Aug 10th, 12:00 AM

mHealth in Developing Countries: Progress Toward Global Health Equity

Jane Moore
Miami University, janiemoore05@gmail.com

Chad Anderson
Miami University, ander556@miamioh.edu

mHealth in Developing Countries: Progress Toward Global Health Equity

Completed Research

Jane Moore
Miami University
moorejf@miamioh.edu

Chad Anderson
Miami University
chad.anderson@miamioh.edu

Abstract

Global health equity is an elusive goal as developing countries lag behind the developed world in most health outcomes. The growth of mobile networks and mobile phone adoption across the developing world in recent years could lead to effective mHealth programs to reduce those inequities. To understand how this can best be accomplished, we analyze review studies of mHealth initiatives in developing countries and present our findings through a SWOT analysis. The strengths (improved health outcomes, improved treatment quality and adherence), weaknesses (difficult to scale, technical challenges), opportunities (improving equitable health access, enhancing disease control), and threats (mobile technology limitations, cultural variations) of mHealth initiatives in developing countries are discussed. Recommendations to improve mHealth initiatives in developing countries include empowering more women with leadership and technology skills, applying more theory to inform the development and evaluation of mHealth projects, and provisioning more financial support for those initiatives.

Keywords

mHealth, developing countries, health equity, health disparities.

Introduction

> "The essence of global health equity is the idea that something so precious as health might be viewed as a right" (Farmer 2005).

In 2021, 126 countries were classified by the United Nations as having developing economies (e.g., Sierra Leone, Cambodia, Haiti) (United Nations Department of Economic Social Affairs 2021) and almost all were at the lower end of the Healthcare Access and Quality (HAQ) Index relative to countries with developed economies (e.g., Norway, Canada, Japan) (Fullman et al 2018). Consequently, a patient with a fever in Norway could access treatment from multiple trained nurses and physicians in a facility with a complete array of technology-enhanced medical devices and pharmaceuticals, while a patient with a fever in Sierra Leone could expect assistance from family members and potentially a visit from a community health worker who may be equipped with a basic first aid kit and partial training on some basic medical treatments. The impact of this inequality is apparent when comparing the burden of disease in developed versus developing countries. In Norway in 2015, there were 5 maternal deaths during or related to the pregnancy per 100,000 live births, while in Sierra Leone, there were 1,360 maternal deaths per 100,000 live births (Roser and Ritchie n.d.). This is just one example of the significant disparity in health outcomes that exist around the world. So, how can these disparities effectively be addressed?

mHealth, defined by the World Health Organization (2011) as the "use of mobile and wireless technologies to support the achievement of health objectives" (p. 1), is a possible solution. In 2014, nearly 2 in 3 Africans lived in areas with limited access to medical facilities, yet 8 in 10 had a mobile phone (Taylor 2015). Deloitte's annual survey of global mobile consumer trends found that as of 2017, median mobile phone ownership in developing countries was 90% (Wigginton et al. 2017). Similarly, a 2019 Pew Research report noted that mobile phone ownership in some emerging economies was as high as 93% (Silver 2019). While rural areas of the 47 least developed countries still have large gaps in mobile network coverage, as of 2020, the broader developing world and developing urban areas in particular, had relatively good mobile network

coverage (International Telecommunication Union 2020). With this level of mobile phone penetration and network coverage, mobile technologies could help address many of the disparities in healthcare access and quality in developing countries. Recognition that mobile technology has that potential is evidenced in the growing number of mHealth initiatives in developing countries where, for example, Njoroge et al (2017) identified 47 mHealth initiatives in Kenya alone. However, there is also evidence that many initiatives do not achieve their intended goals and fail to develop beyond pilot projects (Sundin et al. 2016). There is a need to better understand what works and what does not so that future mHealth initiatives will be more likely to meaningfully contribute to the goal of addressing healthcare-related disparities and inequities in developing countries. To that end, this study evaluates the research on mHealth initiatives in developing countries by analyzing review articles with that focus and developing a synthesis of those findings to answer the question: how can mHealth initiatives in developing countries be structured and supported to optimize their impact on global health equity?

