Assessing the Feasibility and Accessibility of mHealth Application for Supporting the Prevention, Treatment, and Management of Non-Communicable Diseases in Hai Duong Province, Vietnam

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Title Page

Scholarly Report submitted in partial fulfillment of the MD Degree at Harvard Medical School

Date: 9 March 2017
Student Name: Viet Nguyen, BS

Scholarly Report Title: Assessing the Feasibility and Accessibility of mHealth Application for Supporting the Prevention, Treatment, and Management of Non-Communicable Diseases in Hai Duong province, Vietnam

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Abstract
Background: Non-communicable diseases (NCDs) are the leading cause of morbidity and mortality in Vietnam. Mobile health (mHealth) and its role in patient education/disease management are developing. This study examines the feasibility and acceptability of mHealth for supporting NCDs management in rural Vietnam.

Methods: A descriptive study using qualitative methods and convenience sampling. Semi-structured, in-depth interviews and focus group discussions involving potential commune health center (CHC) level users in 1 rural province were performed. In total, 29 participants in 5 FGDs and 5 interviews. Three main topics were covered: 1) Current NCD management; 2) Baseline knowledge of mHealth; 3) Barriers to mHealth.

Results: Barriers to NCD management includes no centralized system to track patient information, prioritization in resource-limited settings, and patient’s curative approach to health care. One-way SMS & disease prevention via risk factor education and appointment reminders were preferred over medication reminders and diagnosis/management.

Conclusion: While there was interest in mHealth as an innovative method to improve NCD management in a resource-limited setting, significant barriers to implementing mHealth, includes literacy, impaired vision, and cultural preferences for face-to-face care. The small study with convenience sampling highlights difficulties to introducing new technology, but may not be broadly generalizable.
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Introduction

Non-communicable diseases in the global context

Non-communicable diseases (NCDs) are defined by the World Health Organization (WHO) as five major groups of diseases: cardiovascular diseases, diabetes, chronic respiratory diseases, mental illnesses, and cancers. NCDs represent 38 million deaths of the worldwide burden of disease, with an over-representation in low-and-middle income countries (28 million) (WHO, 2015). As a low-middle income country in South East Asia, Vietnam has undergone significant epidemiological shift from communicable to non-communicable diseases (World Bank, 2014), requiring changes to the existing health system to reflect the current epidemiological demands (Son, 2012). In 2002, the Government of Vietnam (GOVN) introduced a National Plan for NCD Prevention and Control in an effort to address the growing NCD epidemic; from 1986 to 2008, the proportion of all hospital admissions attributed to NCDs increased from 39% to 69% and mortality secondary to NCDs went from 42 to 63% (Ministry of Health, 2009). Without significant innovation and change in the existing health system, the WHO estimates $7 trillion cumulative economic losses in low-and-middle income countries, far beyond the global cost of implementing a set of high-impact interventions to reduce NCD burden (WHO, 2014).

Given the chronic and progressive nature of NCDs, long-term, proactive, patient-centered primary care is necessary, ideally delivered in a community-based and sustainable fashion (Starfield, 2005). Primary care based health systems include the following features: (i) a person-focus across a lifespan rather than a disease focus; (ii) accessibility with no out-of-pocket payments; (iii) distribution of resources according to population needs, rather than demand; and (iv) availability of a broad range of services, including preventive services and coordination between different levels / tiers in the health system (Starfield, 2005). As Vietnam’s continues to make economic gains, coupled with an aging population and epidemiological transition to NCDs, Vietnam must adapt to deliver chronic care. The challenge is working on a backdrop of a health system designed initially for acute care, while also identifying innovative and economic investments in a resource-limited setting. Nonetheless, rapid globalization and technological advancement offer promising prospects of integrating modern technology to address health care gaps.

Given the rapid growth of mobile phone ownership in low-and-middle income countries (LMICs), the use of mobile technology in health care (mHealth) was considered a key strategic component of NCD management in LMICs during the 2011 United Nations High Level Meeting on NCDs (Fraser et al, 2011).

Health systems strategies globally

With the Declaration of Alma-Ata in 1978, strategies revolved around the use of commune health workers (CHWs) and commune health centers to extend the reach of primary care; by the 1990s, the challenges of resource limitations and the growing global burden of disease became increasingly apparent (Banks, 1993). In particular, a shortage of human labor may serve as a bottleneck in implementing universal health care access (Chen et al, 2004).

Given five billion mobile phone users globally and the widespread availability of cellular devices in the modern world, technology’s role in improving the range of health care access and availability has been a prominent and attractive possibility (Kallander et al, 2013). mHealth has been proposed as a means to “bridge the human resource gap in primary health care delivery systems of developing countries.”
mHealth and its role in improving the quality of clinical decision making, referrals, data collection and patient education have rapidly developed in the last decade (Goel, 2013).

