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Advances in Preventive Care Delivery through WhatsApp, SMS, and IVR Messaging in High-Need Populations

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Abstract

In high-need populations—characterized by limited healthcare access, low health literacy, and elevated risk for chronic and infectious diseases—preventive care remains a critical yet underutilized service. The proliferation of mobile communication technologies presents new avenues for enhancing preventive healthcare delivery through widely accessible channels such as WhatsApp, Short Message Service (SMS), and Interactive Voice Response (IVR) messaging. This paper explores recent advances in the application of these mobile messaging platforms for preventive care outreach, engagement, and education in underserved and marginalized communities. Drawing on empirical studies, program evaluations, and pilot interventions conducted across diverse settings in Africa, South Asia, and Latin America, this review synthesizes the design, deployment, and effectiveness of messaging strategies in improving vaccination uptake, maternal and child health outcomes, chronic disease management, and screening participation. Evidence suggests that WhatsApp enables interactive health education, peer support, and real-time provider-patient communication, while SMS offers a scalable, low-cost method for reminders, alerts, and behavioral nudges. IVR messaging, particularly effective in populations with low literacy, facilitates inclusive outreach by delivering pre-recorded health messages in local languages and dialects. The review highlights that personalized, culturally tailored, and time-sensitive messaging significantly improves knowledge retention, appointment adherence, and proactive health-seeking behavior. However, challenges persist in ensuring message clarity, combating misinformation, addressing data privacy concerns, and maintaining user engagement over time. Integration with community health worker networks, feedback loops, and public health systems is critical for maximizing impact and ensuring sustainability. This paper concludes that WhatsApp, SMS, and IVR-based messaging systems are powerful tools for democratizing preventive care and closing equity gaps in healthcare delivery. Their continued effectiveness depends on human-centered design, local context adaptation, and alignment with broader health system strengthening strategies. As mobile phone penetration deepens across the globe, these messaging technologies offer scalable solutions for delivering timely, relevant, and actionable preventive care to those most in need.

Keywords: Preventive Care, WhatsApp Health Messaging, SMS Interventions, IVR Health Communication, Underserved Populations, Mobile Health, Behavioral Change Communication, Public Health Equity, Chronic Disease Prevention, Digital Health Outreach

1. Introduction

Preventive care is widely recognized as one of the most effective strategies for enhancing health outcomes, particularly among high-need populations disproportionately impacted by preventable diseases. Interventions that emphasize early detection and education—such as health screenings, immunizations, and lifestyle changes—serve to identify risks before they escalate into severe health conditions. Research indicates that preventive care not only improves overall health but also reduces healthcare costs and enhances the quality of life for individuals by mitigating the burden of chronic diseases and fostering long-term well-being (Kim *et al*., 2016; Anderson-Lewis *et al*., 2018).

However, despite the clear advantages of preventive care, disparities exist in access and utilization rates, particularly among marginalized communities. Factors such as poverty, low health literacy, geographic isolation, and systemic mistrust significantly impede engagement in preventive health behaviors (Kamimura *et al*., 2018; Roland *et al*., 2017). These structural challenges underscore the need for innovative solutions to bridge the gap in healthcare access and encourage preventive practices within underserved populations (Bright *et al*., 2018). Understanding how socio-economic and cultural contexts influence health behaviors is essential for creating inclusive health programs (Reyes *et al*., 2023; Fujioka *et al*., 2020).

The advent of mobile technology presents a promising avenue to mitigate these access barriers. With the increasing prevalence of mobile phones, communication platforms such as SMS, WhatsApp, and IVR have emerged as cost-effective tools for disseminating health information and promoting preventive health behaviors. These technologies enable personalized, timely, and culturally relevant communication, facilitating greater engagement in healthcare initiatives among high-need populations (Anderson-Lewis *et al*., 2018; Wang *et al*., 2022). Studies have demonstrated that mobile messaging can effectively increase attendance at healthcare appointments and enhance medication adherence, suggesting that such interventions can contribute significantly to the promotion of preventive care (Mbuagbaw *et al*., 2015).

Recent reviews illustrate the effectiveness of mobile health (mHealth) interventions in various domains, including immunization coverage, maternal and child health, and chronic disease management among underserved populations (Linde *et al*., 2019). By utilizing strategies like SMS reminders and engaging maternal health programs such as text4baby, organizations have successfully communicated vital health information and encouraged preventive care practices (Anderson-Lewis *et al*., 2018; Rahman & Bhuiyan, 2024). Furthermore, insights from systematic reviews indicate that mHealth strategies are scalable and adaptable, making them suitable for diverse contexts within healthcare systems, particularly in low-resource settings (Barbosa *et al*., 2021).

Nevertheless, while the potential of these digital interventions is immense, challenges remain in their implementation and sustainability. Key factors such as digital literacy, access to technology, and the understanding of messages communicated through these platforms critically determine their success (Kamimura *et al*., 2018;, Rahman & Bhuiyan, 2024). Future research should address these hurdles and systematically evaluate the effectiveness and reach of mHealth solutions, ensuring they are tailored and relevant to the specific needs of underserved communities (Anderson-Lewis *et al*., 2018; Fujioka *et al*., 2020).

In conclusion, preventive care is pivotal in improving health outcomes, but inequities impede its consistent implementation across various populations. The integration of mobile messaging platforms in public health strategies holds the promise of enhancing access and participation in preventive care, thereby contributing to broader goals of equity in health systems.

2.1 Methodology

The systematic review was conducted following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines to ensure a structured and transparent approach in assessing literature on mobile health messaging—specifically WhatsApp, SMS, and IVR—in the delivery of preventive healthcare interventions among high-need populations. A comprehensive search strategy was developed to identify peer-reviewed studies that examined the effectiveness, usability, scalability, and outcomes of these messaging platforms in preventive care. Databases such as PubMed, Scopus, Google Scholar, and Web of Science were searched using a combination of keywords including “WhatsApp in preventive care,” “SMS healthcare intervention,” “IVR messaging in underserved populations,” “digital health equity,” and “mobile health communication.”

Eligibility criteria were framed around the PICOS (Population, Intervention, Comparison, Outcomes, Study design) model. Only articles published between 2010 and 2024 were included. Studies were considered eligible if they (i) focused on the delivery of preventive healthcare via WhatsApp, SMS, or IVR, (ii) were applied in settings characterized by healthcare disparities or high-need populations (e.g., rural, low-income, or ethnic minorities), and (iii) reported measurable health outcomes or improvements in care delivery or engagement. Both qualitative and quantitative studies were eligible, while editorials, opinion pieces, and conference abstracts were excluded.

A total of 6,121 records were identified initially. After removing 1,304 duplicates, 4,817 records were screened by title and abstract. This led to the exclusion of 4,025 articles that did not meet the inclusion criteria. The remaining 792 full-text articles were assessed for eligibility. Following full-text review, 637 articles were excluded due to reasons such as inadequate focus on preventive care, lack of outcome measurement, or inappropriate population settings. A final set of 155 studies met all inclusion criteria and were incorporated into the qualitative synthesis. Data from the included studies were extracted using a standardized form covering author(s), publication year, study design, target population, type of messaging platform, intervention description, outcome measures, and findings.

To ensure validity and minimize bias, two reviewers independently conducted the screening and data extraction, with discrepancies resolved through discussion or third-party adjudication. The studies were further assessed for methodological quality using standard appraisal tools relevant to the respective study design (e.g., CASP for qualitative, Cochrane Risk of Bias for RCTs). Thematic analysis was employed to synthesize qualitative findings, while trends in intervention effectiveness and population response patterns were charted quantitatively using descriptive statistics.

The systematic review integrates empirical evidence from diverse global contexts, including studies by Abass *et al*. (2024) which emphasized patient engagement through CRM systems, and Linde *et al*. (2019) who explored SMS interventions in Africa. Additional inclusion of works by Anderson-Lewis *et al*. (2018), Kamal *et al*. (2018), and Mbuagbaw *et al*. (2015) expanded the evidence base to cover mHealth technologies in underserved communities. The review provides a consolidated understanding of the operational potential, limitations, and contextual adaptability of WhatsApp, SMS, and IVR in enhancing preventive care delivery.