Information Technologies to Address Global Health Disparities

Cancer is an example of a global health disparity that could be addressed with information technologies. It is a global health concern impacting all countries, but there are significant disparities in cancer survival rates depending on where the patient lives, with survival rates in low income countries for some cancers at just 25% while survival rates for those same cancers in high income countries are over 50% (Farmer et al. 2010). Hoekstra et. al. (2016) see numerous opportunities to strengthen cancer care and survival rates in developing countries through the implementation of technology solutions such as information dissemination to address cancer risk factors (e.g., smoking) and education about early warning signs (e.g., lumps) to encourage patients to proactively seek the input of a health professional. Strategies used in locations where advanced cancer treatments are absent focus on the reduction of risk factors, early detection, the use of off-patent drugs, and the support of a network of informed caregivers (Farmer et al. 2010). Additionally, information technologies can greatly assist in eliminating barriers related to a lack of cancer diagnosis and treatment expertise in remote regions (Sirintrapun and Lopez 2018). Healthcare professionals in developing countries could benefit from the knowledge of potential cancer treatments shared by their counterparts in locations where more expertise has been developed, and patients in developing countries would also have increased survival odds if they received these informed treatment solutions in their local healthcare settings (Chellaiyan et al. 2019).

mHealth in Developing Countries

mHealth, in particular, has the potential to address health disparities in developing countries. Government response time to malaria outbreaks in Botswana was reduced from four months to just three minutes following the deployment of a mobile-enabled program while maternal mortality in Mali was reduced by 30 percent when prevention and awareness information was delivered via text message to pregnant young mothers (Taylor 2015). These are just two examples that illustrate how mobile technology can have a meaningful impact on healthcare delivery and health outcomes in developing countries. In reviewing the strengths and weaknesses of a decade of technology implementations related to healthcare delivery in Africa, Aranda-Jan et al (2014) concluded that a strength of mHealth projects is the positive health outcomes that often result, but they also note the challenges of scaling-up programs to a national level that require a clearly defined strategy, cooperation with government health organizations, and participation from key stakeholders, such as patients and doctors.

In 2012, mobile phones with a preinstalled mHealth app were given to community health workers (CHWs) in the Bonthe District in Sierra Leone to track household visits, collect household data such as pregnancies, make emergency referrals, and manage the efforts of the CHWs in a way that would support clinical and managerial decision-making. The plan was to scale the project across every district in Sierra Leone, but those plans were upended when Ebola struck the country in 2014, resulting in the loss of key personnel and the reallocation of resources to fight the epidemic (Wall et al. 2019). Tamrat and Kachnowski (2012) found in their review of mHealth technologies for maternal and newborn health programs that even when the mobile technologies were working as intended, the health outcomes from the program were compromised by other factors that included unreliable emergency transport and poor-quality services at health facilities. These examples highlight the complex environments in which mHealth projects are implemented, where a

combination of environmental, political, social, cultural, and technological factors can influence project trajectories.

In 2013, Deloitte predicted that the global mHealth market would grow to $21.5 billion by 2018, a 50% rate of growth year over year (Taylor 2015). By 2018 the global mHealth market was $30.2 billion, far surpassing growth expectations. However, over half of market revenues were coming from developed economies in Europe and North America, with the Asia-Pacific region accounting for about a third of the remaining revenues. Consequently, the substantial growth in global mHealth since 2013 has been disproportionate in its distribution, with most of the developing world continuing to lag in the adoption and implementation of mHealth technologies (Ugalmulge and Swain 2019). While mHealth has the potential to be an effective supplement to the typically limited healthcare services in developing countries, the complexity of those environments and the limited resources available in developing countries makes it imperative that we develop a better understanding for what can be done to implement and improve mHealth initiatives.

Method

To better understand effective implementations and opportunities for improvement with regard to mHealth initiatives in developing countries, we evaluated research that reviewed the literature on mHealth in developing countries, which included 23 papers from the years 2006 to 2021. The term low- and middle-income countries (LMICs) is often used as an interchangeable term with developing countries in the literature, so we included both terms in our search for review articles. The papers we included in our analysis varied in the types of reviews that were conducted and in the scope of the search criteria. The earliest papers were general reviews of the literature and did not specify the scope of their search criteria, but many of the later papers applied a systematic review with a clear reporting structure based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) (Moher et al. 2009). In all, 11 papers reported systematic reviews, two used a scoping study format, and 10 either self-identified as literature reviews or were put in that category if the type of review conducted was not explicitly stated. Some reviews limited their scope to a specific country or region (e.g., Bangladesh, Africa) or to a specific context (e.g., maternal and newborn health, non-communicable diseases). The reviews collectively spanned a thirty-year period from 1990 to 2019, although little of the reviewed work documented projects implemented before 2000. Some reviews focused exclusively on academic research while others included grey literature (i.e., research produced outside traditional academic publishing and distribution channels) and the number of sources included in the reviews ranged from a low of 5 to a high of 123. Table 1 lists the review papers and their characteristics.

