

Perspective

Open Access



Use of mHealth for management of hypertension in low and middle-income countries: opportunities and challenges

Buna Bhandari^{1,2}, Dinesh Neupane³, Poshan Thapa⁴, Pranil Man Singh Pradhan^{2,5}

¹Central Department of Public Health, Tribhuvan University Institute of Medicine, Kathmandu 44600, Nepal.

²Department of Global Health and Population, Harvard T H Chan School of Public Health, Boston, MA 02115, USA.

³Department of International Health, Johns Hopkins Bloomberg School of Public Health, Johns Hopkins University, Baltimore, MD 20205, USA.

⁴School of Population Health, The University of New South Wales, Sydney 2052, Australia.

⁵Department of Community Medicine, Maharajgunj Medical Campus, Tribhuvan University Institute of Medicine, Kathmandu 44600, Nepal.

Correspondence to: Buna Bhandari, Central Department of Public Health, Tribhuvan University Institute of Medicine, Maharajgunj, Kathmandu 44600, Nepal. E-mail: bhandaribuna@gmail.com

How to cite this article: Bhandari B, Neupane D, Thapa P, Pradhan PMS. Use of mHealth for management of hypertension in low and middle-income countries: opportunities and challenges. *Conn Health* 2023;2:1-8. <https://dx.doi.org/10.20517/ch.2022.17>

Received: 29 Sep 2022 **First Decision:** 3 Jan 2023 **Revised:** 23 Jan 2023 **Accepted:** 23 Feb 2023 **Published:** 27 Feb 2023

Academic Editor: Aletta Elisabeth Schutte, Stefano Omboni **Copy Editor:** Ying Han **Production Editor:** Ying Han

Abstract

Despite being the leading cause of global mortality, the hypertension control rate is astonishingly low, particularly in low- and middle-income countries. There is evidence that the mHealth approach is a potential platform for delivering interventions for hypertension management. Our recent study from Nepal also provided strong evidence for reducing blood pressure, improving control rate, and medication adherence. The objective of this paper is to document the real-world experience of designing and implementing a mHealth project in Nepal and relates them with the evidence from other similar Low- and Middle-Income Country (LMIC) settings. We learned that mHealth provides a unique opportunity to bridge the gap between providers and patients, send health education and reminder messages, secure patients' privacy, and make data management easier. We also encountered technological and financial barriers, unclear mHealth policy and guidelines, and low literacy levels, including digital literacy. As many of them are addressable, integrating mHealth provides a promising approach to hypertension management.



© The Author(s) 2023. **Open Access** This article is licensed under a Creative Commons Attribution 4.0 International License (<https://creativecommons.org/licenses/by/4.0/>), which permits unrestricted use, sharing, adaptation, distribution and reproduction in any medium or format, for any purpose, even commercially, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons license, and indicate if changes were made.



Keywords: High blood pressure, mobile health, digital health, developing countries, barriers

BACKGROUND

With rapid globalization and technological advancement, the use of mobile phones continues to rise. It is estimated that 62% of the world's population have access to mobile devices, a 33.5% increment compared to 2016^[1]. Similarly, according to the Telecommunication Union, mobile phone penetration is reported to be 91.53% globally. It is interesting to note that based on the Global system of mobile communication (GSMA) real-time intelligence data, there are more than 11.04 billion mobile connections globally, 3.04 billion higher than the global population^[1]. The use of mobile technologies, especially smartphones, for medical and public health intervention is defined as mobile health or mHealth^[2]. The WHO Global Observatory for eHealth defines mHealth as “a medical and public health practice supported by mobile devices, such as mobile phones, patient monitoring devices, personal digital assistants (PDAs), and other wireless devices”^[3]. Geographic constraints limit access to healthcare in Nepalese. With the availability of motorized transportation, the average time to reach a primary, secondary and tertiary healthcare facility in Nepal was 17.91 minutes, 39.88 minutes and 69.23 minutes, respectively^[4]. There is a growing body of evidence indicating the potential of mHealth in addressing the equity gap by promoting better access and coverage for chronic disease management services in Low- and Middle-Income Countries (LMICs)^[5]. The use of mobile devices and communication networks improves information exchange, delivery and promotion of behaviour change interventions and enhances access and quality of services to reduce the burden of non-communicable diseases (NCD). In addition, it also supports the implementation of NCD management strategies, streamlines the data system, and provides decision support for healthcare providers and the patient population^[5]. Drawing from these positive impacts, mHealth was recognized as one of the 30 high-impact innovations in saving lives, which is especially crucial as we head towards the achievements of targets set in the United Nations Sustainable Development Goals (SDG)^[6].