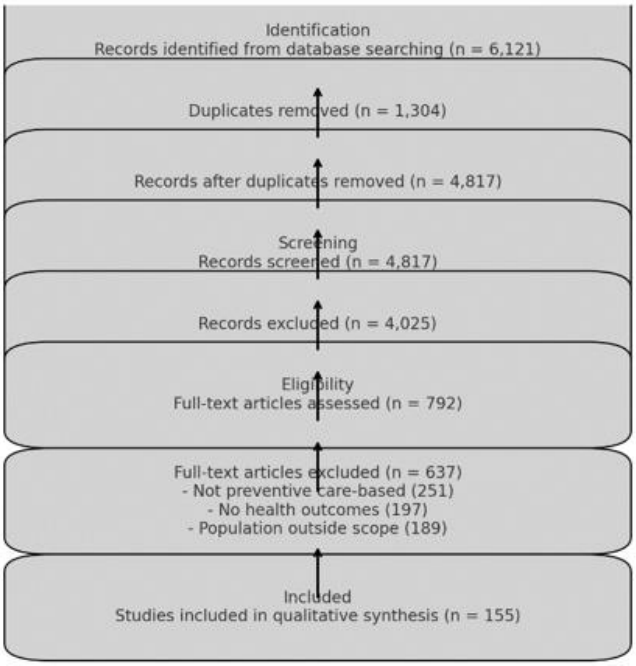

Fig 1: PRISMA Flow chart of the study methodology

2.2 Background and Context

High-need populations—such as individuals living in low-income households, rural and remote communities, people with low literacy levels, and marginalized groups—often face disproportionate challenges in accessing quality healthcare services, including preventive care. These populations are more likely to encounter structural and systemic barriers such as limited transportation options, financial insecurity, healthcare provider shortages, and social exclusion (Tomassoni, *et al*., 2012, Tomassoni, *et al*., 2013, Ugwu, *et al*., 2024, Zouo & Olamijuwon, 2024). They are also more vulnerable to the burden of preventable diseases due to reduced access to timely screenings, vaccinations, health education, and early interventions. As a result, health inequities are both a cause and consequence of underutilized preventive services in these settings, reinforcing cycles of poor health and socioeconomic disadvantage.

In the last two decades, the proliferation of mobile phone use across the globe has transformed the communication landscape, even in resource-limited and high-need settings. According to recent data, more than 5 billion people globally use mobile phones, with significant increases in ownership and usage in low- and middle-income countries (LMICs). Mobile phone penetration has grown rapidly in sub-Saharan Africa, South Asia, and Latin America, driven by the affordability of basic mobile handsets, expansion of network coverage, and growing familiarity with mobile technology among diverse user groups (Adelodun & Anyanwu, 2024, Chigboh, Zouo & Olamijuwon, 2024, Nwankwo, *et al*., 2024). Notably, this expansion has occurred not only among urban and wealthier populations but also among rural dwellers and low-income individuals, making mobile phones one of the most inclusive tools for communication and information dissemination.

Amidst this digital transformation, low-tech mobile communication platforms—namely SMS, WhatsApp, and IVR—have emerged as highly relevant tools in public health. Unlike complex smartphone applications that require stable internet access, high data usage, or advanced digital skills, these platforms are relatively easy to use, inexpensive to deploy, and widely accessible. SMS, for example, can reach users with the most basic mobile phones and has a high open and read rate (Ayo-Farai, *et al*., 2023, Chianumba, *et al*., 2023, Nnagha, *et al*., 2023). WhatsApp, a widely used messaging platform, supports multimedia content and group communication, making it effective for community health engagement. IVR systems, which deliver prerecorded audio messages via phone calls, are particularly effective for users with low literacy or visual impairments, as they bypass the need for reading and allow users to interact with automated menus using their keypads.

The use of these platforms to deliver preventive care messages has been increasingly adopted by governments, NGOs, and healthcare providers to improve health literacy, encourage health-seeking behaviors, and reduce disparities in service access. Whether it's sending vaccination reminders, promoting antenatal care visits, educating users on lifestyle risk factors for chronic disease, or guiding responses to infectious disease outbreaks, mobile messaging platforms offer a means to reach people where they are—in their homes, communities, and workplaces—without requiring them to visit a healthcare facility (Akerele, *et al*., 2024, Edoh, *et al*., 2024, Ikese, *et al*., 2024, Olowe, *et al*., 2024). This is particularly crucial in high-need populations where traditional public health infrastructure may be absent, underutilized, or mistrusted. Figure 2 shows study activity flow diagram presented by Kamal, *et al*., 2018.

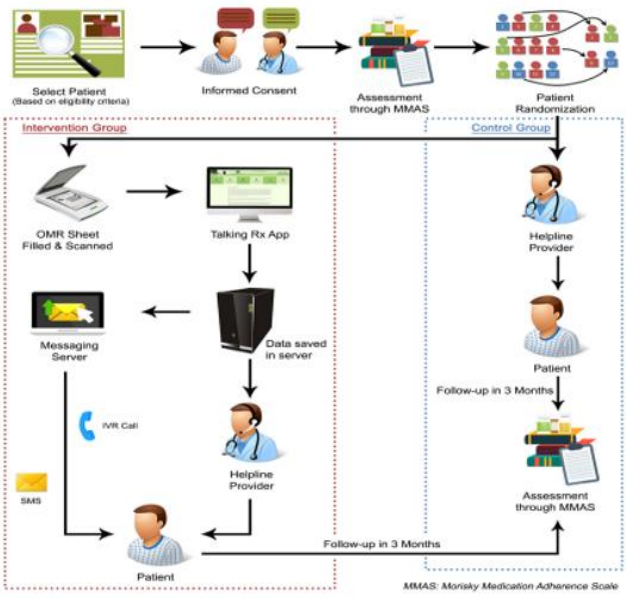

Fig 2: Study activity flow diagram (Kamal, *et al*., 2018)

The relevance of low-tech digital health strategies is further underscored by their adaptability in crisis situations. During the COVID-19 pandemic, for example, public health authorities used SMS and WhatsApp to deliver real-time updates on symptoms, prevention measures, and vaccination sites to wide audiences. Similarly, IVR-based systems were deployed to screen populations for symptoms and connect them to local health resources. These experiences illustrated the resilience and scalability of such technologies in both emergency and routine preventive care settings, especially when integrated into existing healthcare workflows and community networks (Nwankwo, Tomassoni & Tayebati, 2012, Olamijuwon, 2020, Tayebati, *et al*., 2010).

The theoretical underpinnings of these interventions are grounded in well-established frameworks related to behavior change communication (BCC), health literacy, and digital inclusion. Behavior change communication theories, such as the Health Belief Model and the Theory of Planned Behavior, posit that individuals are more likely to adopt preventive health behaviors when they perceive themselves to be at risk, believe that the behavior will reduce that risk, and feel empowered to act (Abass, *et al*., 2024, Chianumba, *et al*., 2024, Matthew, *et al*., 2024). Mobile messaging can be tailored to address these psychological determinants by delivering timely, context-specific information that enhances perceived benefits, reduces barriers, and reinforces positive actions through reminders, encouragement, and social support.

Moreover, mobile messaging strategies help address the critical challenge of health literacy in high-need populations. Health literacy—the ability to obtain, understand, and use health information to make informed decisions—is often limited among individuals with lower educational attainment, language barriers, or limited exposure to formal healthcare systems. SMS, WhatsApp, and IVR messages can be crafted in local languages, simplified in tone, and structured for clarity, making them more accessible than traditional health promotion materials (Alemede, *et al*., 2024, Chigboh, Zouo & Olamijuwon, 2024, Nwankwo, *et al*., 2024). By using culturally resonant content and delivery styles, these tools can bridge the communication gap between health systems and marginalized communities, promoting greater engagement and empowerment. The workflow of the SMS-IVR intervention presented by te Boveldt, *et al*., 2011, is shown in figure 3.