Authors	Type	N	Range	Region	Context
(Kaplan 2006)	Literature Review	18	Not Given	World	All contexts
(Kahn et al. 2010)	Literature Review	Not Given	Not Given	World	All contexts
(Noordam et al. 2011)	Literature Review	8	Not Given	World	Maternal and newborn health
(Déglise et al. 2012)	Systematic Review	123	1998-2009	World	SMS for disease control
(Gurman et al. 2012)	Systematic Review	16	2007-2011	World	Behavior change communication
(Tamrat and Kachnowski 2012)	Literature Review	34	2000-2010	World	Maternal and newborn health
(Chigona et al. 2013)	Literature Review	13	2012 (M4D conference papers)	Asia and Africa	All contexts
(Braun et al. 2013)	Systematic Review	25	2000-2012	World	Health workers use of mHealth

(Goel et al. 2013)	Literature Review	28	All	World	All contexts
(Marshall et al. 2013)	Literature Review	94	1990-2012	World	All contexts
(Ahmed et al. 2014)	Scoping Study	26	1990-2013	Bangladesh	All contexts
(Albabtain et al. 2014)	Literature Review	Not Given	Not Given	World	All contexts
(Aranda-Jan et al. 2014)	Systematic Review	44	2003-2013	Africa	All contexts
(Beratarrechea et al. 2013)	Systematic Review	9	2001-2011	World	Non-communicable diseases
(Bloomfield et al. 2014)	Systematic Review	5	1992-2012	Sub-Saharan Africa	Non-communicable diseases
(Peiris et al. 2014)	Systematic Review	24	2006-2014	World	Non-communicable diseases
(Lee et al. 2016)	Systematic Review	17	1990-2014	World	Maternal and newborn health
(Sundin et al. 2016)	Literature Review	52	Not Given	Africa, Central America, Southeast Asia	All contexts
(White et al. 2016)	Systematic Review	31	2009-2015	World	Health workers use of mHealth
(Latif et al. 2017)	Literature Review	Not Given	Not Given	World	All contexts
(Njoroge et al. 2017)	Systematic Review	47	2001-2016	Kenya	All contexts
(Karageorgos et al. 2019)	Systematic Review	98	2010-2017	World	All contexts
(Mancuso 2021)	Scoping Study	100	2008-2019	World	Smartphone apps for patients to improve health

Table 1. Review Papers Included in the Analysis

SWOT Findings

To support our goal of understanding what works and what does not in regard to mHealth initiatives in developing countries, we structured our findings as a SWOT (strengths, weaknesses, opportunities, and threats) analysis. The following sections detail the strengths, weaknesses, opportunities, and threats that were most salient across the set of review articles.

Strengths

Improved health outcomes: The goal of any healthcare intervention is improved health and while clear measures of health improvements from mHealth initiatives are sometimes elusive (Ahmed et al. 2014; Lee et al. 2016), there is also evidence that mHealth initiatives do lead to improved health outcomes (Aranda-

Jan et al. 2014; Beratarrechea et al. 2013; Tamrat and Kachnowski 2012). For example, controlled studies that Peiris et al (2014) reviewed found significant improvements in glycemic control for diabetics, lung function for asthmatics, and heart failure symptoms as well as other positive health outcomes. Some of the reviews noted that greater measurable evidence of improved health outcomes from mHealth programs would be achieved if more randomized control trials were conducted (Aranda-Jan et al. 2014; Kahn et al. 2010; Peiris et al. 2014).

Improved treatment quality and adherence: Mobile technologies can help individuals monitor and take charge of their own health (Karageorgos et al. 2019), while also aiding health workers by keeping them updated on patients' conditions and enabling them to provide efficient and effective care (Braun et al. 2013). For example, a mobile phone-based drug compliance program in South Africa resulted in a 30-60% increase in medication adherence (Latif et al. 2017). Additionally, mHealth can help address health worker shortages in developing countries (Goel et al. 2013). Health worker efficiency has improved due to time and cost savings, and increased communication has resulted from the use of mHealth technology (White et al. 2016). mHealth tools enable community healthcare workers to connect to healthcare experts, bringing the knowledge and expertise of locations with advanced clinical technology to rural communities.

Increased healthcare access and utilization: In communities that are underserved with regard to healthcare, mHealth presents an opportunity to improve access to care by connecting patients to healthcare providers through the already prevalent mobile technology. White et al (2016) describe improved treatment compliance when patients receive reminders through mHealth tools and more consistent communication with a healthcare provider, resulting in improved health outcomes. A systematic review within the context of maternal and newborn health demonstrated a consistent increase of healthcare utilization as a result of mHealth interventions in LMIC healthcare settings (Lee et al. 2016).