Hypertension is a significant risk factor for heart disease and stroke and is the leading cause of mortality worldwide. Effective treatment of hypertension requires compliance among patients by following the treatment and guidelines prescribed by a healthcare provider^[2]. There is evidence of barriers to self-care for hypertension management due to low health literacy, misconception about hypertension and treatment and knowledge gap among patients with hypertension^[7]. Furthermore, factors such as low diagnosis rates, treatment inertia, health system barriers and limited collaboration within the health sector also aid in uncontrolled blood pressure among patients^[8]. Existing evidence suggests a potential role of mobile health interventions in addressing these identified challenges. In particular, various mHealth applications designed to deliver information and send reminders to patients effectively support self-management of hypertension through behaviour change and medication adherence^[2,9-10]. Previous studies have highlighted challenges in adopting mHealth intervention for chronic disease management, such as poor digital health literacy, particularly among the elderly and people with lower educational status^[2]. Many such challenges and opportunities need to be explored in the low-and middle-income country scenario where mHealth is yet to be explored for broader use in hypertension management.

Opportunities and challenges for the use of mHealth in hypertension management in LMICs

Evidence suggests that mobile technology could be a potential platform to deliver interventions for patients with hypertension in LMICs^[5]. Multiple behaviour change interventions have been tested in these settings using mHealth. This paper is a general overview of the lessons learned from implementation of the pilot randomised controlled trial project using a mHealth (TEXT4BP) intervention to support behaviour change among patients with hypertension in Nepal^[11-12] and qualitative formative study^[13]. The TEXT4BP

intervention was tested among a total of 200 patients with hypertension at a tertiary-level hospital outpatient department setting in Kathmandu, Nepal. TEXT4BP study found promising evidence for improving blood pressure control and medication adherence among patients with hypertension. The improvement in blood pressure control was significantly greater among the intervention arm^[12]. The intervention implemented in the TEXT4BP study was informed by formative research, which explored various opportunities and challenges of blood pressure control and mHealth acceptability involving various study participants^[13]. Our previous formative qualitative study explored the perspectives of patients, providers and key informants (focus groups and in-depth interviews using the Technological Acceptance Model)^[13]. The opportunity and challenges expressed in this article are based on our experience and evidence from other LMIC settings [Figure 1]. Along with the opportunities, some challenges must be critically assessed and addressed to maximize the benefit of using technology in hypertension management.

OPPORTUNITIES

Bridging gap between the health system and patient

Different studies report communication gaps between providers and patients as one of the significant barriers to hypertension management in LMICs^[14]. In the formative research, we found that the healthcare providers had similar perspectives expressing the staff shortage at health centres as one of the reasons for their inability to have adequate contact with patients^[7]. In such a context, the use of mHealth intervention could prove beneficial by bringing patients closer to the health system^[15]. One simple example includes the delivery of information to patients on hypertension management using various mediums like mobile applications, messages, and phone calls^[16]. By utilizing this approach, one health provider can reach out to multiple patients, thus improving the reach and frequency of contact between patients and providers^[16]. Therefore, mHealth presents an excellent opportunity to address human resource shortages and improve patient care by filling the communication gaps.

