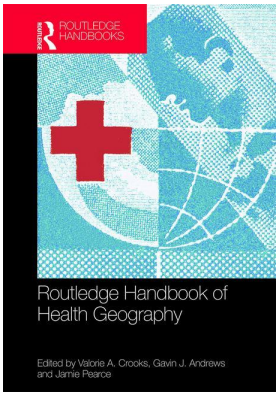

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mHEALTH GEOGRAPHIES
Mobile technologies and health in the Global South

Jonathan Cinnamon and Charlene Ronquillo

The rapid expansion of mobile networks has revolutionized communications worldwide, yet mobile telephony is also having significant effects across a range of issues including education, politics, entertainment, and finance (Steinhubl, Muse and Topol, 2015). This chapter explores one of these effects: the use of mobile technologies in health. Mobility is a fundamentally geographic concept, and thus mobile health (mHealth) is an area that health geographers have and continue to examine.

mHealth refers to the use of wireless and mobile technologies in health and health care and includes a diverse range of activities such as health-information hotlines, telemediated patient care, personal mobile health apps and mobile-health surveillance. mHealth is undertaken actively, by people using all types of mobile phones (basic, feature and smartphones), personal digital assistants (PDAs) and tablet computers, as well as passively, using automated mobile sensing technologies. Whether produced actively by people or passively by sensors, at the core of mHealth is the collection and transfer of digital data; this could be a patient's vital sign information, survey data pertaining to a disease outbreak or simply digital voice or text message data transferred from a rural patient to a medical professional in an urban hospital. Modern digital mobile communication networks are thus central to mHealth, enabling the transfer of data in near real-time over vast distances; however, technologies enabling more local data transfer, such as Wi-Fi, Bluetooth and Near Field Communications (NFC), are also increasingly central to mHealth architectures.

Global interest in mHealth stems from the rapidly increasing availability of mobile technologies and networks, with estimates suggesting that 75% of the world's population will have a mobile phone by 2020 (5.7 billion unique subscribers, and 10 billion total mobile connections) (GSMA, 2017). The decreasing costs and increasing functionality of mobile technologies have captured the attention of the scientific community, governments and health systems, resulting in significant investment of resources into mHealth solutions. Owing to its core characteristics of mobility and portability, mHealth can expand the reach of health-care services to previously underserved populations, including those in rural and remote regions, representing an important step toward universal health coverage, a key goal of the global health agenda (Mehl and Labrique, 2014). Although the evidence is still thin, mHealth is also pursued to meet the objectives of reducing health-care costs (Betjeman, Soghoian and Foran, 2013), influencing positive health behaviors (Gurman, Rubin and Roess, 2012) and improving patient outcomes through more rapid diagnosis of illness and better adherence to treatment regimens (Hamine et al., 2015). Additionally, emerging reasons for attention to mHealth include its potential empowerment of health-care providers, communities and individuals, and the introduction of innovative health-service delivery models that leverage underused resources – for instance, by engaging lay and non-professional health workers and patients (Thondoo et al., 2015).

Across all world regions, people have more access to mobile phones than they do to basic necessities such as toilets and safe drinking water (World Bank, 2013). Growth in mobile-phone ownership presents an important opportunity for the Global South, given their ubiquity in many less-developed settings. Situated within the broader context of limited existing health-care services, mHealth presents the potential to *leapfrog* entrenched health practices and opportunities to develop new ways of delivering health care, with less-developed markets recognized as the key drivers of mHealth (PwC, 2014). Although recent developments in mobile internet and sensor technologies significantly increase the possibilities for mHealth, smartphones are still rare in many less-developed settings, a reality that is tempering some of the enthusiasm regarding mHealth in the Global South. In less-developed settings, many of the more advanced forms of mHealth are currently out of reach, and so, as always, the development of mHealth as a global health agenda must be sensitive to local contexts.