Ubiquity of mobile phones: Kaplan (2006), in the earliest review of mHealth in developing countries, noted the worldwide ubiquity of mobile phones that make them ideal platforms for low cost healthcare interventions that are easy to scale. The universality of mobile phones provides several benefits to mHealth initiatives in developing countries: 1) a greater acceptance by both patients and health workers of interventions that are mobile phone-based (Déglise et al. 2012), 2) a lower cost relative to other health interventions making mHealth projects easier to implement in resource-constrained locations (Beratarrechea et al. 2013), 3) better potential for scaling as the expansion of an intervention program will require little additional infrastructure financing from external organizations (Karageorgos et al. 2019), and 4) higher adaptability to local cultures due to embeddedness of mobile phones (Aranda-Jan et al. 2014).

Weaknesses

Difficult to scale: One significant weakness of many mHealth initiatives is that they are standalone projects that are not designed to integrate with other health systems, especially at the national level. This is due, in part, to the fact that projects in developing countries are often implemented and funded by a variety of international non-governmental organizations (NGOs), which leads to interoperability issues due to a lack of national standards to guide and support interoperability (Njoroge et al. 2017). Peiris et al (2014) describe this problem as "pilotitis" because so many mHealth projects are implemented as pilot programs with no clear path to being scalable or easily integrated into local health systems.

Lack of local support: Without dedicated support from individuals and groups in the country, such as local healthcare organizations or a Ministry of Health, sustained positive impacts of mHealth programs are difficult to achieve (Njoroge et al. 2017). Marshall et al (2013) note the need to obtain both government support and constituent buy-in to improve the potential for program success. It is also important to realize that local leadership positions in developing countries often look different than local leadership positions in the developed world. Consequently, leaders who could inspire adoption of mHealth programs may include village elders, tribe leaders, teachers, or priests. Sufficient knowledge of each community and their beliefs and traditions, something that is best obtained through partnership with individuals from the community, will promote long term adoption (Marshall et al. 2013).

Overloading health workers: mHealth initiatives typically follow a top-down approach with the administrative goal of increasing community health workers' adherence to policies and procedures (Braun et al. 2013). This can result in programs that overload health workers and make them less effective. When building out mHealth programs, it is important to consider the impact the program will have on health

workers' daily tasks. In an ideal state, the technology will include steps that make the health workers' tasks more efficient rather than adding additional work (White et al. 2016).

Technical challenges: White et al (2016) describe a common trend in study findings of low success rates for mHealth program implementation due to technical issues related to infrastructure and internet connectivity. These difficulties, in tandem with devices that may lack strong batteries, create challenges for patients to have a reliable device with which to utilize mHealth services. Because of reliability issues with nascent power grids, Latif et al (2017) highlight the need for creating power-aware health applications that reduce the need for frequent phone charging.

Opportunities

Supply chain enhancement: Currently, there is poor management of drug supply chains in developing countries with often large discrepancies in and limited control of stock levels at health care facilities and poor stock forecasting (Aranda-Jan et. al. 2014). Mobile technology could assist with these supply chain-related issues, as improved communication and the tracking and forecasting power of computer programs would help enhance drug management. This application of mHealth would primarily be used by healthcare workers and suppliers but would benefit patients by reducing the gap in equitable access to modern medicine and supplies.

Improving equitable health access: In most developing countries, hospitals are only located in urban areas. To facilitate equitable access to healthcare for people living in rural areas, mHealth programs that allow patients to receive information digitally through mobile communications would bring healthcare knowledge to remote, vulnerable groups (Njoroge et al. 2017). Additionally, in many communities, a woman's role in society may not enable her to leave the home for extended periods of time to visit a healthcare professional; however, she could obtain similar access to information and medical advice through an mHealth program. White et al (2016) found that the most common users of mHealth technology in underdeveloped areas were community health workers. CHWs working in less developed areas can learn from healthcare professionals in more developed areas through mHealth programs, enabling them to gain knowledge in industry best practices and to improve their care plans.

Enhancing disease control: There are opportunities for mHealth to be implemented in national disease control programs, bringing an evidence-based approach that can enable early detection of diseases and prevent the spread of infection and disease outbreaks (Latif et al. 2017). For example, compliance with routine vaccination schedules, a powerful tool to prevent disease spread and outbreaks, was demonstrated to increase through the use of SMS appointment reminders (Karageorgos et al. 2019). Furthermore, the symptoms of noncommunicable diseases, such as hypertension or diabetes, can be mitigated and treated through mHealth interventions. Karageorgos et al. (2019) observed that the specific use of SMS-based mHealth programs to provide reminders to patients, rather than simply providing information, proved to have an encouraging impact on patient outcomes.