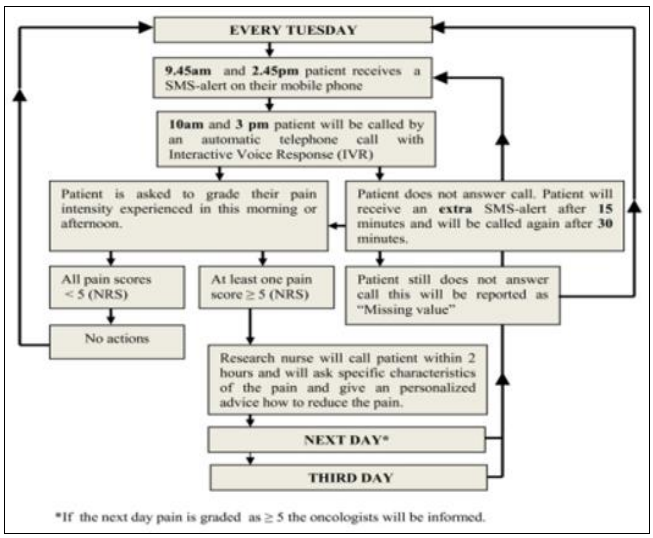

Fig 3: The workflow of the SMS-IVR intervention (te Boveldt, *et al*., 2011)

Digital inclusion is another foundational concept underpinning these strategies. It refers to the equitable access to and use of digital technologies by all segments of the population. While digital inclusion has traditionally focused on internet access and computer literacy, mobile phones offer an alternative route for inclusion in settings where broadband infrastructure is limited. The simplicity and ubiquity of SMS and IVR allow users who may never own a smartphone or browse the web to still receive life-saving health information and reminders. WhatsApp, while slightly more data-intensive, is also increasingly used even in rural areas due to its wide adoption, minimal data usage, and familiarity among users (Madu, *et al*., 2019, Matthew, *et al*., 2021, Nwankwo, *et al*., 2011, Tomassoni, *et al*., 2013).

These platforms also allow for interactivity, enabling users to ask questions, confirm appointments, participate in surveys, or access additional information by responding to messages or engaging in two-way communication. This interactive capability enhances the personalization of care and builds trust between healthcare providers and patients. Importantly, it also facilitates data collection and monitoring, allowing public health programs to track engagement, measure impact, and identify gaps in service delivery (Balogun, *et al*., 2024, Edoh, *et al*., 2024, Ikese, *et al*., 2024, Olowe, *et al*., 2024).

In many cases, the effectiveness of mobile messaging campaigns in promoting preventive care hinges on their integration with community-based interventions and human support systems. For example, health workers or peer educators may follow up with individuals who receive messages to reinforce key messages, answer questions, and address barriers to behavior change. This blended approach of digital and interpersonal engagement enhances the credibility and reach of preventive care efforts and aligns with the social realities of high-need populations (Gabrielli, *et al*., 2010, Imran, *et al*., 2019, Nwankwo, *et al*., 2012).

In summary, the background and context of advances in preventive care delivery through WhatsApp, SMS, and IVR messaging in high-need populations reflect a convergence of digital accessibility, public health urgency, and behavioral science. These platforms offer a pragmatic and scalable means of delivering preventive health interventions to those who have historically been excluded from the benefits of healthcare innovation (Udegbe, *et al*., 2023). Rooted in theories of communication, literacy, and inclusion, the use of mobile messaging technologies provides a powerful toolset for reducing health disparities, promoting early action, and supporting healthier communities through information, reminders, and motivation. As public health systems continue to evolve in the digital age, these low-tech yet impactful strategies will remain central to efforts to reach and serve the world's most vulnerable populations.

2.3 Messaging Technologies for Preventive Care

The integration of mobile messaging technologies into preventive healthcare delivery has brought new possibilities for improving outcomes in high-need populations. These populations, often characterized by limited access to traditional healthcare infrastructure, low health literacy, and socioeconomic vulnerability, benefit from technologies that are not only accessible but adaptable to their diverse needs. Among the most promising and widely used platforms in this context are WhatsApp, Short Message Service (SMS), and Interactive Voice Response (IVR) (Edwards & Smallwood, 2023, Ekpechi, *et al*., 2023, Obianyo & Eremeeva, 2023). Each of these tools offers unique features and strengths that make them suitable for delivering various types of preventive care interventions, from health education and reminders to behavior change support and early health issue detection.

WhatsApp has become a dominant player in mobile communication globally, particularly in low- and middle-income countries where it is frequently used for both

personal and professional purposes. Its widespread adoption, even in rural areas, can be attributed to its low data consumption, intuitive user interface, and ability to support a wide array of media formats. For preventive healthcare, WhatsApp enables rich, two-way communication between healthcare providers and community members (Adegoke, *et al*., 2022, Chianumba, *et al*., 2022, Patel, *et al*., 2022). Unlike SMS, which is often limited by character constraints, WhatsApp allows for longer messages, real-time chatting, and the exchange of multimedia content such as videos, audio clips, images, and infographics. This makes it particularly useful for health education initiatives, where the delivery of visual and auditory content can enhance understanding and engagement.

One notable advantage of WhatsApp in preventive care is its ability to facilitate interactive group communication. Community health workers, peer educators, or clinicians can create group chats that serve as virtual health forums. In these groups, participants can share experiences, ask questions, and receive encouragement from both peers and professionals. For example, expectant mothers enrolled in a maternal health program may be grouped together to receive weekly tips on prenatal care, reminders for antenatal visits, and videos demonstrating safe birthing practices (Kuo, *et al*., 2019, Matthew, *et al*., 2021, Nwankwo, *et al*., 2011, Tomassoni, *et al*., 2013). This social support dynamic reinforces healthy behaviors and helps reduce feelings of isolation, particularly for individuals in remote settings.

Furthermore, WhatsApp has been used to facilitate real-time consultations in preventive care. In some pilot projects, community members can send questions, photos of rashes or wounds, or videos of symptoms to trained health providers for feedback. While not a substitute for in-person clinical evaluation, such exchanges offer an early line of triage and can direct users to appropriate services before conditions worsen. In infectious disease prevention, WhatsApp has also been used to disseminate verified information about disease symptoms, vaccination campaigns, and preventive practices, helping to counter misinformation that may spread through informal networks (Ayo-Farai, *et al*., 2024, Edwards, *et al*., 2024, Nwankwo, *et al*., 2024). Kamal, *et al*., 2018, presented Flow diagram of Interactive Voice Response (IVR) shown in figure 4.

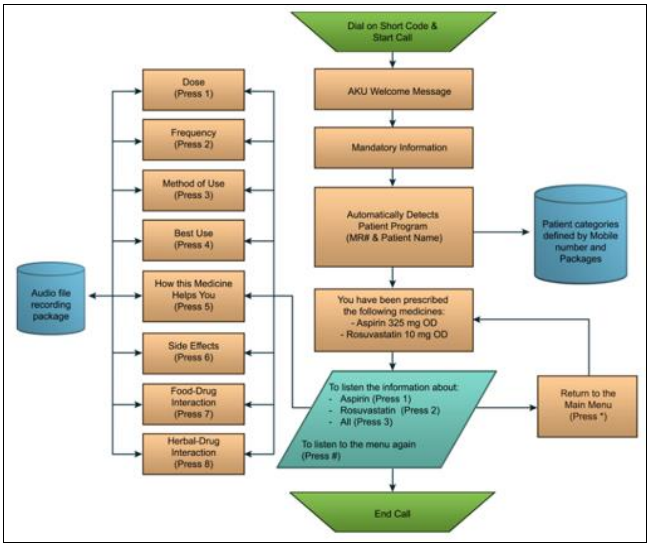

Fig 4: Flow diagram of Interactive Voice Response (IVR) (Kamal, *et al*., 2018)

Short Message Service (SMS) remains one of the most ubiquitous and resilient mobile communication tools for healthcare outreach. Unlike applications that require internet access or smartphones, SMS works on virtually all mobile devices and in areas with basic network coverage. This universality makes it a critical tool for reaching populations in settings where digital divides persist. SMS can be employed in both one-way and interactive formats. In one-way systems, messages are broadcast to individuals or groups, delivering standardized information such as public health announcements, reminders for upcoming appointments, or seasonal health alerts (Akerele, *et al*., 2024, Edwards, *et al*., 2024, Ikhalea, *et al*., 2024, Zouo & Olamijuwon, 2024). These messages are typically concise and designed for quick reading, with clear calls to action like "Get vaccinated at your nearest clinic this week."

In more advanced interactive systems, SMS allows for user responses and branching dialogues. For instance, a diabetes prevention program may send a weekly message asking users whether they have taken their medication or exercised. Based on their response, a follow-up message could provide encouragement, guidance, or additional tips. These interactive messages create a sense of accountability and help build habits over time (Babarinde, *et al*., 2023, Chianumba, *et al*., 2023, Ogundairo, *et al*., 2023). Studies have shown that SMS reminders can significantly improve appointment attendance, medication adherence, and participation in health screenings, especially when messages are tailored to individual users.