Health education and reminders for patients

Like any other chronic disease, taking medication daily is essential to control high blood pressure. In addition, behavioural modifications are also recommended, such as a low salt/fat diet, regular physical activity, and reduction/quitting of smoking and alcoholism. This indicates the complex nature of the disease; therefore, the patients must be constantly reminded and educated. The use of mHealth interventions could be effectively supported by the existing evidence. A systematic review by Hall *et al.* reports the beneficial impact of mHealth in managing chronic diseases, especially in providing client education and supporting behaviour change^[16]. The WHO Global Observatory for eHealth reports SMS technology as a preferred method to ensure treatment compliance globally^[17,18]. Another systematic review focused on LMICs found a positive impact of mHealth on clinical outcomes, medication adherence, and delivery of effective health education to a patient^[19]. Our formative study in Nepal also reported the benefit of mHealth as a reminder tool for behaviour change among patients with hypertension^[13]. These findings favor the use of mHealth for patient education, including medication and follow-up reminders.

Confidential disclosure of information

Stigma related to disclosure of the information is not commonly reported in the case of hypertension compared to other conditions such as HIV/AIDS^[20]. However, in our previous research in Nepal, the need for confidential disclosure of the information was stressed by the patients, especially the young population. Their preferred approach was the delivery of test outcomes and any other related information, such as treatment, via SMS or calls^[7]. It indicates the importance of privacy in managing hypertensive patients. Therefore, a telecommunication platform can be a potential solution to protect patient confidentiality. This stresses the need to prioritise patient privacy in hypertension management, which can be achieved by disseminating patient-related information through digital applications.

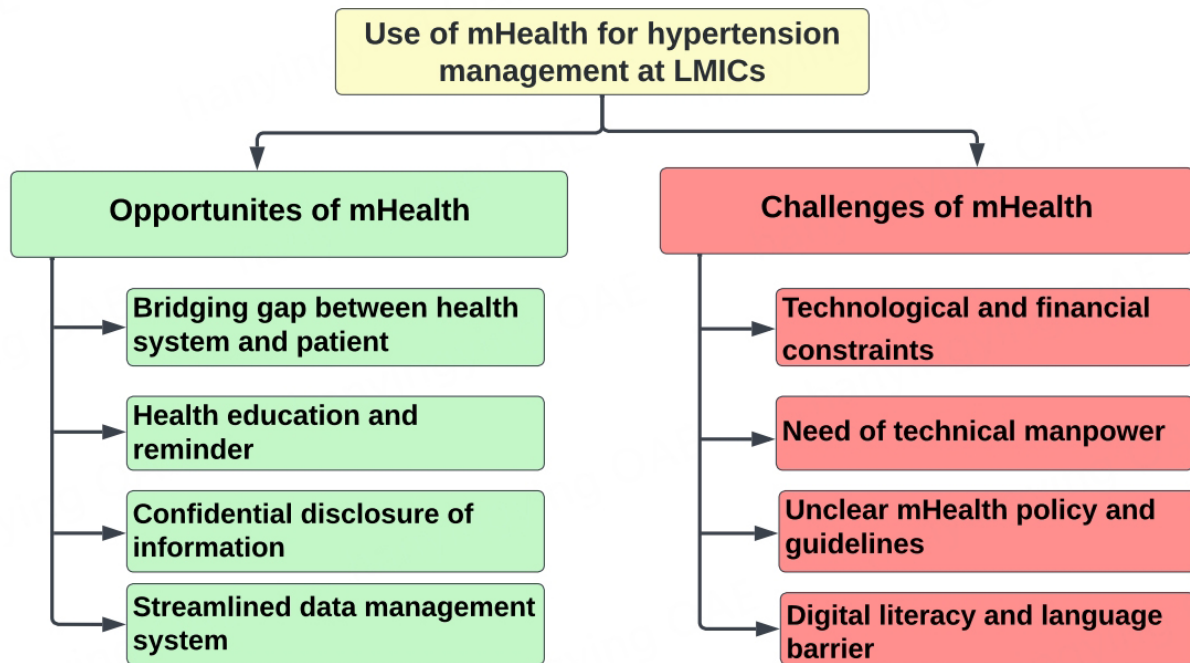


Figure 1. Opportunities and challenges in using mHealth for hypertension management in LMICs.