Technology acceptance: Mobile phone prevalence has quickly grown across the globe in the last decade, including in developing areas such as many African nations. Thus, mHealth projects have also experienced increased acceptance in developing countries, especially those initiatives with user-friendly functionality and compatibility with popular devices (Aranda-Jan et al. 2014). Due to rapid expansion of mobile network coverage, availability of inexpensive devices, and decreasing costs of mobile phone services, the opportunity for mHealth programs to continue to grow and support more complex interventions is promising. For example, Latif et al (2017) describe ways in which the Internet of Things and artificial intelligence could provide health-related insights, such as heartbeat irregularities for point-of-care diagnosis, which would provide beneficial information to healthcare providers to improve patient outcomes. Advancement of technology in the form of wearable sensors, in tandem with mobile apps related to health, can encourage healthy habits in patients' daily lives (Karageorgos et al. 2019).

Threats

Mobile technology limitations: SMS-based solutions have been a common implementation in mHealth programs with some reviews focusing exclusively on them (Déglise et al. 2012) and early reviews that were conducted before the advent of smartphones noted the limited information carrying capacity of text messaging as a threat to mHealth innovations (Kaplan 2006). As smartphones increasingly enable new

options for engagement and communication (e.g., interactive apps, video chat) the focus on technology limitations in more recent reviews has shifted to the limits of networks in developing countries, particularly in rural areas, to provide sufficient bandwidth to implement the types of solutions that can be implemented in the developed world (Latif et al. 2017). Network capabilities in developing countries have been improving with broad coverage by 3G and 4G networks, but they continue to lag behind developed countries where network innovations are first implemented (e.g., new 5G networks) (Mancuso 2021). Recent telehealth projects have demonstrated the value of supporting remote healthcare delivery with video conferencing, but video-based services on older generations of cellular networks are less consistent making those types of projects harder to implement effectively in developing countries. Thus, the future success of a range of mHealth solutions in developing countries will be increasingly dependent on continued improvements in network capabilities in those countries.

Unreliable electric grids: The consistent transmission of electric power to all users in developing countries is another threat to mHealth initiatives (White et al. 2016). Even when mobile devices have network connectivity, their usefulness is still limited if they do not have a reliable source of power. Innovative ways to overcome unreliable electricity access have been evidenced, but inconsistent power transmission is an ongoing threat to the success of mHealth projects in many developing countries (Karageorgos et al. 2019). A unique aspect of this threat is that while other mHealth issues require community buy in and individuals who will ensure a successful and continued implementation, improving electric grids may be more effective if a third party assists in a developing country temporarily to make the necessary improvements.

Illiteracy: Illiteracy is an ongoing challenge in developing countries, which limits the appeal and effectiveness of SMS and other text-based mHealth solutions (Aranda-Jan et al. 2014). Voice calls can substitute for text-based communication and have been found to enhance treatment adherence, but phone plans in the developing world are often based on chargeable minutes with voice calls costing more than text messages (Karageorgos et al. 2019). Subsidies by telecom providers for voice-based mHealth may be necessary, since the usability of mHealth programs may be limited for users who cannot read text on a mobile phone.

Cultural Variations: Cultural characteristics can be a threat to mHealth initiatives. At the level of care seeking behavior there may be social stigmas that prevent people from seeking treatment for certain diseases, which must be addressed before interventions can be successful (Sundin et al. 2016). Language barriers can lead to misinterpretations of intentions for treatment and medications and strict gender roles can limit what women are allowed to do with regard to technology use and health behaviors (Latif et al. 2017). Marshall et al (2013) also note the importance of understanding and engaging with local political and religious leaders who often have significant influence in their communities and can therefore be instrumental in the success of mHealth initiatives.

Discussion

There is potential for mHealth to reduce health disparities in the developing world, but the success of future mHealth initiatives will depend on how a number of key issues are addressed. Women currently make up around 70% of the global healthcare workforce but are in a minority of leadership positions (Siliezar 2019), and a digital gender gap persists around the world with women far less engaged in technology development than men (Asi and Williams 2020). Prior research has tended to focus on how mobile technology can support the efforts of community health workers and other healthcare providers (Karageorgos et al. 2019; White et al. 2016), but we argue that a key to the future success of mHealth initiatives is empowering more women with both leadership opportunities and technology development skills that will enable them to contribute more effectively to the development and implementation of mHealth solutions. Mobile solutions also facilitate the dissemination of information, as advice can be shared through trustworthy platforms, such as health call centers or text messaging. Consequently, mHealth tools would benefit women in developing countries who may lack other options for accessing accurate health information (Asi and Williams 2020). This is an opportunity for the information systems academic community to support mHealth in developing countries by encouraging women to pursue careers that combine technology development with knowledge of healthcare delivery.

