [5]. Voice-based systems allow for nuanced communication in local languages without requiring literacy, making them particularly appropriate for equity-focused interventions. Beyond language translation, cultural appropriateness proved critical for equity. The WHISPER program for female sex workers in Kenya was designed with and for the target community, resulting in content that was trusted due to community involvement [21]. This participatory approach to content development ensured cultural relevance and appropriateness, factors essential for reaching marginalized populations. However, language and cultural barriers extended beyond content to encompass broader sociocultural contexts. In Bangladesh, sociocultural stigma around reproductive health affected young women's willingness and ability to access information through digital platforms, even when content was available in their language [2]. These finding highlight that addressing language barriers, while necessary, is not sufficient to overcome cultural barriers to reproductive health equity.

- *Marginalized and Vulnerable Populations*

Several studies specifically targeted highly marginalized populations, providing important insights into digital health equity for those facing multiple, intersecting vulnerabilities (n=4 studies). The WHISPER program in Kenya was designed specifically for and with female sex workers, a population facing profound marginalization, stigma, and barriers to reproductive health services [21]. The intervention used SMS to deliver informational and motivational messages, role model stories from other sex workers, and on-demand contraceptive information. The participatory design process and community involvement were identified as critical to the program's acceptability and trustworthiness. However, the study also identified important equity challenges: the on-demand system was particularly challenging for less educated users, and privacy concerns were identified as a key risk for this vulnerable population. In the United States, Threats and Gray examined digital health acceptability among lesbian, bisexual, and queer women of color, a population facing intersectional health inequities related to sexual orientation, race, and gender [19]. The study found that sociodemographic factors including education, age, insurance status, and having a usual place of care significantly influenced acceptability of digital health for SRH. Key concerns included data privacy, lack of affective communication in digital platforms, and technology access and digital literacy barriers. The study also revealed concerning knowledge inequities, with only 37.9% of participants aware of HPV vaccination, highlighting that digital health must address not only access but also fundamental knowledge gaps. In India, the Mobile for Mothers intervention specifically targeted tribal communities in rural Jharkhand, populations facing multiple intersecting disadvantages related to ethnicity, geography, and socioeconomic status [7-8]. The intervention used community health workers to reach these underserved populations and provided information in Hindi. However, the intervention could not overcome key sociocultural determinants, with caste and education remaining significant predictors of outcomes [8]. This finding underscores the limitations of technology-based interventions in addressing structural inequities affecting marginalized populations. In Kenya, the USSD-based SRH app targeted adolescents in Kibra, an informal settlement in Nairobi [17]. This population faces urban poverty, limited access to health services, and multiple vulnerabilities. The intervention emphasized ease of use and confidentiality, features particularly valued by this population. However, engagement was limited, with only 54.9% of participants using the app at least once, suggesting that even targeted interventions face challenges in sustained engagement with marginalized populations.

- *Unintended Consequences and Equity Trade-offs*

An important and concerning theme that arose from the synthesis was evidence of unintended consequences and equity trade-offs, where digital health interventions sometimes created new forms of inequity or produced unexpected negative effects (n=6 studies). In India, the mMitra voice messaging service showed a paradoxical finding where the control group performed better than the intervention group on at-home deliveries with skilled birth attendants [9]. This suggests the intervention may have inadvertently created inequities in home birth support, possibly by emphasizing facility-based care without adequately supporting those who chose or needed home births. In Nigeria, a digital comprehensive sexuality education intervention for university students showed mixed results, with an increase in multiple sexual partners in the intervention group [16]. This unintended consequence raises important questions about how digital health interventions may influence behavior in complex and sometimes counterproductive ways, particularly for sensitive topics like sexual behavior. The same Nigerian study found that the intervention increased use of teaching hospitals and primary health centers, reflecting differential access to facility types [16]. While increased service

