Using Mobile Technologies for Healthier Aging

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Acknowledgements

Introduction

Globally, there is a demographic transition underway. People are living longer. Even though "old" is defined differently across the world, there will be more people over the age of 65 than children under five by 2015.[1] By 2050, there will be an estimated 1.5B people age 65 or older.[2] Without strong preparation around prevention, treatment, and rehabilitation, the so-called "silver tsunami" will significantly increase the burden of global diseases associated with aging, notably for non-communicable diseases (NCDs), or chronic diseases such as cancer, diabetes, and cardiovascular diseases. The burden of disease will also include declining cognitive acuity and mental health without adequate preparation. Clearly, this situation creates urgent needs worldwide to extend access to health information, develop new and effective behavior change strategies, and expand access to appropriate health services. With the exponential spread and penetration of mobile phone coverage and access in even the most remote places, mHealth, or the use of mobile information and communication technologies for health, and related software applications offer unique opportunities. By advancing and accelerating innovative mHealth solutions for aging populations, the promise of greater longevity – additional active and productive years – is more likely to materialize.

Objective

The objective of this report is to provide momentum to an emerging conversation on ways mobile communications technology can help people age better and in good health. The report is mindful of the fact that different opportunities and challenges exist in low- and middle-income countries (LMICs) versus developed countries. At the same time, this report considers how mHealth innovations occurring in each are also instructive to one another. Many of the examples in this report are drawn from developed world contexts with a view towards how programs can be tailored for LMIC conditions. This report serves both as a resource and a call-to-action for all stakeholders including project implementers, organizations, the private sector, and policymakers.

Methods

This report was informed by a review of both white and gray literature on aging, chronic conditions, and the use of mobile technologies for health. New ideas and gaps in the existing knowledge base around mHealth and aging were also identified through primary and secondary research. Key informant interviews were conducted with experts in health, technology, and aging populations, as well as individuals with experience in the development and implementation of mHealth programs in countries around the world.

Findings and Conclusions

Research is prolific on aging issues and the base of analytical work around mHealth is growing, but coordination and sharing of lessons learned need improvement. There are several programs, only a few research initiatives, and even fewer trials that focus on the intersection of mHealth and age. Emerging evidence supports the use of mHealth to *promote efficiencies in care management practices and improvements in individual and population health outcomes* through behavior change strategies aimed at *increasing healthier behaviors* (e.g., exercise, appointment attendance, treatment compliance), *reducing unhealthy behaviors* (e.g., tobacco use), and *expanding access to care* for chronic disease management. Additionally, an mHealth for aging ecosystem is beginning to form that includes not only older people, but also others who are a part of an older person's life, including friends, family, caregivers, and healthcare providers. Strategic planning and stronger coordination across the fields of health, information technologies, and aging are necessary to ensure that the full potential of mobile and wireless technology for the improvement of preventive and supportive care for conditions associated with aging can be realized for older people, the fastest growing segment of the population worldwide. A call-to-action is made to catalyze a conversation among stakeholders and to identify areas that can be advanced today.

Globally, there is a demographic transition underway. People are living longer. Even though what is considered as "old" varies around the world, there will be more people over the age of 65 than children under five by 2015.[1a] By 2050, there will be an estimated 1.5B people age 65 or older, with some estimates much higher.[2] This growth is attributable to decreasing fertility rates and increasing life expectancies, which reflect tremendous successes in improving health and quality of lifeworldwide.

However, the impact of a demographic change of this magnitude presents an urgent and immediate challenge globally in health for governments, as well as private and not-for-profit sectors.[1] The extent of the challenge is particularly significant in low- and middle-income countries (LMICs), where the rapid rise in the number of older people far exceeds that of developed countries (See **Figure 1**).[1] Moreover, health systems in LMICs are not prepared to handle a rapidly aging population. In many cases, social safety nets such as social security are not in place.[1] Additionally, for many older people, costs and a lack of access to health services limit the services they receive.[1,2]

The objective of this report is to provide fresh momentum to an emerging conversation on ways mobile communications technology can help people age well. Mindful of the fact that many mHealth applications are occurring in the developed world context, the report also focuses on the opportunities and challenges in the LMIC context.

Figure 1: Number of people age 60 or over in developed and developing countries between 1950 and 2050
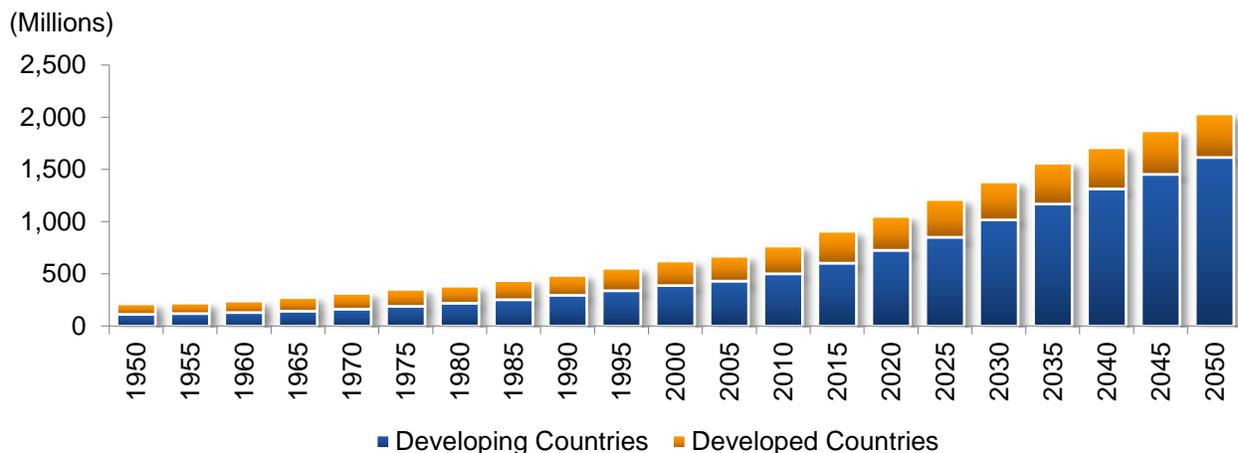
Source: UNFPA, 2012, p. 13.