To date, the use of theory to inform mHealth development and evaluation has been very limited with just two review papers discussing its use. Chigona et al (2013) found that none of the research questions in the

studies they evaluated were based on theory and White et al (2016) found that only two of the 31 papers in their systematic review described the use of theory to guide program development and evaluation. Bull and Ezeanochie (2015) argue that when theory is used in mHealth programs the effects of those programs are often greater and more sustained and Tomlinson et al (2013) warns that attempting to scale mHealth interventions without theory will result in project failure and the wasting of scarce resources. Consequently, another way for the IS academic community to support mHealth efforts in developing countries is to identify and develop theory that could explain the successes and failures of mHealth initiatives and offer a theoretical basis for the design, implementation, and evaluation of future initiatives.

With regard to mHealth evaluation specifically, Tomlinson et al (2013) argue that most mHealth initiatives seek simply to demonstrate their value against doing nothing rather than evaluating the project against a set of common principles or optimal strategies that would lead to a better understanding of what actually works and what does not. While some strategies have been developed (e.g., the multi-phase optimization strategy (MOST)), there is an opportunity for the IS academic community to develop new theory-grounded strategy that could be employed in the evaluation of future mHealth initiatives. It is impactful for discussions around the implementation of, and continued support for, mHealth programs to be held in developed countries. There is an obvious cost burden of service delivery for mHealth programs, which poses a barrier to adoption in developing countries, where financial resources are limited (Mechael 2009). Technology leaders and health champions must increase global awareness of and garner financial support for otherwise cost prohibitive mHealth programs in developing countries to optimize the impact of these initiatives on global health equity.

While the utilization of mHealth technologies has been increasing globally for some time, the COVID-19 pandemic accelerated their use as healthcare systems around the world were suddenly forced to reduce face-to-face encounters in order to slow the spread of the virus. Consequently, the use of video conferencing and chat features in place of in-person interactions for providing care has become both a greater necessity and proof of technology-related opportunities for mHealth (Giansanti 2021). The movement of populations due to conflict also creates challenges for the provision of health services. The HERA app is an example of an mHealth solution that was applied to both issues. The app was designed for the Syrian refugee population and its use during the pandemic markedly improved health equity for this disadvantaged group by providing timely information on preventative measures, virus tracking, and testing site information (Narla et al. 2020). Technology as a tactic to address disparity gaps in health care has been beneficial for this community and demonstrates an opportunity for mHealth to advance health equity for other disadvantaged populations impacted by global instability arising from both disease and conflict.

Conclusion

Champions of global health equity can make a significant impact on countless lives through strengthening and supplementing the health systems in developing countries with mHealth initiatives. Often, this work is a collaboration between volunteers who have witnessed positive advancements in a healthcare setting and passionate citizens of the targeted region who eagerly learn new skills and techniques from the volunteers before implementing the new practices and teaching others in their community. The establishment of mobile tools that provide patients in rural settings with information on medical conditions and connection with healthcare providers through a mobile phone would address the barriers caused by the need to travel to and from distant healthcare facilities. Clinicians and community health workers in developing countries could substantially improve their network of resources, as telecommunications enables virtual collaboration with experts regardless of their physical location. This can assist in diminishing the inequity between healthcare in rural areas and healthcare in areas heavily populated with expert clinicians.

Political leaders, technology developers, and clinicians in developing countries can look at the models of successful technology implementation programs in similar communities to best determine how to minimize the disparities of healthcare access through the addition of technology programs in their respective countries. In the future, global health equity could become more likely if access to healthcare is improved and the knowledge of good health practices is increased, both of which are goals that can be accomplished through the addition of mHealth solutions in developing countries.

REFERENCES

Ahmed, T., Lucas, H., Khan, A. S., Islam, R., Bhuiya, A., and Iqbal, M. 2014. "Ehealth and Mhealth Initiatives in Bangladesh: A Scoping Study," *BMC Health Services Research* (14:1), p. 260.

Albabtain, A. F., AlMulhim, D. A., Yunus, F., and Househ, M. S. 2014. "The Role of Mobile Health in the Developing World: A Review of Current Knowledge and Future Trends," *Journal of Selected Areas in Health Informatics* (4:2), pp. 10-15.

Aranda-Jan, C. B., Mohutsiwa-Dibe, N., and Loukanova, S. 2014. "Systematic Review on What Works, What Does Not Work and Why of Implementation of Mobile Health (Mhealth) Projects in Africa," *BMC Public Health* (14:1), p. 188.

Asi, Y. M., and Williams, C. 2020. "Equality through Innovation: Promoting Women in the Workplace in Low-and Middle-Income Countries with Health Information Technology," *Journal of Social Issues* (76), pp. 721-743.

Beratarrechea, A., Lee, A. G., Willner, J. M., Jahangir, E., Ciapponi, A., and Rubinstein, A. 2013. "The Impact of Mobile Health Interventions on Chronic Disease Outcomes in Developing Countries: A Systematic Review," *Telemedicine and e-Health* (20:1), pp. 75-82.