This chapter aims at advancing a contextually sensitive perspective on mHealth in the Global South. Following a review of mHealth in health geography and a call for more empirical and conceptual attention to the field by geographers, the main section of the chapter explores the recent developments around using two-way SMS (short message service, text messaging) platforms in health research and practice in the Global South, as an increasingly ubiquitous and low-cost data-transfer technology available on all mobile phones. The chapter then concludes with a brief discussion of the challenges and future prospects of mHealth, focusing specifically on the need for health geographers to contribute to this global discussion.

mHealth and health geography

mHealth consists of a broad and expanding range of activities and practices deployed for a variety of purposes. As part of the World Health Organization (WHO) Global Observatory for eHealth's (2011) second global survey on electronic health technologies, mHealth was explored for the first time as a sub-focus of eHealth. The resulting report identified 14 types of mHealth *services* within six broader categories of *activities* being undertaken: communication between individuals and health services, communication between health services and individuals, consultation between health care professionals, intersectoral communication in emergencies, health monitoring and surveillance and access to information for health-care professionals at point of care. Based on a meta-analysis of mHealth literature, Olla and Shimskey (2015) developed a taxonomy to specify the overarching *purpose* of various mHealth applications, based on eight categories of *end-uses*: point of care diagnostics, patient monitoring, wellness, compliance, education and reference, behavior modification, efficiency and productivity and environmental monitoring. Given the disparate collection of mHealth practices to date, classification activities represent an attempt to bring clarity, recognizing that further conceptual attention is needed to understand the complexities of mHealth technologies and applications. However, such attempts at discrete classifications may be of limited utility; the continual advancement of mobile technology and the diverse ways it is intervening in a wide range of health and well-being practices make it clear that mHealth represents a moving target.

Taxonomic impulses of medical science notwithstanding, mHealth as a field remains under-developed theoretically and conceptually, and it can benefit considerably by a more thoroughgoing engagement with the social sciences. Geographic concepts are often invoked in mHealth, often with little explanation, and perhaps as an assumed normative aim. For instance, *overcoming geographical distance and barriers* is a central trope (e.g., Steinhubl, Muse and Topol, 2015); indeed, it was deployed as an organizing concept in the WHO's (2011) path-breaking report on mHealth, subtitled *New Horizons for Health through Mobile Technologies*. Health geographers are well-placed to conceptualize the dimensions and concerns of mHealth, given the decades of attention in geography to interrogating concepts such as distance and its social and ethical implications. For instance, human geographers have fruitfully developed a spatial dimension to understandings of *care ethics* (e.g., Lawson, 2007) – a specifically relational approach to moral actions based on mutuality and reciprocity – and have applied it to consider the ethical responsibilities of local and global actions and caring-at-a-distance.

Achieving health equity is ostensibly a core aim of mHealth programs, which aim to overcome geographic barriers to care access, and it is conceivable how this spatially explicit conceptualization of care ethics can be useful here. Indeed, concepts central to contemporary human geography that have been applied to understand developments in information and communication technologies (ICT) – for example, space-time, scale, networks and mobilities – can also be productively deployed to advance mHealth.

It is perhaps surprising that mHealth appears to be an underexplored research topic in health geography. A search of the leading health-geography journals is potentially revealing: the term "mHealth" has never been printed in the pages of *Health & Place* (a top health-geography journal) and has been only briefly referred to in a single article in the *International Journal of Health Geographics* (a leading technology-focused health-geography journal). The interdisciplinary journal and frequent venue for health-geographic research *Social Science & Medicine* does show some interest in mHealth (~10 articles) in the broader social sciences. However, overall it appears that the term is primarily deployed in the health and medical sciences. The lack of attention to the term does belie a substantial amount of research at the intersection of health geography and mobile technologies, which broadly fits the mHealth purview, if not specifically identified as such.

A key area of mHealth research geographers are engaging with is the distributed collection of disease surveillance data using mobile phone–based data-collection platforms (e.g., Robertson et al., 2010; Cinnamon, Jones and Adger, 2016). Another important research theme is the use of passive mobile sensor technologies to collect environmental-exposure data. Geographers have long been interested in the concept of *activity spaces* (Golledge and Stimson, 1997), the areas of influence on our daily lives often bounded by the places in which we live, work, shop and take leisure. Mobile technologies are enabling significant advances in measuring activity spaces and therefore more geographically accurate collection of data on, for example, exposures to toxins and pollutants (Steinle, Reis and Sabel, 2013), unhealthy food (Sadler and Gilliland, 2015), substances such as tobacco and drugs (Lipperman-Kreda et al., 2015; Mason et al., 2015) and urban social and environmental exposures in children (Loebach and Gilliland, 2016). This area of research is advancing our understanding of *salutogenic* exposures: contact with spaces that are therapeutic or health-promoting (Bell et al., 2015). Geographers have also contributed to a growing body of research on the use of location and movement sensors (e.g., GPS, accelerometer, gyroscope) embedded in wearable technologies or smartphones to record and analyze participants' physical activity and mobility (Barratt, 2017; Jestico, Nelson and Winters, 2016). Similarly, geographers are researching how mobile apps are used for personal monitoring, fitness and self-care activities as part of the *quantified self* movement (Boulos and Yang, 2013). There has been some research by geographers on mobile technologies in health-care settings, such as mobile point-of-care platforms for managing patient data in hospitals (Zargaran et al., 2014). Overall, however, geographers have focused more on the health rather than the health-care side of mHealth.