Source: UNDESA, *World Population Ageing 2011*(2012; forthcoming), based on UNDESA Population Division medium projection scenario, *World Population Prospects: The 2010 Revision*.

Note: The group of "developed countries" corresponds to the "more developed regions" of the *World Population Prospects: The 2010 Revision*, and the group "developing countries" corresponds to the "less developed regions" of the same publication.

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[a] For this report, the term "older," "older people," or "elderly" will be used in reference to individuals age 60 and older. However, the term "older persons" is used by the United Nations, and "seniors" used in the United States in reference to people over age 60.

A Graying World

A Changing Health Landscape

Without strong global action around prevention, treatment, and rehabilitation, the so-called "silver tsunami" will significantly increase the global disease burden for non-communicable diseases (NCDs),or chronic diseases, such as cancer, diabetes, and cardiovascular diseases. The burden of disease will also include declining cognitive acuity and mental health. However, many of these conditions are preventable and can be avoided or mitigated with cost-effective solutions.[2]

Clearly, this situation creates an urgent need throughout the world to extend access to health information, develop new and effective behavior change strategies, and expand service access. The fact that people are living longer can be celebrated – it means advances in sanitation, hygiene, and medical innovation have reaped rewards in terms of years of life gained. The downside, however, is that some people are living longer in poor health, sometimes for a decade or more. In fact, economic losses in LMICs from heart disease, stroke, and diabetes are expected to total US$83B accumulated between 2006 and 2015.[2] Thus, the challenge is to adapt to the changing landscape as quickly as possible by strategically planning for the shifting healthcare needs.

Fortunately, during this demographic transition, another massive global trend is underway: *the mobile phone revolution,* or the exponential spread and penetration of mobile phone coverage and access in even the most remote areas. This year, mobile phone subscriptions have surpassed the 6B on mark for the world's population of 7B.[3] In a survey of older people in 36 countries including many LMICs, 61% of older people had access to a mobile phone in 2011.[1] This trend offers society a unique opportunity to develop and capitalize on options that can accelerate innovative solutions to not only extend life but to add healthy and productive years while simultaneously tackling the growing tide of health issues associated with aging.

The promise of **mHealth** – the use of mobile information and communication technology and applications for health – is the ability to assist in preventing the onset of debilitating, chronic diseases associated with age and also to assist in the management and treatment of existing conditions toward a society of citizens who are more productive, functional, and healthier.

Fact Check: Non-Communicable Diseases

- In 2008, NCDs alone accounted for approximately 86% of the disease burden in high-income countries, 65% in middle-income countries, and 37% in low-income countries

- While NCDs are proportionally more prevalent compared to communicable diseases in high-income countries, 90% of NCD deaths worldwide occur in LMICs

- In LMICs, where many older people are unlikely to have access to healthcare, chronic conditions often go undiagnosed because they are asymptomatic in early stages

- Advanced chronic conditions will increase the strain on existing health systems already suffering from critical health worker shortages, supply chain failures, and inefficiencies at the facility level

- In LMICs, economic losses from heart disease, stroke, and diabetes are expected to total US$83B accumulated between 2006 and 2015

- Treatment for chronic diseases cost US$3.5T across OECD and BRIC countries in 2007

Source:National Institute on Aging, 2011.

Fact Check: Mobile Phones

- In 2012, there are over 6B mobile phone subscriptions for a world population of over 7B

- A survey of older people in 36 countries, including many LMICs, 61% of older people had access to a mobile phone in 2011

- In 2007, using mobile tools and services could have saved a total of US$175 to $210B on chronic disease treatment

Source: UNFPA, 2012; McKinsey & Company, & the GSM Association, 2010.

In 2007, where treatment for chronic diseases cost US$3.5T across OECD[b]and BRIC[c]countries, the use of mobile tools and services had a cost-saving potential of between US$175B and $210B.[4]

Even on mobile phones with less sophisticated features, which are more prevalent today in LMICs, the potential of voice- and text-based applications for age-related issues can provide valuable mHealth services in the form of education, data collection, and two-way communication between patients or caregivers and healthcare providers. As broadband and smartphones become more accessible around the world, refined and secure mHealth applications can offer more solutions in the form of remote diagnostics and monitoring, expert consultation, and health records management.[5]

But are the advances in mobile phone use disproportionately benefitting younger populations? Are incentives in place to encourage the use of mobile phones to advance healthy aging among young, but aging, cohorts? What is being done to increase mobile phone saturation and know-how among older populations?

Already numerous efforts by government agencies and civil society organizations have begun to take advantage of the increasing affordability, ease of use, and ubiquity of mobile phones to implement a wide range of projects and products that enhance the delivery of health interventions. Despite these innovations, the US$175B to $210 billion dollars in savings has yet to occur for chronic diseases, and it will not until more investment is made in containing costs in healthcare across the world through mobile technology. This report serves as a call-to-action to spur the decisions and actions necessary to begin utilizing mobile phones to their full potential in aging, particularly for NCDs. With the parallel trends of a rapidly expanding older population and increasing mobile telephony, the opportunity is too good to pass up.