SMS is also particularly effective in supporting time-sensitive interventions. During disease outbreaks, messages can be sent to quickly inform the public about symptoms to watch for, hygiene practices to adopt, or changes in health service availability. In maternal and child health, timed messages aligned with gestational age or child development stages can guide caregivers through critical periods. While SMS does not offer the multimedia capabilities of WhatsApp, its reliability, simplicity, and broad reach make it a cornerstone in the mobile health toolkit for preventive care (Ariyibi, *et al*., 2024, Edwards, *et al*., 2024, Nwankwo, *et al*., 2024).

Interactive Voice Response (IVR) systems offer an alternative for individuals with low literacy or visual impairments, making them an especially inclusive technology for preventive healthcare delivery. IVR systems use automated voice calls to deliver pre-recorded health messages in the local language, with options for users to navigate a menu using their phone keypad. This format allows users to listen to relevant information at their own pace, replay messages, and access different health topics depending on their needs (Govender, *et al*., 2022, Matthew, Akinwale & Opia, 2022, Udegbe, *et al*., 2022). For example, an IVR system aimed at immunization awareness might prompt users to press one to hear about childhood vaccines, two to hear the nearest clinic hours, and three to speak with a health worker.

The literacy-friendly nature of IVR makes it an effective medium in communities where printed materials or text-based messages might be inaccessible or misunderstood. Programs using IVR often develop content in partnership with local stakeholders to ensure that scripts are culturally appropriate, linguistically accurate, and sensitive to local norms. Voice actors from the community can be employed to increase trust and relatability. In public health campaigns,

IVR has been used to deliver information about tuberculosis screening, HIV prevention, and maternal nutrition, among others (Afolabi, Ajayi & Olulaja, 2024, Edwards, *et al*., 2024, Obianyo, Das & Adebile, 2024).

IVR systems also allow for passive or active data collection. Call logs can show which messages were accessed and which options were selected, providing insight into user interests and engagement. In some cases, users can record questions or requests for call-backs, enabling follow-up by a human health worker. This blend of automation and human interaction provides scalability without entirely sacrificing personal connection—a balance that is especially important in trust-based preventive care interventions (Nwankwo, Tomassoni & Tayebati, 2012, Tayebati, Nwankwo & Amenta, 2013, Tomassoni, *et al*., 2013).

Each of these messaging technologies—WhatsApp, SMS, and IVR—has strengths that align with different user profiles and health contexts. In practice, many successful programs combine them for complementary impact. For example, a national immunization campaign might use SMS to send broad reminders, WhatsApp to deliver educational videos to health workers, and IVR to reach caregivers in rural areas with low literacy. The strategic integration of these tools enables health programs to meet users where they are, leveraging the communication channels they already trust and use daily (Adewuyi, *et al*., 2024, Edwards, Mallhi & Zhang, 2024, Ohalete, *et al*., 2024).

In high-need populations, where barriers to healthcare are multifaceted and entrenched, the use of familiar and accessible messaging platforms offers a pathway to equitable, efficient, and effective preventive care delivery. By tailoring content to user needs, respecting cultural and linguistic diversity, and incorporating feedback mechanisms, these technologies do more than convey information—they foster engagement, support empowerment, and build resilient health behaviors (Ayo-Farai, *et al*., 2023, Chianumba, *et al*., 2023, Katas, *et al*., 2023). As health systems continue to explore digital solutions for prevention, the thoughtful deployment of WhatsApp, SMS, and IVR will remain essential to bridging gaps and extending care to those who need it most.

2.4 Use Cases and Evidence of Impact

The use of mobile messaging technologies such as WhatsApp, SMS, and Interactive Voice Response (IVR) systems has generated growing interest among public health stakeholders seeking to improve preventive care delivery in high-need populations. Across the globe, these technologies have been deployed in vaccination campaigns, maternal and child health programs, chronic disease management, and infectious disease prevention initiatives. Their appeal lies in their low cost, scalability, adaptability to local contexts, and ability to engage hard-to-reach populations through familiar communication platforms (Anyanwu, *et al*., 2024, Ekwebene, *et al*., 2024, Obianyo, *et al*., 2024). A growing body of evidence from pilot programs, government-led interventions, and NGO-supported initiatives demonstrates the positive impact these tools can have on health outcomes, service uptake, and patient engagement in vulnerable communities.

Vaccination campaigns have benefited substantially from the integration of mobile messaging platforms, particularly SMS and WhatsApp, in low-resource settings. In Zambia, an SMS-based system was launched to remind parents about upcoming childhood immunization appointments. Messages were timed to coincide with national immunization schedules and were personalized based on the child's age. The program recorded a significant increase in on-time vaccination rates, particularly for the second and third doses of multi-dose vaccines, where drop-off is common (Ajayi, *et al*., 2024, Emeihe, *et al*., 2024, Johnson, *et al*., 2024, Olowe, *et al*., 2024). Similarly, in India, WhatsApp groups were used by community health workers to engage with mothers and caregivers, sharing infographics, voice notes, and videos that explained the importance of vaccines and addressed common misconceptions. These messages, sent in local languages and accompanied by photos from community members who had already vaccinated their children, fostered peer influence and increased vaccine acceptance. In Nigeria, IVR was piloted in rural areas to deliver immunization awareness through pre-recorded voice messages, improving knowledge among caregivers who could not read printed materials or access written SMS messages.

In maternal and child health programs, mobile messaging platforms have demonstrated wide-reaching effects on antenatal care attendance, facility-based deliveries, breastfeeding practices, and early childhood care. One of the most widely cited programs is MomConnect in South Africa, a national SMS and WhatsApp service that sends stage-based messages to pregnant women and new mothers, offering advice, appointment reminders, and motivational messages. The program has registered over two million users and is credited with improving both antenatal visit attendance and early postpartum care utilization (Usuemerai, *et al*., 2024). Evaluations have shown that users appreciate the sense of support and continuous engagement provided by the messages, with many reporting that the messages encouraged them to seek care when they would not have otherwise done so. Similarly, in Bangladesh, an IVR-based maternal health project provided rural women with voice messages about nutrition, danger signs, and newborn care, leading to improvements in exclusive breastfeeding and immunization uptake (Adelodun & Anyanwu, 2024, Emeihe, *et al*., 2024, Majebi, Adelodun & Anyanwu, 2024).

Chronic disease management, particularly for conditions like diabetes and hypertension, has seen considerable advances through SMS- and WhatsApp-based interventions. These chronic diseases require consistent medication adherence, lifestyle modifications, and regular monitoring, making mobile messaging a valuable tool for ongoing support. In Kenya, an SMS program targeting individuals with hypertension delivered twice-weekly messages with tips on diet, exercise, and medication adherence, while also sending personalized reminders for clinic visits (Akerele, *et al*., 2024, Emeihe, *et al*., 2024, Kelvin-Agwu, *et al*., 2024). A randomized controlled trial evaluating the program found a statistically significant reduction in systolic blood pressure among participants who received the messages compared to a control group. In Mexico, WhatsApp was used by diabetes educators to provide counseling, educational videos, and appointment reminders to patients in urban slums. The two-way communication allowed patients to ask questions and report glucose readings, enabling more responsive care and increasing adherence to care plans. In both settings, the interventions were cost-effective, scalable, and integrated easily into existing clinical workflows.

In the area of infectious disease screening and behavior change, mobile messaging technologies have played a particularly important role. For HIV prevention and treatment adherence, SMS reminders have been widely adopted to improve medication compliance and follow-up visit attendance. In Uganda, a program that sent weekly SMS messages to people living with HIV led to higher rates of viral suppression and clinic retention compared to standard care. Participants reported that the messages served as both reminders and emotional encouragement, reducing stigma and isolation (Abisoye & Olamijuwon, 2022, Chianumba, *et al*., 2022, Udegbe, *et al*., 2023). For populations with low literacy, IVR systems have been used effectively. In Ghana, an IVR-based TB education project delivered voice messages about signs, symptoms, and testing options, leading to a noticeable increase in self-reported TB screening in target districts. During the COVID-19 pandemic, governments across Sub-Saharan Africa and South Asia deployed SMS and WhatsApp bots to distribute real-time updates, hygiene guidelines, and vaccine registration information. In India, the Ministry of Health partnered with WhatsApp to launch a chatbot service that allowed users to access COVID-19 information by sending simple keywords. The bot provided updates on symptoms, myth-busting, and nearby testing centers, and was used by millions during the peak of the outbreak.