mHealth in the Global South using SMS technologies

mHealth in the Global South is frequently considered within the broader field of information and communication technologies for development (ICT4D), a field with considerable geographical influence (e.g., Kleine and Unwin, 2009). Research and practice in this domain focuses on the use of ICTs to improve opportunities and living conditions in less-developed settings, with particular focus on business, governance, health and education (Hilbert, 2012). Positioning mHealth as part of a more established ICT4D project enables mHealth initiatives to learn from its well-developed knowledge base. This is not wholly unproblematic, however. Despite the clear linkages between economic development and health, the overall objectives of *growth* and *progress* that underpin development, and therefore ICT4D (Unwin, 2009), are not always the best route to health improvement; thus, care should be taken in drawing on ICT4D experiences and frameworks to plan and evaluate mHealth projects.

SMS is a simple and highly limited format for data exchange, restricted to 160 characters. Yet in its simplicity lies its significant potential for improving public-health research and practice in the Global South.

SMS messages can be sent and received between any mobile phones, including basic and feature phones most common in the Global South, and between computers and phones. Messages can be either personally tailored for a single recipient or sent out in bulk to all or a targeted subset of mobile users. It is a largely stable and reliable means of data transfer, enabling instant communications between distributed parties anywhere that mobile networks reach, often working even in emergency situations when networks can be too overloaded to connect mobile-phone calls (Revere, Schwartz and Baseman, 2014). It is also a very-low-cost means of communication; mobile customers typically receive messages at no cost and can send them for very little. For the mobile network operators (MNOs), routing SMS messages over the network is very low-cost – estimated at US$0.03 per message in 2009 (Keshav, 2009). As such, there is considerable potential to partner with MNOs to enable free messaging for senders and receivers in mHealth initiatives, especially given the desire of many mobile operators to engage in corporate social responsibility activities – as demonstrated, for example, by the Safaricom Foundation from the leading mobile operator in Kenya (http://safaricomfoundation.org/).

The use of SMS in mHealth initiatives is relatively well documented, especially in the Global North, where text messaging has been used since the 1990s to communicate directly with health-care patients or the general public. A common goal of these programs has been to modify individual health behaviors through regular interaction with health information and advice. For instance, Franklin et al. (2003) describe an SMS initiative that sent targeted messages and general information to young people with type 1 diabetes, with the aim of increasing adherence to intensive insulin regimens. A similar study focusing on follow-up care for bulimia nervosa patients found that the system was effective in providing support to patients who had completed inpatient treatment but still required ongoing monitoring (Bauer et al., 2003). Although these early uses of SMS have been promising, many examples are small-scale pilot initiatives requiring significant human resources to undertake – especially if targeted or responsive messaging is used – which has limited the potential for scaling up.

There has been some progress toward larger-scale mHealth SMS projects that engage a wider population. They are, however, often quite rudimentary in scope, often used only as a platform for distributing generic health information in settings or with groups that lack widespread access to traditional media. Bangladesh has exploited its high mobile-penetration rate (even in rural areas) to undertake SMS health campaigns targeting the entire (mobile) population. The country's government has used SMS to send alerts and information about national immunization day and breastfeeding week and reported wide acceptance, although their ability to evaluate the program for effectiveness (e.g., in influencing individual health-seeking behaviors) is limited (Khatun et al., 2015). The MAMA (Mobile Alliance for Maternal Action) and MomConnect initiatives in South Africa have used SMS as part of a multichannel strategy to communicate directly with expectant and new mothers. SMS has been an especially important channel in South Africa, a country that has high rates of maternal death in younger women and higher mobile-phone penetration than that of radio and television (Bateman, 2014). The South African government received a 50% discount on SMS messaging costs from the country's MNOs (Bateman, 2014); cost will hopefully be an uncommon deterrent in the future, as more substantial discounts or free messaging should be possible, given the negligible cost to operators.