Streamlined data management system

Similar to any disease condition requiring longitudinal care delivery, the importance of a streamlined data system in hypertension management cannot be overemphasized. Digital tools, such as mHealth applications, are found to be more cost-effective than a paper-based system and can be utilized to collect patient data at the point of service delivery or for longitudinal patient record management. Such a system also allows an integrated care delivery for hypertension patients; for example, the care delivered by a Community Health Worker can be linked to a health facility and vice versa. Similar systems have already been tested in some LMICs, such as Cambodia, Senegal and Nepal, and have proven effective in patient monitoring and follow-up^[16,21].

CHALLENGES

Technological and financial constraints

Even though a high penetration of mobile technology exists in LMICs, various challenges limit countries from leveraging the full potential of technological advancement in a health system. The WHO Global Observatory Group reports multiple challenges, such as operational costs and underdeveloped infrastructure^[18]. Importantly, internet cost, speed and network coverage remain significant constraints in resource-poor settings^[22]. An underdeveloped health information system was a significant barrier to the continuity of care for hypertensive patients in rural India^[23]. Similarly, studies from Bangladesh^[24], Kenya^[25], and Nepal^[13] have identified information carrying capacity, language, and improper recording of the patient's details as barriers to implementing mHealth interventions. In our previous study in Nepal, though stakeholders expressed enthusiasm regarding using mHealth for hypertension management, the participants also described various resource and technology-related challenges. Such as the requirement of technical departments and experts for software development and program monitoring^[13]. There is also ongoing debate globally around the safety and confidentiality of patient data with the introduction of digital solutions in a health system^[26].

Need for technical manpower

Though we identified that mHealth could address the health human resource gap in delivering health services, it could not overcome the barriers of lack of technical manpower in the health system. Since Health workers are overloaded with other health-related activities, they cannot be involved in the mHealth-related direct technical services, so there should be enough technical expertise or manpower to organise the data-related patients and link with mHealth services and health workers. This issue was highlighted in our previous study, especially through key informants and healthcare providers^[13]. Previous studies from Nepal also reported that the need for good infrastructure and trained human resources is key to the success of the rural-telemedicine program in Nepal^[27]. Therefore until and unless the technical manpower is not integrated into the healthcare system, operationalisation of digital health in the healthcare delivery system of LMICs could be a challenge.

Unclear mHealth policy and guidelines

A clear policy and guidelines are essential for any program's successful development and implementation^[22]. However, in the case of mHealth/ digital health, this remains a missing piece in many LMICs. This gap of unclarity of policy in privacy and confidentiality of the data implementation strategy was also highlighted by the WHO^[18]. Most LMICs do not have clarity about the data handling, copyright and measures to protect the privacy and confidentiality of the shared information in mHealth policies. In addition, policy and guidelines have not addressed the equity of access to the mHealth program; often, such services are utilized mainly by the accessible (technological and financial) community only^[28]. Further, technological aspects are rapidly evolving, so changes in existing policies are another huge gap in incorporating mHealth into the health system of the LMICs.

Digital literacy and language barrier

Digital literacy is reported as a significant barrier to the implementation of mHealth in LMIC settings^[29]. It is a crucial factor determining the acceptability and usability of mHealth interventions among hypertensive patients. This issue of language and literacy barriers in reading text messages and operating mobile apps are reported barriers in research conducted in South India by Sydney *et al.* (2012) and Smith *et al.* (2015)^[20,30]. Language and literacy barriers are also identified in a report focusing on mHealth in LMICs^[26]. These are similar to our study findings in that participants expressed concern about digital illiteracy, as most patients with hypertension were elderly and illiterate^[13], with only 31% of them digitally literate^[31]. Such issues can create significant barriers to implementing mHealth in LMICs.