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utilization might seem positive, differential access to facility types may reflect or reinforce socioeconomic inequities in quality of care received. In India, a postnatal mHealth intervention found that synchronous group calls showed greater benefits than asynchronous options, but this design excluded women unable to attend scheduled calls [10]. This represents an equity trade-off where optimizing effectiveness for some participants created barriers for others, particularly those with inflexible work schedules or caregiving responsibilities. In Colombia, the DoctorChat teleconsultation app experienced high attrition, with only 25% of initial participants completing follow-up surveys [18]. Low app usage (83% consulted only 1-3 times) suggested barriers to sustained engagement. High attrition rates raise equity concerns, as those who drop out may differ systematically from those who remain engaged, potentially in ways related to socioeconomic status, digital literacy, or other equity-relevant characteristics. In Kenya, only 54.9% of adolescents in an informal settlement used an SRH app at least once, meaning nearly half did not engage at all [17]. This partial engagement pattern suggests that even when interventions are available and targeted to underserved populations, substantial proportions may not benefit, potentially widening gaps between those who engage and those who do not. These unintended consequences and equity trade-offs highlight a critical insight: digital health interventions do not automatically promote equity and may sometimes undermine it. Careful attention to potential negative effects, ongoing monitoring of equity impacts, and adaptive intervention design are essential to ensure that digital health advances rather than compromises reproductive health equity.

IV. DISCUSSION

➢ *Summary of Evidence*

This scoping review synthesized evidence from 20 studies examining the impact of digital health technologies on reproductive health equity across diverse populations and settings. The findings reveal a complex and nuanced picture, while digital health technologies demonstrate considerable potential to reach underserved populations and overcome traditional barriers to reproductive health access, they simultaneously face significant equity challenges and may sometimes exacerbate existing disparities.

Seven major equity dimensions stood out from the synthesis namely, geographic access, gender disparities, socioeconomic barriers, digital literacy and technology access, language and cultural barriers, marginalized populations, and unintended consequences. These dimensions frequently intersected, reflecting the multifaceted nature of health inequity. For example, rural women in low-income settings may face simultaneous barriers related to geography, gender, socioeconomic status, and digital literacy, requiring interventions that address multiple equity dimensions simultaneously. The evidence suggests that digital health interventions can promote reproductive health equity when they are intentionally designed with equity as a primary goal, incorporate features that address specific barriers faced by underserved populations, engage communities in design and implementation, and are adapted to local contexts including language, culture, and infrastructure. Examples of equity-promoting design features identified in this review include local language content [5,7-9,14-15], voice-based delivery for low-literacy populations [5,9,13-14], delivery through trusted community health workers [7-8,12], offline functionality to address connectivity limitations [5], and participatory design with target communities [21] However, the review also identified substantial evidence that digital health interventions do not automatically promote equity and may inadvertently create new forms of exclusion or reinforce existing disparities. The digital divide encompassing device access, internet connectivity, and digital literacy emerged as a pervasive barrier that can exclude the most disadvantaged populations from digital health benefits [2,4,15,21]. Cost barriers, including device costs, airtime, data charges, and service fees, limited access for low-income populations. Gender disparities in device ownership and autonomy created gendered patterns of access [3,15]. Perhaps most concerning, several studies documented unintended consequences where interventions produced paradoxical negative effects or increased risky behaviors [9-10,16]. A critical insight from this review is that digital health technologies interact with, rather than replace, structural determinants of health inequity. Several studies found that interventions could not overcome fundamental socioeconomic determinants such as caste, education, or poverty [8,12]. This finding underscores that digital health should be understood as one component of comprehensive strategies to promote reproductive health equity, not as a technological solution that can substitute for addressing structural inequities. The geographic concentration of studies in South Asia and East Africa reflects both the burden of reproductive health inequity in these regions and the rapid expansion of mobile technology in LMICs. However, the limited evidence from other regions, including Latin America, the Middle East, and high-income countries, represents an important gap. The single study from a high-income country focused on an underserved population (LBQ+ women of color in the United States) [19], highlighting that reproductive health inequity is not solely an LMIC issue but affects marginalized populations globally.

➢ *Implications for Policy and Practice*

The findings of this review have several important implications for policymakers, program implementers, and digital health developers seeking to promote reproductive health equity. Digital health interventions will not automatically promote equity simply by virtue of using technology. Equity must be an explicit, intentional goal from the earliest stages of intervention design. This requires conducting equity analyses to identify which populations face the greatest barriers to reproductive health access, understanding the specific nature of those barriers, and designing interventions that directly address them. Equity considerations should be integrated throughout the intervention lifecycle, from needs assessment through design,

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implementation, and evaluation. Given the intersecting nature of health inequities, interventions should address multiple equity dimensions simultaneously. For example, an intervention targeting rural women should consider not only geographic barriers but also gender, socioeconomic status, literacy, language, and cultural factors. Single-dimension approaches are unlikely to be sufficient for populations facing multiple, intersecting vulnerabilities. The evidence strongly supports participatory approaches that engage target communities in intervention design and implementation. Community involvement ensures cultural appropriateness, builds trust, addresses privacy and confidentiality concerns, and increases the likelihood that interventions will be acceptable and effective for intended populations [21]. For marginalized populations in particular, community engagement is not merely a best practice but an ethical imperative.