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[b] There are 34 countries that are members of the Organisation for Economic Co-operation and Development.
[c] Brazil, Russia, India, and China

For aging populations, mHealth holds promise for improving health, enabling greater independence, and transforming the ecosystem of traditional healthcare delivery through potentially cost-effective mechanisms, whether it be a simple text-based program or an advanced mobile application. Certain mechanisms focus on prevention for those who are healthy or in manageable stages of their conditions (e.g., screening, early treatment, behavior modification). Others serve those at advanced stages of illnesses (e.g., access to care, improved quality of care, adherence to care regimens, and caregiver support). Across prevention and care, solutions provided by mHealth generally fall into three broad categories:

- **Education** – equipping individuals with easier access to validated health information
- **Motivation** – encouraging individuals to adhere to treatment regimens and attend appointments through messages and reminders
- **Connectivity** – creating new and strengthening existing communication channels, particularly between caregivers and older people; improving monitoring; and strengthening interventions

In general, mHealth solutions leverage mobile phone features such as text or voice messages, which can be educational or motivational for the patient. At the same time, these features can improve connectivity. Chronic conditions benefit from near real-time monitoring of blood pressure, heart rate, and changes in cholesterol levels. End users of mHealth solutions include older individuals, healthcare providers, caregivers, and families, which create a seamless mobile ecosystem to enable a more functional andproductive lifestyle. Emerging evidence supports the use of mHealth *to promote efficiencies in care management practices and improvements in individual and population health outcomes* through behavior change strategies aimed at *increasing healthier behaviors* (e.g., exercise, appointment attendance, treatment compliance), reducing unhealthy behaviors (e.g., tobacco consumption), and *expanding access to care* for chronic disease management. In addition, the ability to link mobile devices to software applications and information hardware systems extends options for disease monitoring and surveillance, and medical record updates.

The tremendous potential of mobile phones to promote wellness by enabling the individual to manage, maintain, and improve his or her own health is relevant for individuals at any age because, in fact, we are all getting older. Despite the promise, however, society is far from benefiting from the full potential of mHealth for aging.

The Beginning of a Mobile Ecosystem for Aging

In the past decade and through the increasing ubiquity of mobile phones, communities have emerged – for example groups of individuals responsible for caring for a friend or family member. Such informal groups connect with healthcare and service providers, forming a virtual network of support. Although not yet seamless, this "mHealth ecosystem" capitalizes on the ability of mobile phones to address four major areas (See **Figure 2**).

Figure 2: Four areas that mobile phones can address in the mHealth ecosystem

Reduce the Delay in Seeking Care	Increase Healthcare Access	Improve the Patient-Provider Interaction	Develop Aging-Friendly Health Services
Bring attention and care to the present moment or near real-time, which encourages more proactive (and less reactive) attitudes for health promotion	Extend healthcare beyond health facilities into the community and households, where wellness maintenance and management of chronic conditions	Turn short, discrete doctor visits at a facility, where providers ask patients to recall past events, to more frequent, small events in a larger ecosystem,	Broaden healthcare to respond to chronic conditions and not merely injuries, infections, and emergencies

Within the forming mobile ecosystem, there are three main types of end users that applications are focusing on: (1) older individuals, (2) caregivers, and (3) providers (See **Figure 3**).

Figure 3: The mHealth ecosystem surrounding healthier aging includes older people, their caregivers and family members, as well as health providers.

- **Health Providers**
  - mHealth programs can take advantage of health providers' pivotal and respected role in providing healthcare monitoring and information. However, this may not be feasible in all settings. The United Nations Population Fund (UNFPA) *Ageing in the Twenty-First Century* report mentions that some older people "often experienced the attitudes or lack of expertise of [healthcare] professionals as barriers to accessing adequate [healthcare]."[7] This was not reported for older individuals interviewed from Northern and Western Europe or Canada. Thus, using a thorough understanding of existing health system dynamics, the relationship between older individuals and providers, and the perceptions of older individuals on receiving health services, are necessary to inform an mHealth aging program before selecting providers as end users.

- **Caregiversand Family**
  - Some older people may be affected by conditions that influence their ability to easily interact with mobile phones, such as impaired hearing or dementia. Consequently, mHealth interventions that are focused on helping caregivers and family members could be valuable. For example, a community of friends and family of an older individual can use a mobile phone application to help maintain a schedule of caregiving activities.

- **Older People**
  - A recent New York Times article articulated one of the barriers to the uptake of mHealth in the older community: "What's Wi-Fi and Do I Really Need a Smartphone?" The article described how many older adults feel fearful or anxious about technology, or embarrassed about their lack of understanding.6 Over time, individuals already comfortable and accustomed to having mobile technologies in their hands will surpass one of the arbitrary thresholds by which society considers them "old." Characteristics of the older population will change, for example, as the Baby Boomer generation in the developed world surpasses age 65. However, there is still a large portion of the current older population that is resistant to using mobile technology for a variety of reasons. Understanding the perceptions of older individuals regarding technology will be critical for adoption to increase.

Existing mHealth Strategies and Opportunities for Healthier Aging

The Broad Landscape of mHealth for Active and Healthy Aging

Some examples of mHealth applications are drawn from developed countries such as home monitoring, advances in social inclusion, smart homes, and sophisticated health technologies. In these cases, broader lessons can be learned that may be applicable to populations with limited resources. mHealth solutions in LMICs have been extracted from other health fields including HIV/AIDS and maternal and child morbidity and mortality and applied to the context of aging. For example, basic texting platforms, such as Text4Baby in the U.S., send text message with reminders and information to women during pregnancy and to new mothers regarding newborn care and health.[6] The same program can be tailored for an older population also at high risk for preventable diseases.

To confront challenges in aging, the broad landscape of mHealth is developing projects and applications aimed at:

- Increasing efficiency and coordination among caregivers through electronic health recordkeeping

- Increasing physical, social, and cognitive stimulation

- Improving health and living conditions, particularly for women who have longer life expectancies and may have lost a spouse, through income generation activities and health services

- Improving health and living conditions for grandparents who may be raising grandchildren by providing support (e.g., in the case where middle-aged family members are moving to the cities and the older generation remain in rural settings to raise grandchildren or continue with family farms)

- Expanding access to emergency services with systems that can receive emergency calls and arrange transportation to providers or other parts of formal health systems

- Providing at-home support and health services to older individuals by connecting them with caregivers

- Expanding health services to remote or rural areas through teleconsultation services or hotlines, where older individuals can reach providers or community health workers can reach older people with appropriate medicine and point-of-care applications uploaded to mobile phones (e.g., applications to do routine monitoring, procedures to identify advanced illnesses, measurements of vitals and degree of frailty, and mental health assessments)

The following sections further detail prevention and supporting behavior change, NCDs, and cognitive decline and mental health in the context of aging.