Based on our experience in Nepal, simple mHealth can work but needs collaboration and cooperation with multiple sectors to make digital friendly health system. In addition, feasibility testing of a simple mHealth intervention could be a starting point, and then gradual scaling up the program could be a practical implementation strategy in LMIC settings. However, the problem we face is that scaling up the program is another big challenge in LMICs settings, even after there is evidence of effectiveness of feasibility study or other generated evidence.

Ways forward

mHealth could be a suitable medium for intervention delivery for a patient with hypertension in an LMIC setting, if designed meticulously. Firstly, there is a need to have a clear guiding policy to inform the implementation process and ensure the protection of the data and privacy of participants. We echo having a mHealth community or a governing body in each health department^[22]. Secondly, Government commitment and multisectoral collaboration, such as with the ICT department and hospital and coordination with the health system, must overcome the identified structural barriers. Concerned stakeholders, including policymakers, should be encouraged to invest more in technological

infrastructure^[22]. Additionally, the need and preferences of the participants should be explored while designing the mHealth intervention to be acceptable and sustainable in the local setting^[32,33]. WHO's mHealth Assessment and Planning for Scale (MAPS) to scale up their mHealth project is an excellent tool to address the usability issue of mHealth^[34]. Further, alternate mediums, such as including family members of illiterate/older groups or using video/voice/symbolic messages, could be instrumental in addressing the digital literacy barriers. Future research should explore how best to implement culturally tailored mHealth intervention in the regular healthcare system to increase the long-term adoption and sustainability of the effectiveness of such innovative approaches in LMIC settings. However, the finding of this paper should be interpreted cautiously as it is not a review paper that summarizes all the existing literature in the field. In addition, future studies should explore the ways of transferring the successfully implemented mHealth strategies for hypertension management at HICs to LMIC settings to address the identified challenges. Ultimately, there should be a practical approach for scaling up the generated evidence and incorporating it into policy and practice.

CONCLUSION

mHealth provides a multifaceted opportunity for hypertension management in low- and middle-income countries. The implementation experiences support that mHealth could be implemented outside the research environment and on a large scale. Although there are some challenges yet to be overcome, this should not preclude the integration of mHealth in hypertension management. Many of these challenges are addressable by making hypertension management a national and global priority.

DECLARATIONS

Authors' contributions

Made a substantial contribution to the conception and writing of the manuscript: Bhandari B
Contributed to the manuscript's conception, writing and editing: NeupaneD, Thapa P, Pradhan PMS
All authors approved the final manuscript for submission.

Availability of data and materials

Not applicable.

Financial support and sponsorship

None.

Conflicts of interest

All authors declared that there are no conflicts of interest.

Ethical approval and consent to participate

Not applicable.

Consent for publication

Not applicable.

Copyright

© The Author(s) 2023.

REFERENCES

1. Turner A. Mobile user statistics: discover the number of phones in The World & Smartphone Penetration by Country or Region. Bankmycell 2023. Available from: <https://www.bankmycell.com/blog/how-many-phones-are-in-the-world> [Last accessed on 24 Feb