- *Implications for Research*

This review identified several important gaps and priorities for future research on digital health and reproductive health equity. Many existing studies examine effectiveness without explicitly analyzing equity impacts. Future research should routinely include equity analyses that examine differential effects by relevant subgroups for example, socioeconomic status, education, rural-urban, gender, age and ethnicity. Study designs should ensure adequate sample sizes for subgroup analyses, and reporting should disaggregate results by equity-relevant characteristics. Equity should be considered a primary outcome, not merely a secondary consideration. Most included studies examined short-term outcomes, with limited evidence on sustained effects or long-term equity impacts. Research is needed to understand whether digital health interventions produce lasting changes in reproductive health equity or whether effects diminish over time. Longitudinal studies that track equity outcomes over extended periods would provide valuable insights into sustainability and long-term impact. While this review identified multiple equity dimensions and barriers, the mechanisms through which digital health interventions affect equity remain incompletely understood. Research employing mixed methods, mediation analyses, and theory-driven approaches could elucidate the pathways through which digital health promotes or undermines equity. Understanding mechanisms is paramount for designing more effective equity-focused interventions.

- *Strengths and Limitations*

This scoping review has several important strengths. We employed a rigorous, transparent methodology following the established Arksey and O'Malley framework, with systematic searching, duplicate screening and data extraction, and comprehensive synthesis. The broad scope of the review allowed us to map the full breadth of evidence on digital health and reproductive health equity, including diverse populations, settings, and technology types. The thematic synthesis approach enabled identification of patterns and themes across heterogeneous studies. The inclusion of all 20 studies meeting criteria, rather than selective reporting, provides a comprehensive overview of the evidence base. However, several limitations should be acknowledged. As a scoping review, we did not conduct formal quality appraisal of included studies or attempt meta-analysis of quantitative findings. Therefore, we cannot make definitive statements about the robustness or generalizability of findings from individual studies. The quality and rigor of included studies varied, and some findings are based on single studies requiring replication. The search was limited to English-language publications, potentially excluding relevant research published in other languages, particularly from non-English-speaking LMICs. This language restriction may have introduced bias toward certain geographic regions and populations. The definition and measurement of equity varied considerably across studies, with some explicitly examining equity as a primary outcome and others addressing equity only implicitly through study design or discussion. This heterogeneity made synthesis challenging and may have resulted in inconsistent identification of equity-related findings. Finally, the rapid pace of technological change means that some findings, particularly regarding specific technology platforms or features, may become outdated quickly. The evidence base reflects technologies available at the time studies were conducted, which may not represent current or emerging digital health modalities.

V. CONCLUSION

Digital health interventions demonstrate potential to reach underserved populations and overcome traditional barriers to reproductive health access, particularly when intentionally designed with equity as a primary goal, adapted to local contexts, and implemented with community engagement. However, the evidence also reveals significant equity challenges, including the digital divide, cost barriers, literacy requirements, and unintended consequences that may sometimes exacerbate existing disparities. The findings highlight the critical need that digital health technologies are not inherently equity-promoting or equity-undermining; rather, their equity impacts depend fundamentally on design choices, implementation approaches, and attention to structural determinants of health inequity. Technology alone cannot overcome fundamental socioeconomic, gender-based, and structural barriers to reproductive health equity, but when thoughtfully designed and implemented as part of comprehensive strategies, digital health can be a valuable tool for advancing equity. For digital health to fulfill its potential to promote reproductive health equity, several conditions are essential: explicit attention to equity from the earliest stages of intervention design, addressing multiple intersecting equity dimensions simultaneously, meaningful community engagement, adaptation to local infrastructure and cultural contexts, integration with existing health systems, ongoing monitoring for unintended consequences, and addressing cost and digital literacy barriers. As digital health technologies continue to proliferate globally, ensuring that they advance rather than undermine reproductive health equity is both an

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ethical imperative and a practical necessity for achieving universal access to sexual and reproductive health services. This review provides a foundation for evidence-informed policy, practice, and research to realize the equity-promoting potential of digital health for reproductive health.

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