These case studies demonstrate not only the efficacy but also the flexibility of mobile messaging in diverse health contexts. In Peru, an SMS campaign aimed at improving cervical cancer screening uptake sent motivational messages and appointment reminders to women overdue for Pap smears. The campaign resulted in a 24% increase in screening attendance compared to control regions. In Indonesia, mobile health workers used WhatsApp to coordinate community health sessions, share COVID-19 prevention videos, and collect reports on vaccine hesitancy trends (Ayo-Farai, *et al*., 2024, Emeihe, *et al*., 2024, Kelvin-Agwu, *et al*., 2024). These real-time insights helped local health authorities adjust strategies and deploy targeted outreach. In Sierra Leone, an IVR-based health hotline provided anonymous counseling on sexual and reproductive health, reaching adolescents who may have faced barriers to in-person services due to stigma or lack of transportation.

Evidence from these and other programs suggests several recurring themes contributing to the effectiveness of mobile messaging in preventive care. First, personalization and timing matter. Messages that are tailored to the recipient's stage of care, health condition, or demographic profile are more likely to be read, understood, and acted upon. Second, interactivity enhances engagement. Two-way communication—whether through WhatsApp chats, SMS surveys, or IVR response options—allows users to feel heard, ask questions, and become active participants in their care (Adhikari, *et al*., 2024, Eze, *et al*., 2024, Johnson, *et al*., 2024). Third, language and cultural relevance are key. Messages delivered in local languages and crafted with community input resonate more strongly and overcome literacy and trust barriers. Finally, integration with human support systems strengthens impact. Many successful programs complement digital messaging with follow-up by community health workers, in-person visits, or hotline access, creating a blended model of care that maximizes reach and depth.

While challenges remain—such as ensuring data privacy, avoiding message fatigue, and maintaining updated contact lists—the growing body of evidence supports the continued investment in messaging-based preventive care programs. As technology access deepens and digital literacy improves, especially in high-need populations, these platforms are poised to play an even larger role in bridging gaps in healthcare delivery, increasing early intervention, and empowering individuals to take charge of their health (Elujide, *et al*., 2021, Khosrow Tayebati, *et al*., 2011, Nwankwo, *et al*., 2012). Future innovations may include AI-powered message personalization, voice-based chatbots, and integration with electronic health records, but even the simplest forms of messaging continue to make a measurable difference in global health equity.

2.5 Design and Implementation Strategies

Designing and implementing effective preventive care messaging through platforms such as WhatsApp, SMS, and Interactive Voice Response (IVR) in high-need populations requires thoughtful strategies that prioritize contextual relevance, user engagement, and systems integration. High-need populations—those facing socioeconomic vulnerability, limited healthcare access, or low literacy—demand targeted interventions that not only reach them but resonate with their lived experiences (Usuemerai, *et al*., 2024). For messaging technologies to be impactful, careful attention must be given to how content is crafted, when and how often messages are sent, who receives what messages, and how these digital tools complement existing community health worker (CHW) outreach. These strategies collectively form the backbone of effective digital health communication in preventive care delivery.

Central to any successful messaging intervention is the creation of culturally sensitive and linguistically tailored content. In diverse communities, especially in Sub-Saharan Africa, South Asia, and parts of Latin America, where linguistic plurality and cultural nuances are prevalent, a one-size-fits-all approach to message design often leads to disengagement or misinterpretation. Content must be crafted in local languages and dialects, using vocabulary and phrasing familiar to the target population (Okoro, *et al*., 2024, Olamijuwon & Zouo, 2024, Olorunsogo, *et al*., 2024). Beyond translation, cultural sensitivity involves aligning messages with local beliefs, values, and health practices. For instance, in communities where traditional medicine or religious beliefs influence health decisions, messaging should acknowledge these perspectives and incorporate them into the broader health narrative. This could mean collaborating with local leaders or faith-based institutions to co-develop content that respects and integrates cultural norms, thereby increasing trust and receptivity.

Visual and audio components, particularly relevant for WhatsApp and IVR platforms, also benefit from cultural tailoring. Images used in health promotion videos or infographics should reflect local attire, household settings, and community figures to enhance relatability. Voice messages in IVR systems should be recorded using local accents and familiar tones, preferably by community members, which increases the authenticity and emotional connection of the communication (Maduka, *et al*., 2023, Majebi, *et al*., 2023, Ogundairo, *et al*., 2023). The goal is not just to inform but to engage, reassure, and motivate

action through messaging that feels personalized and grounded in the recipient's social reality.

Equally important is the consideration of timing and frequency in the deployment of preventive care messages. Poorly timed or overly frequent messages can lead to message fatigue, annoyance, or even user drop-off, undermining the very goals of the intervention. Timing strategies should be informed by the daily routines and information consumption patterns of the target audience. For example, sending SMS reminders early in the morning or in the early evening may coincide with times when individuals are more likely to check their phones (Alemede, *et al*., 2024, Eze, *et al*., 2024, Katas, *et al*., 2024, Obianyo, *et al*., 2024). In agricultural communities, messages scheduled outside peak farming hours may be more effective, while in urban areas, commuting hours might present optimal windows for engagement.

Frequency should strike a balance between maintaining user interest and avoiding oversaturation. For health campaigns such as vaccination reminders, a well-spaced schedule—perhaps a week before the appointment, two days before, and on the day of—is often effective. For chronic disease management or health education, weekly or biweekly messages may provide continuity without being intrusive (Abass, *et al*., 2024, Eze, *et al*., 2024, Johnson, *et al*., 2024, Olowe, *et al*., 2024). Additionally, spacing messages across different content types (text, images, audio) and tones (informational, motivational, interactive) can help maintain engagement over time. Scheduling tools and automated delivery platforms allow for precise control over timing and frequency, enabling dynamic adjustments based on user feedback and engagement data.

Personalization and user segmentation are also critical to designing impactful preventive care messaging. Treating all users as a homogeneous group diminishes the potential of digital communication to drive meaningful behavior change. Instead, segmenting users by key attributes—such as age, gender, health status, literacy level, and previous engagement—allows for the delivery of content that is directly relevant to each individual's needs and circumstances. For example, pregnant women may receive trimester-specific messages on nutrition and check-ups, while older adults with hypertension could get tips on salt reduction and medication adherence (Chukwuma, *et al*., 2022, Gbadegesin, *et al*., 2022, Udegbe, *et al*., 2023).

Data collected at enrollment, or through ongoing interaction, can inform segmentation strategies. In WhatsApp-based systems, users might select topics of interest via menu options; in IVR systems, keypad responses can route users to content suited to their life stage or health condition. Personalization goes beyond content delivery—it also involves tone and emotional appeal. Messages that address users by name, reference previous behaviors (e.g., "You attended your last screening—great job!"), or offer affirmations of progress can foster a sense of recognition and accountability, which are powerful motivators for health behavior change (Kuo, *et al*., 2019, Madu, *et al*., 2020, Nwankwo, *et al*., 2012, Tayebati, *et al*., 2011). Systems must also respect user preferences for language, format (text vs. voice), and message frequency, offering opt-out or customization options as part of ethical and user-centered design.

Perhaps one of the most impactful implementation strategies is the integration of messaging technologies with community health worker (CHW) outreach. CHWs are trusted figures in many high-need communities and serve as critical links between formal healthcare systems and the population. When digital messaging is combined with CHW engagement, the result is a hybrid model that reinforces messages, addresses user questions, and facilitates follow-through on preventive actions (Balogun, *et al*., 2023, Eyeghre, *et al*., 2023, Mgbecheta, *et al*., 2023). For example, an SMS campaign encouraging cervical cancer screening might prompt recipients to contact a local CHW, who can then provide details about clinic hours, assist with transportation, or even accompany the individual to the appointment.

WhatsApp groups managed by CHWs offer a dynamic environment for group education, peer support, and two-way communication. CHWs can answer real-time questions, share photos from health events, or clarify instructions following a broadcast message. In IVR systems, users might be offered the option to connect directly to a CHW by pressing a number at the end of the call. This human interaction not only bridges gaps left by technology but also helps reinforce message credibility and resolve uncertainties that might otherwise go unaddressed (Nwankwo, Tomassoni & Tayebati, 2012, Ogbonna, *et al*., 2012, Tayebati, *et al*., 2013).

Training CHWs to use messaging platforms effectively is essential for this integration to succeed. CHWs must be equipped not only with digital tools but also with communication skills to manage group dynamics, provide emotional support, and maintain professional boundaries online. Standard operating procedures should outline workflows for message follow-up, data sharing, and privacy protection, ensuring a seamless experience for the end user (Adelodun & Anyanwu, 2024, Ezeamii, *et al*., 2024, Majebi, Adelodun & Anyanwu, 2024). Moreover, feedback from CHWs should be incorporated into the iterative refinement of messaging content and delivery strategies, as they are best positioned to observe community responses and suggest improvements.