- 2023].
2. Cao W, Milks MW, Liu X, et al. mHealth Interventions for self-management of hypertension: framework and systematic review on engagement, interactivity, and tailoring. *JMIR Mhealth Uhealth* 2022;10:e29415. DOI PubMed PMC
 3. World Health Organization. mHealth: new horizons for health through mobile technologies. Global Observatory for eHealth Series Vol 3. 2011. Available from: <https://www.cabdirect.org/cabdirect/abstract/20113217175> [Last accessed on 24 Feb 2023].
 4. Cao WR, Shakya P, Karmacharya B, Xu DR, Hao YT, Lai YS. Equity of geographical access to public health facilities in Nepal. *BMJ Glob Health* 2021;6:e006786. DOI PubMed PMC
 5. Beratarrechea A, Lee AG, Willner JM, Jahangir E, Ciapponi A, Rubinstein A. The impact of mobile health interventions on chronic disease outcomes in developing countries: a systematic review. *Telemed J E Health* 2014;20:75-82. DOI PubMed PMC
 6. PATH. The Innovation Countdown 2030. Reimagining global health.30 high-impact innovations to save lives. NORAD, USAID,PATH; 2030. Available from: <https://www.path.org/resources/innovation-countdown-2030-reimagining-global-health/> [Last accessed on 24 Feb 2023].
 7. Bhandari B, Narasimhan P, Vaidya A, Subedi M, Jayasuriya R. Barriers and facilitators for treatment and control of high blood pressure among hypertensive patients in Kathmandu, Nepal: a qualitative study informed by COM-B model of behavior change. *BMC Public Health* 2021;21:1524. DOI PubMed PMC
 8. World Health Organization. Hypertension care in Thailand: best practices and challenges, World Health Organization. Country Office for Thailand 2019. Available from: <https://apps.who.int/iris/handle/10665/330488> [Last accessed on 24 Feb 2023].
 9. Chow CK, Redfern J, Hillis GS, et al. Effect of lifestyle-focused text messaging on risk factor modification in patients with coronary heart disease: a randomized clinical trial. *JAMA* 2015;314:1255-63. DOI PubMed
 10. Bobrow K, Farmer AJ, Springer D, et al. Mobile phone text messages to support treatment adherence in adults with high blood pressure (SMS-text adherence support [StAR]): a single-blind, randomized trial. *Circulation* 2016;133:592-600. DOI PubMed PMC
 11. Bhandari B, Narasimhan P, Vaidya A, Jayasuriya R. Theory-based mobile phone text messaging intervention for blood pressure control (TEXT4BP) among hypertensive patients in Nepal: study protocol for a feasibility randomised controlled trial. *BMJ Open* 2020;10:e040799. DOI PubMed PMC
 12. Bhandari B, Narasimhan P, Jayasuriya R, Vaidya A, Schutte AE. Effectiveness and acceptability of a mobile phone text messaging intervention to improve blood pressure control (TEXT4BP) among patients with hypertension in nepal: a feasibility randomised controlled trial. *Glob Heart* 2022;17:13. DOI PubMed PMC
 13. Bhandari B, Schutte AE, Jayasuriya R, Vaidya A, Subedi M, Narasimhan P. Acceptability of a mHealth strategy for hypertension management in a low-income and middle-income country setting: a formative qualitative study among patients and healthcare providers. *BMJ Open* 2021;11:e052986. DOI PubMed PMC
 14. Khatib R, Schwalm JD, Yusuf S, et al. Patient and healthcare provider barriers to hypertension awareness, treatment and follow up: a systematic review and meta-analysis of qualitative and quantitative studies. *PLoS One* 2014;9:e84238. DOI PubMed PMC
 15. Kaplan WA. Can the ubiquitous power of mobile phones be used to improve health outcomes in developing countries? *Global Health* 2006;2:9. DOI PubMed PMC
 16. Hall CS, Fottrell E, Wilkinson S, Byass P. Assessing the impact of mHealth interventions in low- and middle-income countries-what has been shown to work? *Glob Health Action* 2014;7:25606. DOI PubMed PMC
 17. Thakkar J, Kurup R, Laba TL, et al. Mobile telephone text messaging for medication adherence in chronic disease: a meta-analysis. *JAMA Intern Med* 2016;176:340-9. DOI PubMed
 18. WHO Global Observatory for eHealth. mHealth: new horizons for health through mobile technologies: second global survey on eHealth. World Health Organization 2011. Available from: <https://apps.who.int/iris/handle/10665/44607> [Last accessed on 24 Feb 2023].
 19. Hurt K, Walker RJ, Campbell JA, Egede LE. mHealth interventions in low and middle-income countries: a systematic review. *Glob J Health Sci* 2016;8:54429. DOI PubMed PMC
 20. Sidney K, Antony J, Rodrigues R, et al. Supporting patient adherence to antiretrovirals using mobile phone reminders: patient responses from South India. *AIDS Care* 2012;24:612-7. DOI PubMed
 21. Ni Z, Atluri N, Shaw RJ, et al. Correction: evaluating the feasibility and acceptability of a mobile health-based female community health volunteer program for hypertension control in rural nepal: cross-sectional study. *JMIR Mhealth Uhealth* 2020;8:e19048. DOI PubMed PMC
 22. Wallis L, Blessing P, Dalwai M, Shin SD. Integrating mHealth at point of care in low- and middle-income settings: the system perspective. *Glob Health Action* 2017;10:1327686. DOI PubMed PMC
 23. Lall D, Engel N, Devadasan N, Horstman K, Criel B. Challenges in primary care for diabetes and hypertension: an observational study of the Kolar district in rural India. *BMC Health Serv Res* 2019;19:44. DOI PubMed PMC
 24. Islam MN, Karim MM, Inan TT, Islam AKMN. Investigating usability of mobile health applications in Bangladesh. *BMC Med Inform Decis Mak* 2020;20:19. DOI PubMed PMC
 25. Kariuki EG, Okanda P. Adoption of m-health and usability challenges in m-health applications in Kenya: case of Uzazi Poa m-health prototype application. *IEEE AFRICON* 2017. DOI
 26. Wambugu SC, Villella C. mHealth for health information systems in low- and middle-income countries challenges and opportunities in data quality, privacy, and security. Available from: <https://www.measureevaluation.org/resources/publications/tr-16-140.html> [Last accessed on 24 Feb 2023].