The potential for scaled-up SMS mHealth initiatives has significantly advanced in recent years, due to the development of computer-based software platforms for creating and operating custom automated SMS messaging services. Platforms such as Frontline SMS (www.frontlinesms.com) and the UNICEF-developed RapidPro SMS (https://community.rapidpro.io) are being used across the Global South by organizations engaging in ICT4D activities. A key advantage here is the ability of these systems to enable automated *two-way conversations*, compared to earlier uses of SMS in these contexts largely based on *one-way information sharing*. In these two-way SMS systems, not only information but also questions can be sent out to mobile-phone users. If receivers respond to the prompt, the answer is recorded in a database on the host computer/website. Depending on the response, the SMS software can trigger further, customized questions (see Figure 40.1). The simple ability to answer an automated message means that anyone with a mobile phone – any health

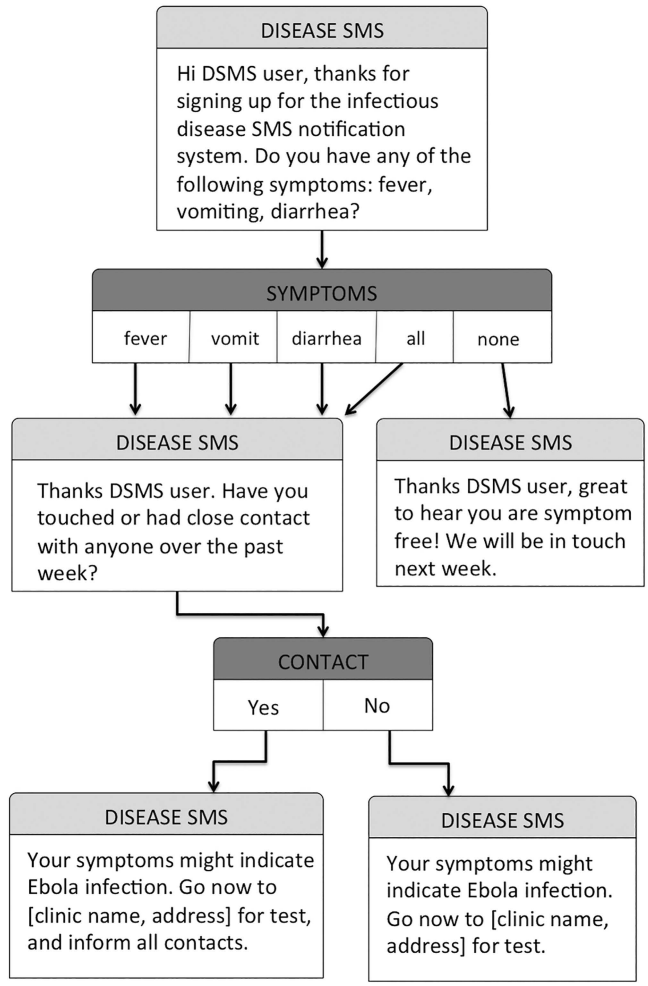

Figure 40.1 An example of SMS two-way conversation architecture

professional, civic official or member of the public – in any part of the country can contribute real-time information on any health issue. The potential is almost limitless. In particular, these developments can enable much more rapid and effective surveillance of health conditions, information on the social and environmental determinants of health and monitoring of health resources and infrastructure.

A particularly promising application of two-way SMS is its use for health surveillance during emergencies. Cinnamon, Jones and Adger (2016) conducted a study to ascertain how two-way SMS systems can be used to enhance informational awareness in the management of communicable-disease outbreaks. Results highlighted the significant potential to enable near-real-time surveillance of disease cases via automated SMS-based surveys directed to health professionals or emergency responders in remote outbreak zones underserved by other communications or transportation links, as was the case in parts of West Africa during the 2013–2015 Ebola outbreak.

Connecting directly with the public via SMS may stop outbreaks before they happen. *Syndromic surveillance* efforts aim to enable early prediction of outbreaks by accessing various data sources that pertain to

disease symptoms – everything from Web searches to school/work absentee records, medication sales and weather data (Mandl et al., 2004). Drawing on citizen science and crowdsourcing approaches, two-way SMS systems can also be a source of actively produced syndromic data for identifying new locations and populations to target with prevention resources. The EbolaTracks SMS system (Tracey et al., 2015), while only a proof of concept and undertaken in a developed-country setting (Australia), illustrates the potential use of a basic two-way SMS system for direct symptom monitoring and triage for individuals potentially infected with a communicable disease. Developed during the recent Ebola outbreak, the system was pilot-tested with participants returning to Australia from Ebola-affected countries in West Africa. Participants were provided with a mobile phone and digital thermometer. They were told to take their temperature twice daily for 21 days (maximum Ebola incubation period) and respond via SMS with the reading and any noted symptoms. High readings triggered SMS questions to participants, and then, if there was no response, an SMS and email alert were sent to an on-call medical officer, who would contact and follow up with participants to assess their condition. This type of mHealth application is potentially invasive; however, restrictive control measures are often necessary under conditions of highly contagious disease outbreaks (see also Koch, 2016) and are perhaps more appealing than the alternative of quarantine.