Monitoring and evaluation also play a pivotal role in sustaining and optimizing these strategies. Metrics such as message open rates, response rates, and service uptake trends provide valuable insights into what is working and what needs adaptation. Qualitative feedback—gathered through surveys, interviews, or CHW reports—adds depth to these metrics, revealing user satisfaction, barriers to engagement, and cultural appropriateness of content. This data should inform ongoing message design, segmentation criteria, and outreach planning, fostering a cycle of continuous improvement (Akerele, *et al*., 2024, Ezeamii, *et al*., 2024, Kelvin-Agwu, *et al*., 2024).

In conclusion, the design and implementation of preventive care messaging through WhatsApp, SMS, and IVR in high-need populations demand a multifaceted and culturally attuned approach. Culturally sensitive and linguistically relevant content ensures messages are both understood and trusted. Careful scheduling and frequency help sustain engagement without overwhelming recipients. Personalization and segmentation enhance relevance and effectiveness, while integration with CHW outreach creates a supportive, human-centered model that bridges digital and physical health systems (Adaramola, *et al*., 2024, Ezeamii, *et al*., 2024, Ohalete, *et al*., 2024). By combining these strategies, preventive care interventions can achieve greater

reach, resonance, and impact among the communities that need them most.

2.6 Challenges and Considerations

Despite the promising advancements in the use of WhatsApp, SMS, and Interactive Voice Response (IVR) messaging to support preventive care delivery in high-need populations, a range of challenges and critical considerations must be addressed to ensure that these interventions are effective, equitable, and sustainable. While mobile messaging technologies offer considerable potential to bridge access gaps and increase the reach of public health messaging, they are not immune to systemic, social, and technological limitations (Usuemerai, *et al*., 2024). Among the key challenges are user engagement issues, disparities in digital access and literacy, the prevalence of misinformation and trust deficits, concerns around data privacy and ethics, and gaps in monitoring and evaluation frameworks. These issues, if unaddressed, risk undermining the benefits of messaging-based preventive care and could reinforce existing health inequities.

One of the foremost challenges in messaging-based health interventions is maintaining consistent user engagement over time. Message fatigue, or the gradual loss of interest and responsiveness due to the repetitive or excessive nature of messages, is a common phenomenon in mobile health (mHealth) initiatives. High-need populations, especially those dealing with complex life challenges such as food insecurity, unemployment, or chronic illness, may deprioritize health messages when they are perceived as irrelevant, overly frequent, or intrusive (Okoro, *et al*., 2024, Olamijuwon, *et al*., 2024, Olorunsogo, *et al*., 2024). Additionally, if messages are not tailored to the user's specific health needs or life context, they may become background noise—read passively or ignored entirely. Striking the right balance between frequency and relevance is difficult but essential. If messaging systems do not adapt to user behavior, engagement tends to decline, which in turn weakens the impact of preventive health communication and reduces the likelihood of behavioral change.

Closely related to engagement is the issue of digital literacy and disparities in mobile phone ownership and usage. While mobile phone penetration is relatively high in many low- and middle-income countries, significant gaps persist in who has access to a phone, the type of phone they use (basic vs. smartphone), and their ability to use it effectively. These disparities are often along lines of gender, age, geography, and socioeconomic status. Women, particularly in rural areas, may face restrictions in mobile phone use due to cultural norms or lack of financial resources (Ayo-Farai, *et al*., 2024, Ezeamii, *et al*., 2024, Oboh, *et al*., 2024, Oshodi, *et al*., 2024). Older adults may struggle with unfamiliarity with mobile interfaces, while individuals with low literacy may be unable to understand written SMS or WhatsApp messages. Although IVR systems attempt to address literacy barriers, even voice-based systems require basic familiarity with mobile device navigation. Without appropriate user support, inclusive design, or community-based digital literacy training, these technological divides can limit the reach and effectiveness of messaging interventions and exclude those most in need of preventive health services.

Misinformation and trust issues further complicate the delivery of digital health messages. In many high-need populations, there is a long-standing skepticism toward official health communication, particularly when it comes from government sources or foreign-funded initiatives. This mistrust can be exacerbated in digital formats, where messages may be perceived as impersonal or anonymous. Moreover, the same mobile platforms used for legitimate health communication—especially WhatsApp—are also used to circulate rumors, myths, and unverified health claims (Adhikari, *et al*., 2024, Ezeamii, *et al*., 2024, Ogundairo, *et al*., 2024). During public health emergencies such as the COVID-19 pandemic, misinformation about vaccines, treatment options, and prevention measures spread rapidly via WhatsApp groups, undermining official health campaigns. The challenge for health authorities and program designers is to build trust through transparency, authenticity, and community engagement. Messages must be delivered in a tone that resonates with users, supported by credible sources, and reinforced by trusted community figures such as local health workers, religious leaders, or peers who can validate the information.

Equally critical are concerns around data privacy, confidentiality, and the ethical use of personal health information. Mobile messaging interventions, by their very nature, involve the collection, storage, and transmission of sensitive user data—names, phone numbers, health conditions, behavioral responses, and more. In contexts where legal protections for digital health data are weak or poorly enforced, there is a significant risk of data breaches, misuse, or unauthorized access. For vulnerable populations, such breaches can lead to stigma, discrimination, or even violence (Madu & Nwankwo, 2018, Nasuti, *et al*., 2008, Nwankwo, *et al*., 2011, Tayebati, *et al*., 2013). For instance, receiving HIV-related messages on a shared or monitored phone could expose a user's status to family members or community members, with serious consequences. Ethical considerations must guide the design of all mHealth interventions. Programs must obtain informed consent, minimize data collection to what is strictly necessary, anonymize data when possible, and implement security measures to protect user information. Furthermore, there should be mechanisms for users to opt out of services at any time, and clear policies on how their data will be used, shared, or stored.

Monitoring, evaluation, and feedback mechanisms present another set of challenges. Many mobile messaging programs lack robust systems to track user interaction, measure outcomes, and incorporate user feedback. Without effective monitoring, it is difficult to assess whether messages are being read, understood, and acted upon—or if they are reaching the intended audience at all. Program designers often rely on self-reported data, which may be limited by recall bias or social desirability (Babarinde, *et al*., 2023, Eyeghre, *et al*., 2023, Nwaonumah, *et al*., 2023). Metrics such as delivery rates, response rates, and click-throughs (in the case of WhatsApp links) can provide some insights, but these do not capture the qualitative dimensions of user experience, such as satisfaction, cultural fit, or emotional response. Feedback loops, where users can share their thoughts, ask questions, or suggest improvements, are essential but often underdeveloped. IVR systems may allow users to press a button to request more information or speak with a health worker, but these features are not always followed up with human engagement. Effective evaluation must also go beyond usage metrics to examine health outcomes, behavior change, and community impact. This

requires both quantitative and qualitative research methods, longitudinal tracking, and collaboration with local stakeholders.

In addition to these specific challenges, the broader sustainability of mobile messaging programs must be considered. Many interventions are donor-funded pilot projects that struggle to maintain momentum once external funding ends. Integration into existing health systems, local ownership, and policy alignment are critical to ensuring that successful interventions are not short-lived. Moreover, as mobile technologies evolve and user expectations change, programs must adapt their platforms, content, and delivery strategies to remain relevant and impactful (Adelodun, *et al*., 2018, Chianumba, *et al*., 2021, Tayebati, *et al*., 2012, Tomassoni, *et al*., 2013). This requires continuous investment in technological upgrades, staff training, and cross-sector partnerships between health authorities, telecommunications companies, and community organizations.

In conclusion, while WhatsApp, SMS, and IVR messaging technologies offer immense promise for advancing preventive care delivery in high-need populations, they are not a panacea. Their success depends on thoughtful, user-centered design that addresses the complex social, technological, and ethical landscapes in which they operate. Challenges such as message fatigue, digital exclusion, misinformation, privacy concerns, and weak monitoring must be systematically addressed through adaptive strategies and inclusive governance (Akerele, *et al*., 2024, Fagbenro, *et al*., 2024, Kelvin-Agwu, *et al*., 2024). By anticipating and responding to these challenges, stakeholders can ensure that mobile messaging interventions not only extend the reach of preventive health services but also enhance trust, equity, and resilience in global health systems.