Prevention and Supporting Behavior Change

Prevention plays a large role in healthy aging. By focusing on decreasing unhealthy behaviors such as smoking or increasing healthy behaviors, such as staying fit and taking actions to avoid getting sick, mHealth can help improve the quality of life of older people so that they can continue supporting their families and communities.[1, 7] Text messaging and one-on-one calls are examples of the way mobile phones are being used to improve lives by (1) helping people become better informed, motivated, and encouraged to practice self-management of their own health; (2) improving patient satisfaction levels; (3) offering more tailored and targeted interventions; and (4) improving patient-provider relationships.5 In short, solutions facilitate education, motivation, and connectivity. These techniques can be applied to a number of prevention initiatives, such as weight loss, physical activity promotion, and blood pressure management.

Behavior change is crucial for optimizing services and maximizing the impact of cost-effective prevention, care, and treatment.[8] Mobile behavior change communication (mBCC) includes such tools as electronic reminders to take medications and quizzes to improve the skillsets of healthcare providers.

Existing mHealth Strategies and Opportunities for Healthier Aging

Tobacco Use

One example of how mHealth can support behavior change is mHealth for tobacco usage cessation. Smoking and tobacco use are common risk factors for cancer. Smoking also contributes to other NCDs such as chronic lung disease and cardiovascular disease.[9] It further accelerates a common concern of many older people – premature wrinkling. Although current evidence about the use of mHealth for tobacco use cessation is largely derived from developed world contexts, lessons learned may be applied in LMICs. Two studies – one conducted in New Zealand and the other in the United Kingdom – have found that individuals receiving personalized and motivational text messages were more likely to quit smoking.[10,11] Another study that evaluated a smoking cessation intervention that utilized email, webpages, interactive voice response, and text messages found that individuals receiving the intervention were significantly more likely to quit (22.3% vs. 13.1%).[12] In these types of studies, individuals were asked to set a specific quit date at enrollment, and behavior change models were used to inform the design of text message content.[13,14]

Non-Communicable Diseases

While some mHealth solutions focus on behavior change to mitigate risk factors, others are aimed at treatment for NCDs and adherence to curative or palliative therapies. In many cases, older people suffer from multiple chronic conditions.[9] This is a critical consideration for mHealth application developers; the complexity of using multiple apps for different diseases could inhibit uptake among older people (See **Figure 4**).

Ease-of-use will be a critical factor in ensuring that mHealth solutions are successful in addressing chronic conditions in environments outside of the traditional healthcare system. Since it is difficult for many patients with chronic conditions to travel to health clinics, or for these patients to keep track of their health information and trends using paper-based logbooks, mHealth provides real-time, analyzable options that can both empower patients and feed statistics into provider information systems.

Figure 4: Prevention and control for non-communicable diseases[15,16]
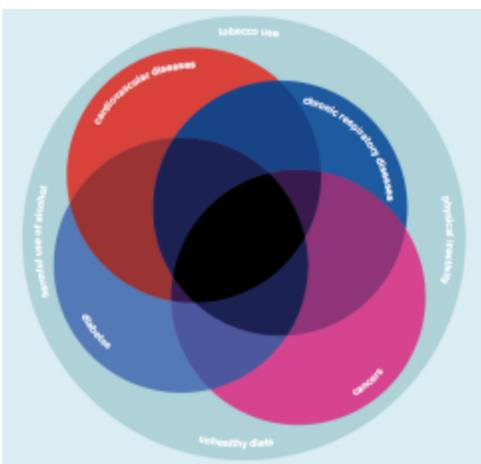
In developed countries, a great portion of mHealth interventions for NCDs involves wearable sensors that can monitor NCD-related measurements and informative vital signs, which will eventually become embedded sensors in the not-so-distant future. Although wearable sensors may not be as applicable in LMICs, the agility of mHealth technology is present in that it can help influence positive behavior changes over time for subtle nudges towards aging well, provide timely information and access to care, connect older persons in a larger health and social ecosystem, and inform health providers on aggregated population indicators and trends with location-based data.

Sources: WHO 2012; WHO 2008.

Education

To further address education and information dissemination, mHealth projects targeting cardiovascular health and prevention of cardiovascular diseases (CVDs)[d], such as the "Use of Mobile Technology to Prevent Progression of Pre-Hypertension in Latin American Urban Settings" trial, are gaining momentum throughout the world.[17] This program is utilizing text messages and phone calls to promote lifestyle modification focused on reducing blood pressure in Argentina, Guatemala, and Peru.

MediNet is another tool that is used to create personalized recommendations for individuals with high blood pressure.[18] In this system, the patient is hooked up to at-home glucose and blood pressure monitoring sensors that transmit readings to a mobile phone with a USB or Bluetooth connection custom built for the user's phone. The patient is guided through a series of lifestyle and exercise questions, and both the individual's responses and the sensor readings are analyzed in the system using electronic reasoning, returning a personalized response to the patient. MediNet's effectiveness has not been reported, but the developers have mentioned their intentions to develop a low-cost version of the system for economically-disadvantaged individuals living in countries in the Caribbean.[18]

Motivation

Several mHealth applications focus on motivating individuals in terms of behaviors and patient self-management to improve health outcomes. One example is a mobile coaching option for individuals with type-2 diabetes, with which they are able to enter blood glucose values, carbohydrate intake, medication, and other information on their mobile handsets and then receive automated messages specific to their data.[19] Algorithms are used to send patients both educational and motivational messages, and patients are encouraged to communicate electronically with educators.[19] Type-2 diabetics can also benefit from a mobile phone application that allows patients to take pictures of their food consumption, as an alternative to the traditional strategy of food journaling with pen and paper.[20]Other efforts to improve diabetes management have focused on reinforcing the provider-patient relationship with mobile phones.[21]

Connectivity

The enhanced ability for older people and their caregivers to engage with healthcare professionals remotely addresses a key challenge for the aging population. The connectivity provided by some mHealth solutions allows health workers to visit older people in their home and conduct routine screening and other basic evaluative procedures. For example, OScan is an easy-to-use mobile device that enables community health workers to screen for oral cancer using camera phones.[22] This technology was first tested in India, where there is one dentist for every 250,000 people. By taking pictures of suspected lesions, community health workers can quickly reach dentists and oral surgeons who are miles away for a diagnosis. Simple screening programs are particularly important in LMICs,where many cancer cases are presented to medical professionals at late stages because of a lack of prevention and treatment options.