Epidemiology of NCDs in Vietnam

Vietnam is located in South East Asia, with a population of 91.7 million as of 2013 (WHO). A WHO assessment in 2014 identified the risk of death from diabetes, cancer, cardiovascular diseases, and chronic lung diseases between ages of 30 through 70 years as 17%. In comparison to the 1990s, when the highest cause of number of life years lost was secondary to lower respiratory infections, by 2010, cerebrovascular disease had become the highest ranking cause of number of life years lost (WHO, 2014). Aside from death, chronic diseases are the predominant cause of debilitation: the top five conditions contributing to years lived with disability are low back pain, major depressive disorder, chronic obstructive pulmonary disease, neck pain, and migraine (WHO, 2014).

Broadly, the strategy to combat the risk factors for disease burden in Vietnam include targeting tobacco and alcohol use, dietary interventions to reduce obesity, and screening and treating hypertension (WHO, 2014). Over the course of 4 years, data compiled and analyzed by the WHO suggested that the rate of alcohol consumption doubled from 5.7% to 12.1% in men (from 2004 to 2008). Previous estimates of obesity in 2008, showed a 1.7% of the total population, with a skew towards urban populations, where the prevalence rate was 43% in urban regions versus 17% in rural areas (Khan, 2008).

Vietnamese Health System

The health system in Vietnam is divided between a preventative and curative system. These two systems are not integrated at all levels; at the national and provincial level, there are various national institutes which collaborate with the Ministry of Health (MOH) to execute directives, which are implemented through vertical planning.

The preventative public health sector includes 11,400 commune health centers (CHCs), 900 hospitals (730 general hospitals and 103 specialized hospitals), 860 general clinics, and 9 specialized clinics based on WHO and Ministry of Health 2012 data. The CHC is the entry-point of care and contains a population of roughly 5,000 people for both rural and urban regions. The next tier includes the district health center which offers first level in-patient hospital services. From there, district health centers may refer to provincial hospitals or specialty clinics.

At the national and provincial level, the curative and preventative care systems are separate. Through a system of vertical programming, the preventative care system has direct collaboration with national institutes to subsequently dictate programs at the provincial, district, and at the final and most proximal to the patients, the CHC level. CHCs are responsible for implementing national target programs, which receive central and provincial funding. The MOH provides a Benchmark of Standards, as outlined by Decision 3447/QĐ-BYT dated 22/9/2011, to ensure a system of regulation between CHCs.

Doi Moi occurred in 1986, as a series of economic reforms involving privatization, decentralization, and deregulation, while preserving a clearly socialist governmental structure. This economic shift served as a catalyst for the emergence of a parallel private health care system, which evolved to include private hospitals in metropolitan areas. Alongside the legalization of a private medical sector was the arrival of an independent pharmaceutical industry beyond governmental / state control, a market which offered pharmaceutical products under the dictum of supply and demand (MG, 1995). Consequently, health
seeking behaviors evolved to include more self-medication and self-treatment, and higher utilization of private sector medical services (Ha, 2002). Over time, patient volume decreased at district and commune level health centers (MG, 1995); CHCs were thus relegated to treating patient populations incapable of affording private sector services and operating vertical national targeted health programs based on governmental funding (Fritzen, 2007).

Mistrust of governmental institutions and more rural locations pose an additional challenge to the effective outreach of CHC centers, which must combat the general perception that public institutions frequently offer lower quality services and insufficient provisions (Philips, 2006). As a result, many Vietnamese patients choose to bypass the CHC referral system and seek access to public and private provincial national hospitals, despite the exceptionally overcrowded/overwhelmed facilities (Fritzen, 2007). International medical tourism is another path towards bypassing the public sector for those with economic means, evident by the proliferation of private clinics along with internationally/domestically funded private hospitals (Nguyen TK, 2014).

Uses of mHealth Globally

eHealth is based on the WHO definition (WHO e-Health toolkit): the transfer of health resources and health care by electronic means, encompassing three main areas

a. the delivery of health information for health professionals and health consumers, through the Internet and telecommunications.
b. using the power of IT and e-commerce to improve public health services, e.g. through the education and training of health workers.
c. the use of e-commerce and e-business practices in health systems management.

mHealth is a subcategory of eHealth: the use of portable electronic devices with software applications to provide health services and manage patient information. For the scope of this study, eHealth interventions
are narrowly focused on mHealth, as end-targets are simple mobile phone applications for data entry, electronic decision support, and text messages to for community health workers.

According to the International Telecommunication Union (ITU), there are now over 5 billion wireless subscribers; over 70% of them reside in LMICs as of 2012. The GSM Association reports coverage of wireless signals across 85% of the global population, well beyond the scope of the electrical grid (2013). In LMICs, penetration of mobile phone networks in LMICs exceeds other infrastructure, including paved roads / electricity. As this study was conducted in 2012, it is likely that these networks have only developed in terms of reach, speed, and scope in the ensuing years, transforming the access, delivery, and management of health services through complementary use of mHealth for strengthening health systems (2013).

Electronic tools may positively impact the safety and delivery of primary care: eHealth applications can increase communication between health care workers with patients and families (Bates, 2010) which allows more coordinated, integrated, and efficient health systems (Sittig, 2010). Globally, electronic tools assist members of the health care team, allowing for more rapid access to information while providing care within the community.