2.7 Policy and System-Level Integration

The integration of WhatsApp, SMS, and Interactive Voice Response (IVR) messaging into preventive care delivery for high-need populations has evolved into a vital component of digital public health strategies. However, for these interventions to be effective at scale and long-lasting, they must move beyond isolated pilot projects and become embedded within broader health systems and policy frameworks (Ajibola, *et al*., 2024, Folorunso, *et al*., 2024, Majebi, Adelodun & Anyanwu, 2024). This process of system-level integration requires thoughtful alignment with national preventive health policies, strategic collaborations with telecommunications providers and non-governmental organizations (NGOs), rigorous assessments of cost-effectiveness and scalability, and a long-term commitment to building sustainable digital health infrastructure that can adapt to changing needs and technologies.

Aligning mobile messaging programs with national preventive health policies is a foundational step in ensuring their relevance, legitimacy, and impact. Most countries already have established health promotion and disease prevention strategies that include priorities such as maternal and child health, vaccination uptake, non-communicable disease prevention, and early detection of infectious diseases. Integrating mobile messaging into these existing priorities not only increases efficiency but also ensures that digital interventions reinforce rather than duplicate or conflict with ongoing public health efforts (Madu & Nwankwo, 2018, Nwankwo, *et al*., 2012, Nwankwo, Tomassoni & Tayebati, 2012). Ministries of health must take a leadership role in embedding WhatsApp, SMS, and IVR-based communication tools into national health strategies and ensuring that they are coordinated with other service delivery mechanisms, such as community health worker programs and facility-based outreach. This requires developing regulatory guidelines and operational frameworks that define how messaging content is created, who approves it, which populations are targeted, and how messaging systems are evaluated and sustained.

Policy alignment also involves addressing issues such as message standardization, data sharing protocols, and interoperability with national health information systems. If a mobile messaging platform sends appointment reminders, tracks user engagement, or collects health-related feedback, that data should ideally feed into existing digital health records or reporting systems used by government agencies (Udegbe, *et al*., 2023, Usuemerai, *et al*., 2024). Such integration ensures a comprehensive view of health service utilization and can help policymakers identify gaps, monitor public health trends, and plan resource allocation. It also legitimizes mobile messaging as a routine component of preventive care delivery, rather than a supplemental or parallel tool.

Strategic partnerships with telecommunications providers and NGOs play a pivotal role in scaling and sustaining messaging interventions. Telecom companies offer the infrastructure necessary for delivering SMS, IVR, and data-based WhatsApp services, and their involvement can significantly reduce the operational costs of large-scale campaigns. In many successful programs, telecom providers have offered bulk messaging discounts, zero-rated health content, or supported the development of custom health platforms. Their technical expertise can also help optimize delivery rates, troubleshoot network issues, and ensure compliance with data protection regulations (Olowe, *et al*., 2024, Olulaja, Afolabi & Ajayi, 2024, Shittu, *et al*., 2024). Formal public-private partnerships between ministries of health and mobile network operators can institutionalize such collaborations and outline roles, responsibilities, and shared objectives.

NGOs bring complementary strengths to the table, including experience in community-based health programming, user-centered design, and behavior change communication. Many NGOs have longstanding relationships with high-need communities and can support message co-creation, pilot testing, and cultural adaptation. They can also manage feedback loops, train community health workers to engage with digital platforms, and conduct monitoring and evaluation activities (Okon, Zouo & Sobowale, 2024, Olamijuwon, *et al*., 2024, Olorunsogo, *et al*., 2024). The role of NGOs is particularly important during the initial phases of implementation when community trust, responsiveness, and flexibility are crucial to building acceptance of new technologies. However, for long-term success, these partnerships must be carefully structured to prevent fragmentation or duplication of efforts. Coordinated frameworks that bring together telecoms, NGOs, government agencies, and donors are essential to streamline processes, share data responsibly, and scale promising innovations across regions.

A critical aspect of system-level integration is assessing the cost-effectiveness and scalability of mobile messaging interventions. While individual pilot studies have shown

positive results—such as increased appointment adherence, improved vaccination rates, and greater knowledge of preventive behaviors—it is essential to analyze whether these benefits justify the investment at scale (Adigun, *et al*., 2024, Folorunso, *et al*., 2024, Kelvin-Agwu, *et al*., 2024). Cost analyses must account for message delivery fees, platform maintenance, content development, staff time, and support services such as call centers or follow-up visits. In comparison to traditional outreach methods like house visits or radio campaigns, mobile messaging often offers a lower cost per person reached, especially when delivered to large populations. However, cost-effectiveness can vary widely depending on the frequency and complexity of messages, the level of personalization, and the need for human support.

Scalability assessments must also consider operational feasibility across diverse geographic, linguistic, and technological environments. What works in an urban setting with strong network coverage may not be easily replicable in rural or conflict-affected regions. Therefore, scalability requires flexible system design, local capacity building, and phased implementation that allows for testing and adaptation (Uwumiro, *et al*., 2024, Zouo & Olamijuwon, 2024). Government buy-in, local stakeholder engagement, and long-term funding models must be secured early to avoid reliance on short-term donor projects that often collapse once external support ends. Robust evaluation mechanisms should accompany scale-up efforts to ensure that the intervention maintains its quality, equity, and effectiveness as it reaches larger and more diverse populations.

Building sustainable digital health infrastructure is the final pillar of policy and system-level integration. For mobile messaging to remain a reliable tool for preventive care, governments must invest in the underlying digital systems that support it. This includes creating national health databases that allow for secure user registration and segmentation, developing centralized content libraries that can be localized and updated as needed, and maintaining the servers and software platforms required for large-scale messaging campaigns (Balogun, *et al*., 2023, Ezeamii, *et al*., 2023, Katas, *et al*., 2023, Usuemerai, *et al*., 2024). Capacity-building is also crucial: Healthcare workers, program managers, and IT personnel must be trained to manage digital tools, analyze usage data, and respond to user feedback. Establishing dedicated digital health units within ministries of health can provide the institutional anchor needed to manage these investments over time.

Moreover, sustainability depends on protecting user data and earning public trust. Legal frameworks must ensure that health messages comply with privacy regulations, and systems should be built with encryption, secure data storage, and user consent protocols. Public education about how data is collected, used, and protected can increase user confidence and willingness to participate in digital health initiatives (Adelodun & Anyanwu, 2024, Ibikunle, *et al*., 2024, Ogugua, *et al*., 2024). Ethical oversight bodies should be involved in the development and review of messaging content, especially for sensitive topics such as HIV, sexual health, or mental health, to ensure that digital communication adheres to the same standards as face-to-face healthcare delivery.

In conclusion, the integration of WhatsApp, SMS, and IVR messaging into preventive care systems for high-need populations holds enormous potential—but realizing that potential requires more than technological innovation. It demands strategic alignment with national policies, robust cross-sector partnerships, economic feasibility planning, and sustained investment in digital infrastructure. When embedded into the broader health system, supported by policy, and driven by evidence and community engagement, mobile messaging technologies can become powerful, scalable tools for promoting health equity, improving preventive care uptake, and strengthening public health systems across diverse settings (Ayo-Farai, *et al*., 2024, Ibikunle, *et al*., 2024, Oddie-Okeke, *et al*., 2024).

2.8 Future Directions

As mobile messaging technologies like WhatsApp, SMS, and Interactive Voice Response (IVR) continue to play a pivotal role in advancing preventive care delivery, especially in high-need populations, attention must now shift toward future directions that can enhance their impact, scalability, and integration into broader digital health ecosystems. Innovations in artificial intelligence (AI), the emergence of multichannel outreach strategies, and the exploration of research gaps provide fertile ground for evolving these interventions into more dynamic, responsive, and inclusive systems (Anyanwu, *et al*., 2024, Idoko, *et al*., 2024, Kelvin-Agwu, *et al*., 2024). To sustain progress and address persistent disparities in healthcare access, the next generation of mobile messaging in preventive care must be increasingly personalized, coordinated across platforms, and informed by rigorous evidence and human-centered design.

One of the most transformative future directions is the integration of AI-driven tools, particularly chatbots, into mobile messaging platforms to enable personalized care messaging at scale. Traditional one-size-fits-all messages—while effective to a degree—often fail to address the nuanced health needs, behavior patterns, and preferences of individual users. Chatbots powered by natural language processing and machine learning algorithms can engage users in real-time conversations, providing tailored responses based on their unique characteristics, risk factors, and interaction history (Elujide, *et al*., 2021, Khosrow Tayebati, Ejike Nwankwo & Amenta, 2013), Tomassoni, *et al*., 2013). These AI-powered assistants can ask follow-up questions, assess health literacy levels, and adjust the complexity and tone of messages accordingly. For example, a chatbot integrated into WhatsApp can offer customized reminders for prenatal checkups, respond to common queries about nutrition or vaccine side effects, and escalate more complex cases to human health workers when necessary.