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[d]CVDs are the number one cause of death globally and will increasingly affect the world's aging population (WHO 2008).

Because diabetic patients are sometimes required to take at-home vital and blood glucose level measurements, mobile phones offer the opportunity for the measurements to be collected and sent to a server via text messaging.[23] These data can then be monitored and the patient can either be sent a text message when they have forgotten to take measurements or if measurements are at risky levels.[24] Similar to diabetes, disease management for CVDs involves constant monitoring of pulse, blood pressure, and other vital information. Two solutions are a wearable sphygmomanometer and pulsimeter, whereby the former reminds an individual to measure his or her blood pressure and the latter to measure his or her pulse.[25] Both have wireless transmission abilities, which allow the information to be transmitted to servers accessible to doctors.[25] In all cases, these applications offer encouragement to patients to be more cognizant of their present health and provide opportunities to more quickly detect acute attacks or complications based on measurements as well as reaching out when help is needed with a simple phone call.

However, connectivity does not always directly link to healthier behavior change. In response to the challenges of being able to continue monitoring patients after they have left the doctor's office, a wireless monitoring system was developed in Italy for patients to transmit information regarding symptoms and quality of life to medical professionals.[26, 27] When piloted with 97 cancer patients, those who responded had very low levels of missing data; however, 42% of the individuals did not opt to take part, which suggests that adoption issues may hinder uptake of the system.[27] This is a reminder that mobile technology may not be familiar for everyone.

Cognitive Decline and Mental Health

Common cognitive decline and mental health disorders impacting aging populations include memory loss, depression, and dementia. None of these issues receive sufficient attention in LMICs, and co-morbidity is often poorly addressed.[1,28] Social isolation is a significant challenge facing older people, particularly women who tend to live longer than men in most societies, since it can have negative effects on an individual's overall health and wellbeing. Although there is a common belief that an increase in technology use could have an adverse effect on socialization, it has been found that there is a strong, positive relationship between the size and diversity of people's closest social ties with the frequency of use.[29] mHealth solutions in this context emphasize the basic ability of mobile phones to offer a way for humans to talk to each other. mHealth can alleviate pressures felt by patients and families when the need to seek care for mental disorders is necessary. Particularly in LMICs, mobile phones allow remote communication between patients and mental health professionals.

To better customize mobile phones and applications for older users, more research and innovation will be needed in design and manufacturing, as well as selecting handsets, features for use, and applications. For many older people, the biggest barrier to adoption of mobile phones is cost.[1] This is true in both LMICs and some developed countries that have high poverty rates among older age groups. According to a recent report published by the UNFPA and HelpAge International, income security is among the most urgent concerns of older people worldwide.[1]

Second, trust is a key barrier to adoption since a decision to continue using or to discard an mHealth application is easily influenced in the first few moments of an individual's interaction with it.[30] For older populations, who may not have as much exposure or comfort with mobile phone applications, the trust hurdle may be higher than average. mHealth solutions designed with older people in mind will likely have a better chance of success and continued use than those aimed at the general population.

Third, ergonomics play a pivotal role in individuals' decisions whether to continue use of a technology. Special attention is required when considering mHealth ergonomics, for example, which handsets are better geared for use by aging populations. Large screens and large buttons that are easy to see and touch are better for older individuals with impaired vision and hearing. Additionally, cognitive decline can have an effect on how screen flow is perceived. Audio options should be predesigned and preset to allow older people to more easily hear conversations over a handheld phone and to notify them of incoming calls, text messages, or other alerts.

The selection of a user communication type (i.e., voice vs. text vs. video) for a mHealth aging program should be based on the program's objectives. Limitations of mobile technologies and communication strategies with older people as a target population should be thoroughly researched, as these limitations could have critical effects on the program's success. Limitations affecting communication strategies such as illiteracy should be taken into consideration. Additionally, user population preferences, such as easily disabling auto-correct functions during text messaging and improving ease of use for voice-to-text features, are particularly important to account for when literacy rates are lower – usually in the LMIC context – or when eyesight capabilities decline among older individuals.

The potential for mHealth to address the needs of aging populations on a deeper and broader scale is enhanced because, in some cases, existing applications aimed at children, adolescents, or young adults can be tailored with minimal effort. In other cases, motivations for behavior change may differ significantly between younger and older individuals.

Evidence is growing on the benefits of mHealth in general; however, right now, there is not enough. As the field of mHealth grows in sophistication, it will likely be progressively easier to find appropriate "off-the-shelf" solutions.[5] For now, best practices regarding design principles for aging populations are emerging. These can go a long way to guide mHealth application developers. Some examples of best practices for design include[31]:

- **Designs should not assume that all older users are impaired**. Growing old does not necessarily result in impairment. In fact, variability in performance may actually increase among older people as they age, meaning that some older people may actually have better performance than some younger people

- **Designs should accommodate how aging results in changes to one's senses (how we perceive), cognition (how we think), body (how we react), and social status (what we want).** Suggested considerations include:
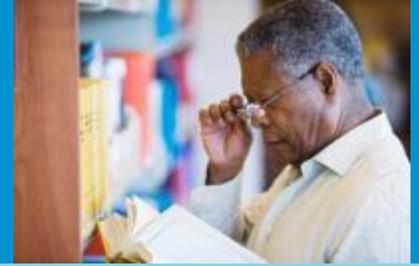
- Ways to easily repeat commands since spoken commands may be easily forgotten (in comparison to text or icons that can be looked at again for reminding)