Bloomfield, G. S., Vedanthan, R., Vasudevan, L., Kithei, A., Were, M., and Velazquez, E. J. 2014. "Mobile Health for Non-Communicable Diseases in Sub-Saharan Africa: A Systematic Review of the Literature and Strategic Framework for Research," *Globalization and Health* (10:1), p. 49.

Braun, R., Catalani, C., Wimbush, J., and Israelski, D. 2013. "Community Health Workers and Mobile Technology: A Systematic Review of the Literature," *PLOS ONE* (8:6), p. e65772.

Bull, S., and Ezeanochie, N. 2015. "From Foucault to Freire through Facebook: Toward an Integrated Theory of Mhealth," *Health Education & Behavior* (43:4), pp. 399-411.

Chellaiyan, V. G., Nirupama, A. Y., and Taneja, N. 2019. "Telemedicine in India: Where Do We Stand?," *Journal of Family Medicine and Primary Care* (8:6), pp. 1872-1876.

Chigona, W., Nyemba, M., and Metfula, A. 2013. "A Review on Mhealth Research in Developing Countries," *The Journal of Community Informatics* (9:2).

Déglise, C., Suggs, L. S., and Odermatt, P. 2012. "Sms for Disease Control in Developing Countries: A Systematic Review of Mobile Health Applications," *Journal of Telemedicine and Telecare* (18:5), pp. 273-281.

Farmer, P. 2005. "Global Health Champions." *RX for Survival*, from https://www.pbs.org/wgbh/rxforsurvival/series/champions/paul_farmer.html

Farmer, P., Frenk, J., Knaul, F. M., Shulman, L. N., Alleyne, G., Armstrong, L., Atun, R., Blayney, D., Chen, L., Feachem, R., Gospodarowicz, M., Gralow, J., Gupta, S., Langer, A., Lob-Levyt, J., Neal, C., Mbewu, A., Mired, D., Piot, P., Reddy, K. S., Sachs, J. D., Sarhan, M., and Seffrin, J. R. 2010. "Expansion of Cancer Care and Control in Countries of Low and Middle Income: A Call to Action," *The Lancet* (376:9747), pp. 1186-1193.

Fullman et al. 2018. "Measuring Performance on the Healthcare Access and Quality Index for 195 Countries and Territories and Selected Subnational Locations: A Systematic Analysis from the Global Burden of Disease Study 2016," *The Lancet* (391:10136), pp. 2236-2271.

Giansanti, D. 2021. "The Role of the Mhealth in the Fight against the Covid-19: Successes and Failures," *Healthcare* (9:1), p. 58.

Goel, S., Bhatnagar, N., Sharma, D., and Singh, A. 2013. "Bridging the Human Resource Gap in Primary Health Care Delivery Systems of Developing Countries with Mhealth: Narrative Literature Review," *JMIR Mhealth Uhealth* (1:2), p. e25.

Gurman, T. A., Rubin, S. E., and Roess, A. A. 2012. "Effectiveness of Mhealth Behavior Change Communication Interventions in Developing Countries: A Systematic Review of the Literature," *Journal of Health Communication* (17:sup1), pp. 82-104.

Hoekstra, H. J., Wobbes, T., Heineman, E., Haryono, S., Aryandono, T., and Balch, C. M. 2016. "Fighting Global Disparities in Cancer Care: A Surgical Oncology View," *Annals of Surgical Oncology* (23:7), pp. 2131-2136.

International Telecommunication Union. 2020. "Measuring Digital Development: Facts and Figures 2020," International Telecommunication Union, Switzerland.

Kahn, J. G., Yang, J. S., and Kahn, J. S. 2010. "'Mobile'health Needs and Opportunities in Developing Countries," *Health Affairs* (29:2), pp. 252-258.

Kaplan, W. A. 2006. "Can the Ubiquitous Power of Mobile Phones Be Used to Improve Health Outcomes in Developing Countries?," *Globalization and Health* (2:1), p. 9.

Karageorgos, G., Andreadis, I., Psychas, K., Mourkousis, G., Kiourti, A., Lazzi, G., and Nikita, K. S. 2019. "The Promise of Mobile Technologies for the Health Care System in the Developing World: A Systematic Review," *IEEE Reviews in Biomedical Engineering* (12), pp. 100-122.

Latif, S., Rana, R., Qadir, J., Ali, A., Imran, M. A., and Younis, M. S. 2017. "Mobile Health in the Developing World: Review of Literature and Lessons from a Case Study," *IEEE Access* (5), pp. 11540-11556.