This form of personalized interaction not only deepens user engagement but also offers a scalable solution to the human resource challenges faced in high-need settings. AI chatbots can operate 24/7, handle thousands of simultaneous conversations, and maintain consistency in message quality—tasks that would otherwise strain already overburdened health systems. In addition, as these systems learn from user interactions, they can become more predictive over time, identifying patterns of non-compliance or disengagement and triggering targeted interventions before health outcomes worsen (Abass, *et al*., 2024, Igwama, *et al*., 2024, Kelvin-Agwu, *et al*., 2024, Olowe, *et al*., 2024). However, for such AI solutions to be effective, they must be built with culturally and linguistically diverse populations in mind, ensuring that the technology can understand and generate messages in local languages,

dialects, and cultural contexts. Ethical considerations, particularly regarding data privacy and algorithmic bias, must also be addressed through transparent governance frameworks.

As the landscape of communication technology evolves, future strategies will increasingly rely on multichannel outreach to amplify reach and effectiveness. While SMS, WhatsApp, and IVR each offer distinct advantages, their limitations can be mitigated through strategic integration with other platforms, including social media, mobile apps, community radio, and even paper-based tools for truly disconnected regions. A multichannel strategy recognizes that users have varying levels of access to technology and that preferences differ across demographics such as age, gender, and geography (Attah, *et al*., 2022, Chianumba, *et al*., 2022, Opia, Matthew & Matthew, 2022). For instance, a rural woman with limited literacy may rely on IVR calls for health updates, while a young urban male may prefer WhatsApp-based text or video messages. A hybrid approach allows health systems to meet users where they are, using the most accessible and trusted channels for each group.

Moreover, multichannel systems enable layered messaging—reinforcing key health behaviors through different modalities. A vaccination campaign might use SMS for reminders, WhatsApp for educational infographics and testimonial videos, IVR for voice-based myth-busting, and radio for broader community awareness. By combining these approaches, programs can maximize message retention, increase perceived relevance, and encourage action. These multichannel strategies can also support two-way feedback loops and data triangulation, giving health providers a more comprehensive view of user behavior and enabling them to adjust strategies in real time (Bello, *et al*., 2024, Igwama, *et al*., 2024, Katas, *et al*., 2024, Okobi, *et al*., 2024). Crucially, the success of multichannel systems depends on centralized coordination, interoperability of platforms, and careful message sequencing to avoid confusion, contradiction, or information overload.

Despite the growing momentum of messaging-based preventive care, significant research gaps and innovation opportunities remain. A major gap lies in the limited empirical data on long-term outcomes and sustained behavior change resulting from messaging interventions. While short-term gains in service uptake or knowledge acquisition have been documented, fewer studies have explored how these tools influence long-term adherence to preventive behaviors, such as healthy eating, regular screenings, or chronic disease self-management (Gabrielli, *et al*., 2010, Khosrow Tayebati, *et al*., 2013, Nwankwo, *et al*., 2011). Future research must examine these longitudinal impacts, using both quantitative and qualitative methods to assess not only clinical outcomes but also psychosocial effects such as empowerment, trust in the health system, and perceived self-efficacy.

Another area requiring further exploration is the integration of messaging technologies with diagnostic and monitoring tools. The convergence of mobile messaging with remote diagnostics—such as wearable health trackers, mobile-based blood pressure monitors, or at-home testing kits—can create new opportunities for personalized and responsive preventive care. For instance, users could receive tailored advice based on their real-time blood glucose readings or physical activity levels, thereby bridging the gap between information dissemination and actionable care. Such innovations could be particularly transformative for managing non-communicable diseases in low-resource settings, where facility-based follow-up is often sporadic or delayed (Bello, *et al*., 2024, Igwama, *et al*., 2024, Katas, *et al*., 2024, Okobi, *et al*., 2024).

Moreover, there is untapped potential in exploring how messaging platforms can support social determinants of health. While most interventions focus on biomedical content, future strategies could address broader needs such as food security, mental health, housing, or gender-based violence. A WhatsApp chatbot could guide users to local food distribution centers or safe shelters, while an IVR system could offer emotional support and referral services for individuals experiencing anxiety or domestic abuse (Adelodun & Anyanwu, 2024, Igwama, *et al*., 2024, Majebi, Adelodun & Anyanwu, 2024). By broadening the scope of messaging to include social and environmental health factors, preventive care systems can become more holistic and responsive to the realities of high-need populations.

Innovation opportunities also lie in user co-design and participatory development. Too often, digital health tools are designed top-down, without sufficient input from the communities they are intended to serve. Future efforts should invest in participatory design processes, involving users at every stage—from needs assessment and message development to pilot testing and scale-up. This approach not only enhances cultural relevance and usability but also fosters community ownership and trust (Ayo-Farai, *et al*., 2023, Ezeamii, *et al*., 2023, Katas, *et al*., 2023). User-driven innovation can reveal surprising insights, such as preferred message formats, optimal delivery times, and trusted sources of information, which might not be apparent through traditional program design methods.

Lastly, as digital tools become more sophisticated, the regulatory and ethical frameworks governing their use must evolve in tandem. Future directions must prioritize ethical innovation—ensuring that AI, chatbots, and multichannel systems are deployed in ways that respect user autonomy, promote inclusivity, and safeguard personal data (Afolabi, Ajayi & Olulaja, 2024, Igwama, *et al*., 2024, Ohalete, *et al*., 2024). Governments, civil society organizations, and private sector partners must work together to establish standards for content accuracy, data sharing, consent, and accountability. Building public trust in digital health systems will be essential to their sustainability and effectiveness.

In conclusion, the future of preventive care delivery through WhatsApp, SMS, and IVR messaging in high-need populations is rich with possibility. AI and chatbots promise to bring personalization and scale; multichannel strategies offer reach and adaptability; and a growing recognition of research and innovation gaps presents opportunities for deeper impact. As technology advances, the focus must remain on equity, engagement, and integration—ensuring that digital tools serve as bridges rather than barriers to better health (Al Hasan, Matthew & Toriola, 2024, Igwama, *et al*., 2024, Okhawere, *et al*., 2024). By embracing innovation while remaining grounded in the needs and voices of communities, the next generation of messaging-based preventive care can drive meaningful, sustainable improvements in global health.

2.9 Conclusion

The advancement of preventive care delivery through WhatsApp, SMS, and IVR messaging in high-need

populations represents a transformative shift in how public health systems can engage, educate, and empower communities traditionally underserved by conventional healthcare infrastructure. The key findings across various use cases—from vaccination campaigns and maternal health to chronic disease management and infectious disease control—underscore the power of mobile messaging technologies to reach large populations quickly, deliver culturally relevant information, and promote timely health-seeking behavior. Evidence has consistently shown improvements in appointment adherence, health knowledge, service uptake, and user satisfaction when messaging interventions are thoughtfully designed and integrated with local systems.

Strategic implementation of these tools, however, depends on several critical factors. These include tailoring messages to cultural and linguistic contexts, optimizing timing and frequency for sustained engagement, personalizing content through segmentation, and ensuring ethical standards for data privacy and consent. Integration with community health worker outreach further strengthens the reach and trust of these digital platforms, anchoring them within the human networks that form the backbone of care delivery in many high-need regions. Moreover, aligning digital messaging with national health strategies, leveraging telecom and NGO partnerships, and planning for scalability and sustainability are essential steps for system-level integration.

Looking ahead, the vision for equitable preventive care through mobile messaging lies in leveraging innovation while prioritizing inclusion and trust. The emergence of AI-powered chatbots, multichannel delivery strategies, and hybrid systems that blend digital with in-person support offers exciting opportunities to personalize and deepen health engagement. Yet, these advances must be guided by community participation, ethical rigor, and continuous evaluation. Mobile messaging is not just a tool for communication—it is a bridge to equity, a pathway to resilience, and a foundation for more responsive, person-centered public health systems. By investing in these technologies and the systems that support them, we can move closer to a future where everyone, regardless of geography, literacy, or income, has access to timely, relevant, and empowering preventive care.

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