- Ways to restart or start over when mistakes have been made

- Icons that are intuitive and understood by older persons – especially across different cultures

- Input buttons large enough to accommodate possible reduced fine-motor control

- Information should be in a large, legible font

- Inputs that provide a visual (lighting up) or auditory (beeping) input so the user has confirmation that their action was received

- Speech not used for input (speech recognition) unless it is very fast and very reliable since mistakes and delays in speech recognition may be frustrating and confusing

- **Simple design can go further.** Because cognition, or memory, changes with age, mHealth device designs should not require older users to retain information. Thus, the menu layout of an mHealth device should be simple.Older people may become confused and unable to comprehend or remember a complex menu structure provided by an application

- **Focus on the user experience**. Older people may need more time to complete certain tasks, so there should be no actual or perceived sense of time urgency. The user may need very explicit indications from the system they have done it correctly and that the desired process is successfully underway

- **Make the user interface as easy as possible**. Some complex features could be preloaded by a doctor or a mobile application developer so that older users only have a single "easy" button to press. Basic medical information could be automatically entered for an older user by knowing the individual's medical needs. Additionally, some smart systems may anticipate user needs through imputing their medical history in relation to the current date and time. For example, an older user could receive a prompt based on knowledge of current medications that states, "You appear to be nearly out of your medicine; shall we reorder?"

Successful design is not just about products that are practical or ergonomically functional. The design should allow the user to feel an emotional appeal or connection to the device. For older adult users, that emotional connection is more likely to exist if the mHealth application appears as trustworthy, reliable, and kind.[5] In other words, mHealth applications should be designed with "emotional intelligence" for older people.

> **Women in Focus**
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> The issue of women and aging deserves particular attention from the design and policy perspectives. One subcategory is that which is directed at the asymmetry between populations of men and women in old age. Although age discrimination occurs around the world for both men and women, women live longer than men and are more likely to endure ill health for longer amounts of time. Illiteracy and low education levels, for which women suffer disproportionately than men, have been associated with lower levels of seeking health services, for example, in cancer screening in Latin America and the Caribbean. Additionally, several factors specific to women (e.g., multiple pregnancies, fistula, heart disease, certain types of cancer, the onset of menopause which increases the risks of osteoporosis and bone fractures) are unique to women at later ages. Women are more likely than men to live alone, and this increases the risk of poverty and isolation. The economic and mental burdens associated with aging women, particularly widowed and single, can oftentimes overshadow the benefits of greater longevity as compared to men. In order to better respond to older women's needs, mHealth aging applications should account for these issues.

Source: WHO 2008; Reyes-Ortiz et al. 2007

While a movement to advance mHealth targeting maternal, newborn, and child health (MNCH) is well underway, a parallel effort to address the needs and opportunities of aging populations has yet to materialize. Policymakers and other stakeholders are increasingly aware of the promise of mHealth. Entrepreneurs are prolific in developing new applications targeting the needs of older people. How will these trends coalesce around the needs of rapidly aging populations and what is needed to ensure scalability and cost-effectiveness? A call-to-action is needed for project implementers, organizations, the private sector, and policymakers to help rapidly advance mHealth solutions for aging populations.

What project implementers need to do…

- **Start small and expand**. mHealth projects for aging should begin small before scaling-up. Many lessons have already been learned in mHealth from other health topic areas such as HIV/AIDS and MNCH. It is best to draw from the lessons learned in these applications as much as possible so that costs can be cut and quicker implementation can occur with the support of governments and public-private partnerships

- **Collaborate with other experts**. Experts in the mobile technology field will need to engage with experts in aging to understand the nuances or major differences in the ways older people will benefit, how they will respond, and how to measure success

- **Focus on and empower the end user**. Since older people will generally trail younger populations in uptake and comfort with new technologies, designs should emphasize simplicity.[5] Understanding end users and their needs and capabilities will ensure the sustainability of a program.[5] In order to do this, projects should consider several components.[32] These include:

    – Put the end users at the center of mHealth for aging design

    – Assess the needs and challenges of older users including knowledge, ability to recognize problems, ability to express their concerns, motivation, difficulty incorporating healthier behaviors into their schedule, access – or lack thereof – to transportation, and healthcare stigmas affecting older people

    – Incorporate positive and motivating strategies for the aging population

    – Provide critical information, support, and links to reputable resources that enable healthy aging

What organizations need to do…

- **Create effective business models for sustainability**. Effective business models coupled with monitoring and evaluation (M&E), as well as supportive policy, regulation, and mechanisms for more sustainable funding (e.g., payer commitments, subscriptions by patients or providers, insurance discounts), would enable meaningful scale-up and commercialization of mHealth

- **Integrate M&E from the beginning and generate evidence for identifying effective solutions**. Although there is growing proof that mHealth programs and applications are being implemented worldwide, the evidence base of mHealth program and application effectiveness does not confirm what actually works, or does not, and why.[5,33] Project managers and evaluation specialists should improve their use of real-time data and apply an aging lens in recommending improvements. M&E should be incorporated to help these projects evolve, increasing their usefulness and effectiveness over time. Since mobile technologies are electronic, data for M&E purposes can be extracted more easily than ever. However, the World Health Organization (WHO) 2009 Global eHealth survey stated that only 12% of United Nations Member States reported conducting evaluations of mHealth programs.[33] As adapted from Cash-Gibson (2012), there are several suggestions for what to monitor and evaluate, specifically for programs focused on disease prevention and management.[34] An adaptation of these suggestions include the following:

- – Primary Outcomes
  - • Quality of data recorded
  - • Lifestyle modifications of relevance to the mHealth program (e.g., tobacco consumption, weight, dietary intake, physical activity levels)
  - • Data disaggregated by age and gender