27. Bhatta R, Aryal K, Ellingsen G. Opportunities and challenges of a rural- telemedicine program in Nepal. *J Nepal Health Res Counc* ;13:149-53. [PubMed](#)
28. McCool J, Dobson R, Whittaker R, Paton C. Mobile Health (mHealth) in Low- and Middle-Income Countries. *Annu Rev Public Health* 2022;43:525-39. [DOI](#) [PubMed](#)
29. Nouri SS, Avila-Garcia P, Cembali AG, Sarkar U, Aguilera A, Lyles CR. Assessing mobile phone digital literacy and engagement in user-centered design in a diverse, safety-net population: mixed methods study. *JMIR Mhealth Uhealth* 2019;7:e14250. [DOI](#) [PubMed](#) [PMC](#)
30. Smith R, Menon J, Rajeev JG, Feinberg L, Kumar RK, Banerjee A. Potential for the use of mHealth in the management of cardiovascular disease in Kerala: a qualitative study. *BMJ Open* 2015;5:e009367. [DOI](#) [PubMed](#) [PMC](#)
31. The Himalaya Times. Illiteracy, old policies hurdles for digital Nepal. Available from: <https://thehimalayantimes.com/business/illiteracy-old-policies-hurdles-for-digital-nepal> [Last accessed on 24 Feb 2023].
32. Albright K, Krantz MJ, Backlund Jarquin P, DeAlleaume L, Coronel-Mockler S, Estacio RO. Health Promotion Text Messaging Preferences and Acceptability Among the Medically Underserved. *Health Promot Pract* 2015;16:523-32. [DOI](#) [PubMed](#)
33. Davey S, Davey A, Singh JV. Mobile-health approach: a critical look on its capacity to augment health system of developing countries. *Indian J Community Med* 2014;39:178-82. [DOI](#) [PubMed](#) [PMC](#)
34. World Health Organization. Geneva, Switzerland. The MAPS toolkit. 2015. Available from: https://apps.who.int/iris/bitstream/handle/10665/185238/9789241509510_eng.pdf [Last accessed on 24 Feb 2023].