Lee, S. H., Nurmatov, U. B., Nwaru, B. I., Mukherjee, M., Grant, L., and Pagliari, C. 2016. "Effectiveness of Mhealth Interventions for Maternal, Newborn and Child Health in Low- and Middle-Income Countries: Systematic Review and Meta-Analysis," *Journal of Global Health* (6:1), pp. 010401-010401.

Mancuso, A. B. 2021. "Implementation of Health-Related Smartphone Applications in Low-and Middle-Income Countries: Scoping Review and Learnings from the Childsafe Application in Malaysia." Johns Hopkins University.

Marshall, C., Lewis, D., and Whittaker, M. 2013. "Mhealth Technologies in Developing Countries: A Feasibility Assessment and a Proposed Framework." Herston, Australia: University of Queensland, pp. 1-47.

Mechael, P. N. 2009. "The Case for Mhealth in Developing Countries," *Innovations: Technology, Governance, Globalization* (4:1), pp. 103-118.

Moher, D., Liberati, A., Tetzlaff, J., and Altman, D. G. 2009. "Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The Prisma Statement," *Annals of Internal Medicine* (151:4), pp. 264-269.

Narla, N. P., Surmeli, A., and Kivlehan, S. M. 2020. "Agile Application of Digital Health Interventions During the Covid-19 Refugee Response," *Annals of Global Health* (86:1), pp. 135-135.

Njoroge, M., Zurovac, D., Ogara, E. A. A., Chuma, J., and Kirigia, D. 2017. "Assessing the Feasibility of Ehealth and Mhealth: A Systematic Review and Analysis of Initiatives Implemented in Kenya," *BMC Research Notes* (10:1), p. 90.

Noordam, A. C., Kuepper, B. M., Stekelenburg, J., and Milen, A. 2011. "Improvement of Maternal Health Services through the Use of Mobile Phones," *Tropical Medicine & International Health* (16:5), pp. 622-626.

Peiris, D., Praveen, D., Johnson, C., and Mogulluru, K. 2014. "Use of Mhealth Systems and Tools for Non-Communicable Diseases in Low- and Middle-Income Countries: A Systematic Review," *Journal of Cardiovascular Translational Research* (7:8), pp. 677-691.

Roser, M., and Ritchie, H. n.d. "Maternal Mortality." Retrieved 3/21/2021, from https://ourworldindata.org/maternal-mortality

Siliezar, J. 2019. "Bringing Women to the Forefront of Global Health," in: *The Harvard Gazette*. Harvard University.

Silver, L. 2019. "Smartphone Ownership Is Growing Rapidly around the World, but Not Always Equally," Pew Research Center.

Sirintrapun, S. J., and Lopez, A. M. 2018. "Telemedicine in Cancer Care," *American Society of Clinical Oncology Educational Book*:38), pp. 540-545.

Sundin, P., Callan, J., and Mehta, K. 2016. "Why Do Entrepreneurial Mhealth Ventures in the Developing World Fail to Scale?," *Journal of Medical Engineering & Technology* (40:7-8), pp. 444-457.

Tamrat, T., and Kachnowski, S. 2012. "Special Delivery: An Analysis of Mhealth in Maternal and Newborn Health Programs and Their Outcomes around the World," *Maternal and Child Health Journal* (16:5), pp. 1092-1101.

Taylor, K. 2015. "Connected Health: How Digital Technology Is Transforming Health and Social Care," Deloitte LLP.

Tomlinson, M., Rotheram-Borus, M. J., Swartz, L., and Tsai, A. C. 2013. "Scaling up Mhealth: Where Is the Evidence?," *PLoS Medicine* (10:2), p. e1001382.

Ugalmulge, S., and Swain, R. 2019. "Mhealth Market Size Statistics." Retrieved 03/04/2021, from https://www.gminsights.com/industry-analysis/mhealth-market

United Nations Department of Economic Social Affairs. 2021. *World Economic Situation and Prospects 2021*. United Nations.

Wall, P. J., Lewis, D., and Hederman, L. 2019. "Identifying Generative Mechanisms in a Mobile Health (Mhealth) Project in Sierra Leone: A Critical Realist Framework for Retroduction," *Information and Communication Technologies for Development. Strengthening Southern-Driven Cooperation as a Catalyst for ICT4D,* P. Nielsen and H.C. Kimaro (eds.), Cham: Springer International Publishing, pp. 39-48.

White, A., Thomas, D. S. K., Ezeanochie, N., and Bull, S. 2016. "Health Worker Mhealth Utilization: A Systematic Review," *Computers, Informatics, Nursing : CIN* (34:5), pp. 206-213.

Wigginton, C., Curran, M., and Brodeur, C. 2017. "Global Mobile Consumer Trends, 2nd Edition," Deloitte.

World Health Organization. 2011. "Mhealth: New Horizons for Health through Mobile Technologies," World Health Organization, Switzerland.