- – Secondary Outcomes
  - • Response rates to invitations to assessments
  - • Patient treatment compliance
  - • Biomarker readings (e.g., blood cholesterol level changes, blood pressure readings, glycosylated hemoglobin levels)
  - • Cost-effectiveness
  - • Patient and provider satisfaction with methods
  - • Adverse events (e.g., hospitalizations, morbidity, mortality)
  - • Data disaggregated by age and gender

- **Address confidentiality, privacy, and security issues**. Confidentiality, privacy, and security are all serious concerns in respecting and protecting individual health information. However, 56% of European member states and 50% of member states in the Americas reported in the WHO 2009 Global eHealth survey that missing legal guidelines for privacy and confidentiality are the top two barriers to mHealth implementation.[33,35] Without regulations or set boundaries, health information sent via mobile phones across wireless networks can result in serious violations of patients' rights.[35] Health professionals should be properly trained in informing patients about their rights in deciding who can access his or her patient information.[36] Interventions that use mobile phones as a communication gateway with patients can cause confidentiality and privacy concerns for individuals who share their mobile phones with friends or family members.[37] This has been expressed more frequently in mHealth interventions that focus on diseases that carry stigma and discrimination.[37,38]

What the private sector needs to do…

- **Participate in partnerships to create effective mHealth business models for sustainability.** For the private sector, collaboration with project implementers and non-profit organizations will be key. Organizations that have expertise in aging populations as well as mobile phone network providers should collaborate with project implementers and organizations. These partnerships should devise mechanisms for more sustainable funding (e.g., payer commitments, subscriptions by patients or providers, insurance discounts), which will enable meaningful scale-up and commercialization of mHealth for aging.

What policymakers need to do…

- **Create an enabling environment to facilitate wide-scale use of mobile phones for aging**. One of the often-cited reasons for successes achieved in mHealth interventions is strong commitment and support from local governments. Governments that have invested in mHealth or eHealth, which is electronic information transfer for health, have a solid understanding of the potential positive outcomes and advancements that mobile technologies can bring to their constituents. For example, the Government of Bangladesh has supported the development of an eHealth plan as well as text messaging services for health. The Government of Rwanda, as another example, has developed its own eHealth plan in addition to a nationwide interoperable electronic health information system, an electronic medical record system, a mobile phone-based system for community health worker communication responsibilities, and a new eHealth Center of Excellence.[33,39] However, in some countries, sending private patient information over mobile is limited by regulations and confidentiality laws.

- **Implement coordinated strategies that support program sustainability**. Because mHealth is a new field, the landscape is saturated with pilot projects that have yet to be brought to scale. Only within the past few years have countries begun to incorporate mobile phone use in national plans and policies, creating an enabling environment for general acceptance and increased use. As aging and NCDs become integral pieces of national development plans, poverty reduction strategies, and stronger legislation, government use of mHealth for improving the health of older people can encourage and drive health systems and private marketplaces to adopt similar applications.

There are promising examples of how mHealth can successfully address the conditions that occur most frequently among older populations, including those, which if left untreated, result in disability. Wireless disease monitoring, health promotion, and self-management in non-communicable disease (NCD) interventions represent just a few mHealth applications addressed in this report. Increasingly, the information and data transferred via mobile devices is becoming more personal and tailored to end users – a promising sign and a critical success factor among older populations.[27]

On a more basic level, mHealth applications are enhancing a sense of social connectivity and cognitive stimulation, which is critical for older people facing isolation, depression, and fear of disability in their mature years. Not all older persons are able – due to disability, lack of transportation, or caregiving responsibilities – to join their friends in person for social stimulation. So far, not enough older individuals are enjoying the fruits of mHealth because of ongoing barriers to adoption, as addressed in this report.

In fact, large strides still need to be made before mHealth reaches its full potential for healthier aging. In particular, these include tailoring mHealth applications focused on NCDs for use by older people and their families, friends, and caregivers; translating learned lessons from developed countries to LMIC contexts, and in some cases vice versa; and focusing more on the health needs of older women. These are all achievable if strategic efforts are coordinated amongst stakeholders across the mHealth, aging, and health systems fields.

At the project level, rigorous evaluation is needed to determine how to best mitigate the factors hindering scale-up and commercialization of mHealth projects. Suggestions include creating effective business models for sustainable demand generation; establishing a long-term mission; filling research gaps in monitoring and evaluation for identifying effective solutions and guidance; focusing on the end user whether it be older individuals, caregivers, or health providers; obtaining and incorporating feedback from the end user; and addressing confidentiality, privacy, and security issues.

At the policy level, top-down mechanisms can enable an environment in which mHealth aging projects can grow to be sustainable and scalable. Policies are needed to advance the integration of mobile phones and other information and communications technology into national health plans, chronic disease action plans, and socioeconomic support policies aimed at preventing poverty and disability in older populations.

Healthy and active aging is a goal that most individuals hope to achieve. mHealth offers a unique and versatile platform to help people realize that goal. The rapid graying of populations, or expansion in the number of older people, in both developed and LMICs is certain. It is also clear, as the UNFPA and HelpAge International indicate, that "[t]he balance between the challenges and opportunities of population [aging] will in large part be determined by whether people age in good or in poor health" (p. 60).[1] What remains to be seen is the extent to which mHealth will serve as a tool and resource to help aging populations remain healthy and productive for as long as possible. The first step in moving forward is to ensure that research and discussions about the mobile and demographic revolutions intersect. All stakeholders – project implementers, organizations, the private sector, policymakers, and individuals – must also work together to address the gaps and challenges described throughout this report and, in particular, in its call-to-action. Strategic planning and stronger coordination across the fields of health, information technologies, and aging are necessary to ensure that the full potential of mobile and wireless technology to improve preventive and supportive care for conditions associated with aging can be realized for older people, the fastest growing segment of the population worldwide.