In addition to the use of two-way SMS to collect public health surveillance data, it can also be used to share up-to-date information on health protocols, resources and infrastructure to enhance the functioning of the health-care system itself. A project undertaken in two remote regions of Malawi enrolled 77% of its community health workers (CHWs) in a two-way SMS information sharing and reporting system, which replaced less-effective methods that included sending messages via ambulance or using the radio for one-way communications (Lemay et al., 2012). District health managers used the system to send out messages advising CHWs of available resources, training opportunities and changes in protocol, while the CHWs used the system to ask specific medical questions, to report resource requirements and to organize patient referrals and transfers. Through such a system, there is the potential to better leverage non- and para-professional health-care workers, a vital but often underused health-system resource in the Global South. The key premise of equipping these workers with mHealth lies in its potential to function as additional health-system infrastructure and open the possibility for *task shifting* of health-care tasks and responsibilities traditionally held by professional or specialized health-care providers, which can enable health workers with limited training to receive support and expand their scope of work.

Conclusions: optimism for the future of mHealth

mHealth is still a relatively new field; its relevance and scope are still evolving, paralleling the dynamism of the mobile-technology sector itself. That said, mHealth is a mature enough field to be subject to significant critique. Figure 40.2 illustrates the phases that technologies often progress through over time, from initial introduction to eventual widespread productivity. mHealth consists of a dizzying array of technologies and application areas, and so its current position of technological progression is variable. In fact, few mHealth technologies are likely to have made it even to the *slope of enlightenment* stage of progression, despite some having a history reaching back to the 1990s.

Pilotism is a widespread problem, whereby mHealth technologies never emerge out of testing or are never scaled up. Indeed, as Andreassen, Kjekshus and Tjora (2015, p. 62) note after 20 years of work on ICT projects in health, "most projects remain projects." The ability to confirm health benefits of mHealth initiatives is limited, and so it is unclear whether initiatives improve clinical outcomes (Free et al., 2013), and there is little evidence confirming some of the grander ambitions of cost savings, progress toward universal health coverage and patient and care-worker empowerment. Indeed, some studies have documented negative impacts of mHealth introduction, such as increased costs (Ryan et al., 2012), which suggests that proponents must be wary of technological determinism. In fact, in some cases, initiating these so-called solutions sometimes just strips time and resources away from established health and medical practices (see Higgins, 2014).

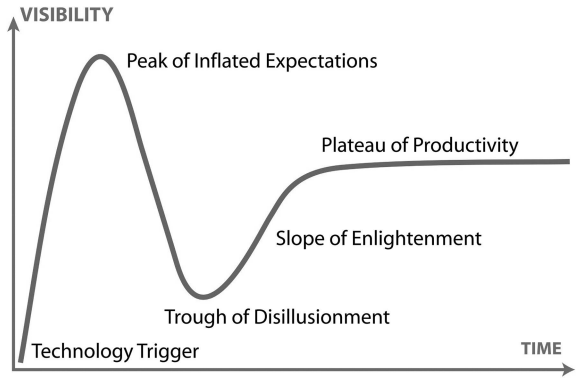

Figure 40.2 The technology cycle. This *cycle* describes a generalized pattern of five key stages that technologies often follow over time – from their introduction, to reaching peak hype, followed by a sharp decline in expectations and a slower return to productivity.

Creative commons licensed image from Wikimedia Commons, based on Gartner Hype Cycle (www.gartner.com).

Yet, there is space for optimism about the future of mHealth, especially when considering it as part of the broader social phenomenon of digital citizenship and research on digital lives. The intersection of health, society and technology is a key space in which for health geographers and other social scientists to make an important contribution. For instance, work by Hampshire et al. (2015, p. 97) documents how younger generations in sub-Saharan Africa are engaging in a "digitally-mediated form of therapeutic citizenship" in which they use their mobile phones in informal, but creative and strategic, ways to access health information and health care. As we progress toward an even greater recognition of the social and spatial conditions that shape health and health care, health geographers can and should be at the forefront of research on both the formal and the informal roles that mobile technologies play in health advancement around the world.

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