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Making aging healthier is challenging. One of the most challenging parts of improving aging is agreeing on the problem. This section describes two frameworks that this call-to-action aims to advance regarding new perspectives on aging and the role innovative technology can play as a solution. Drawing from recent academic literature and civil society thought leadership, both of these frameworks fundamentally support the fact that aging does not begin at a specific age but instead is a lifelong process where, in general, healthy behaviors can promote wellbeing.

Framework 1: The Vicious and Virtuous Cycles of Physical Wellness and Cognition Among the Elderly

The first framework, drawn from a discussion paper entitled "Sustaining the Golden Thread: The Economic Opportunity of Aging for China,"[7] visually represents two ways particular attitudes and behaviors can either accelerate or delay physical and cognitive decline among older people (See **Figure 5**). The vicious cycle emphasizes that excluding elderly populations can isolate and marginalize them, as well as limit how much they can – and feel they can – contribute, all while increasing the stereotype that older people are a burden. All of these events can fuel certain behaviors and attitudes, resulting in accelerated physical and cognitive decline among the elderly. Removing these perceptions among both the elderly and other segments of the population is a critical element of healthier aging around the world.

By reversing the vicious cycle, the virtuous cycle capitalizes on the knowledge and productive roles older people already have in society. With a well-thought-out strategy that considers molding positive changes in attitudes, practices, and policy, society will be better able to benefit from a lifetime wealth of knowledge and experiences of older generations; aging individuals will feel and see themselves as contributors. With stronger physical and cognitive capacities, which can imply healthier aging, reductions can be expected in costs placed on older people, their families, and their health systems from age-related illnesses.

Figure 5: Two ways particular attitudes and behaviors can accelerate or delay physical and cognitive decline among elderly
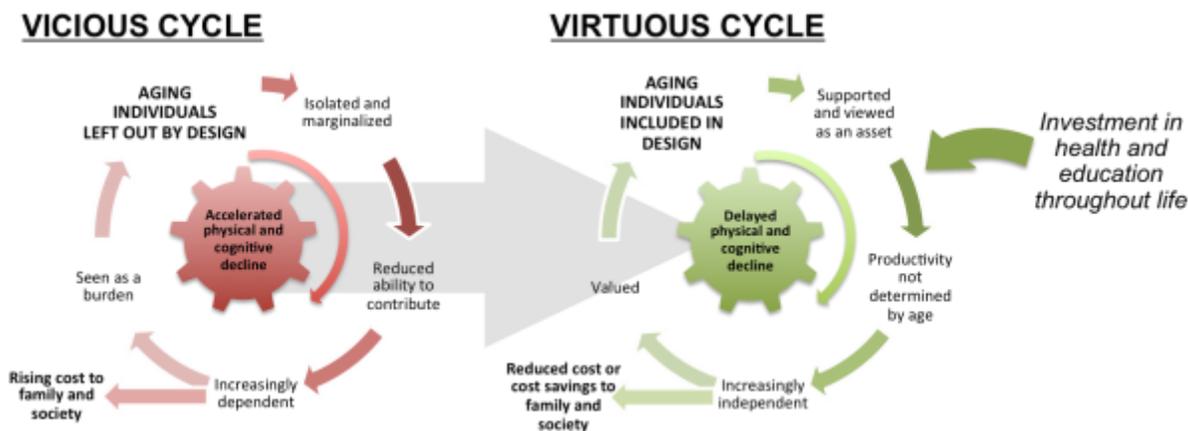
Source: Adapted from Zadek 2012

Mobile technologies can help catalyze the movement toward a more virtuous cycle, particularly for NCDs, as well as cognitive acuity and mental health. When designed appropriately and through targeted programs, mHealth can empower older people and their caregivers in such a way as to delay physical and cognitive declines, at the same time allowing improved quality of life through better disease management.
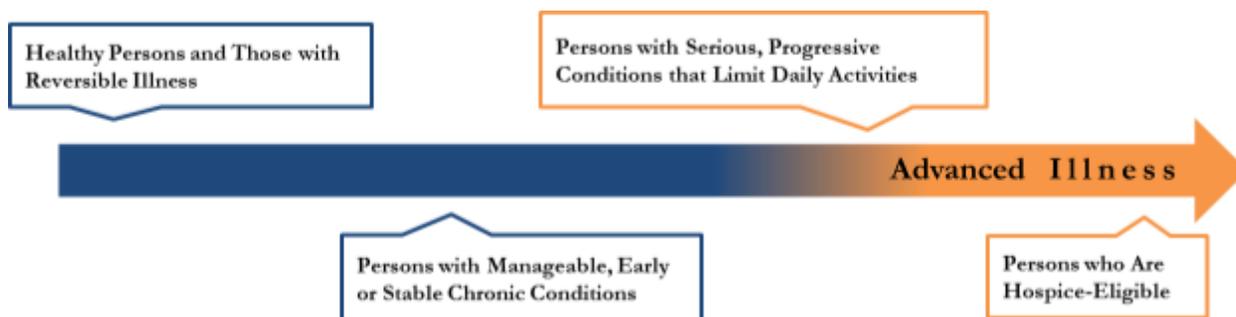
Framework 2: Aging on the Health Continuum

With age comes increased susceptibility to developing a chronic disease and developing co-morbidity from more than one chronic disease.40 Developed by the Coalition to Transform Advanced Care (C-TAC), the second framework contextualizes the health continuum of older individuals by illustrating how illnesses can advance (See **Figure 6**). As shown, individuals, regardless of age, may endure illnesses that can develop into chronic conditions, which can then worsen and limit daily activities such as getting out of bed, getting dressed, using the toilet, bathing, eating, and taking medicine. Ideally, care for chronically ill people, including those at advanced stages, is appropriate, seamless, and individually-tailored so that they can live with security and dignity. Needless to say, older people are more likely to suffer from co-morbidity.

Figure 6: Development of Advanced Illness on the Health Continuum. (Figure from Coalition to Transform Advanced Care (C-TAC). Call to Action: Transforming Advanced Illness Care.[41])

Source: C-TAC, 2012.