While eHealth interventions may provide support in the implementation of primary care in resource-limited settings, it cannot replace existing health infrastructure/systems nor can it be an independent solution (Kallander, 2013). As the most poor and vulnerable populations are disproportionately limited in health care access due to socioeconomic and geographic factors, electronic tools to support patient self-management may be invaluable strategies to increase services in resource-limited settings.

According to 2011 WHO research, up to 30% of developing countries were using SMS and other mHealth tools to support disease treatment and management (WHO, 2011). These tools improve community engagement via increased peer-to-peer communication (Strachan 2012). As NCDs involve progressive diseases, with many of the crucial components falling outside of a formal health system—medication adherence, making healthy lifestyle choices on a daily basis, etc—disease prevention and management must tackle baseline patient education and include an integrated, multidisciplinary care team.

Strategies to improve patient self-management include a wide spectrum of options, ranging from interactive applications on smart phones/tablets to text-messages (SMS) on simple phones (Free, 2013). While online interventions involving interactive features and targeting behavior change, SMS reminders, and decision support tools have had positive patient outcomes (Moore, 2014), a Cochrane systematic review of mobile application efficacy has demonstrated mixed results (Marcano 2013). This ambiguity suggests a need for more research to clarify the details of successful intervention.

**Mobile health technology in Vietnam**

Vietnam has 6 licensed mobile operators. As of 2011, 40 % of Vietnam's population used mobile phone, with 3G internet coverage in over 95% of the country. In the last 10 years, the mobile telecommunications market in Vietnam has grown by approximately 79% per year (Tran, 2012).

Current costs associated with cell phone usage are 200 VND/SMS and 1500 VND/1 min. The market predominantly is based on pre-paid package services.

Based on a report by the Pew Global Survey regarding the use of internet globally as well as use of cell phones, large age gaps occur among ownership of smart phones, with significant variation based on age.
In Vietnam, China, and Thailand, a difference of 30 percentage points exist between those between the ages of 18- to 34-year olds and those older than 35 (Poushter, 2015). The Pew Global Survey also evaluated the use of mobile devices for texts in the past 12 months, with a median of 76%; Vietnam, like many countries in emerging and developing markets, reported 76% (Poushter, 2015). In comparison, the Philippines, Venezuela, Indonesia and South Africa reported 95% or more of regular texting, and the United States reports 81%.

**mHealth Potential in NCD Management in Vietnam**

Rapid proliferation of pilot mHealth projects has generated enthusiasm among governments, donors, and health program implementers (Labrique, 2003) by suggesting a large potential to address specific health system constraints that may hinder effective delivery of health interventions. Key components of mHealth implementation for reducing costs include patient education regarding disease knowledge, bypassing geographic barriers, and improved efficiency in data collection (Marshall, 2013).

Current NCD mHealth trials, particularly those utilizing text message interventions to support exercise, diet, and smoking cessation, have reported improved health outcomes related to NCD management (Jacobs, 2014; Cole-Lewis, 2010; Liu, 2008; Anglada-Martinez, 2015). Though information gaps remain in terms of long-term effect, costs, acceptability, and mechanisms for the effectiveness of mHealth, it has been shown to improve patient’s perception of self-management of chronic illnesses in developed countries and to improve the quality of care delivered by commune health workers in developing countries (Wantland, 2004). mHealth projects in Vietnam have included interactive SMS exchanges with ethnic minorities regarding sexual health transmission (Le, 2012), commune health workers training in rural areas (Health., B.S.o.P), and SMS communication regarding STIs/abortions amongst youth (Spaer, 2013).

Rather than focusing on the evaluation of a specific mHealth technology, this research seeks to frame mHealth as an element of innovative health systems delivery (WHO, 2011; Fraser, 2011). This shift in perspective would focus on identifying key obstacles/constraints to the delivery of effective health interventions and to help guide the development of more effective mHealth approaches (Travis, 2004).

This is the first study to examine the use of mHealth in support of NCD education and management in rural Vietnam.

**Student role**

This project was made possible by the generous financial support of the US State Department Fulbright Research Fellowship and the Scholars in Medicine Office at Harvard Medical School. The project was initially designed and submitted as a student proposal for evaluation by the Fulbright committee prior to departure in September 2015. Upon arrival in the host country, the project underwent revision under the guidance of in-country mentor, Dr. Hoang Van Minh. Research was conducted through the technical assistance of the staff at Hanoi School of Public Health.

Dr. Hoang Van Minh and Dr. Kim Bao Giang helped review proposals and offer insights on tailoring the project to suit the research environment of northern Vietnam. These mentors helped introduce the principle researcher to conferences and leading international researchers on the subject of mHealth within Hanoi. One research assistant, Nguyen Bao Ngoc, helped with the logistical coordination with research
sites as well as translation of the material. Four experienced Vietnamese-speaking researchers with international master’s degrees in public health helped with revising the various interviews and focus-group discussions as well as the formal data collection. The principle researcher was present at the interviews to observe the group dynamics as well as to formulate notes from the experience. Audio recordings were used as a secondary source of information from the interviews; these files were transcribed by the researcher team immediately following the interview. The transcription was translated and thematically coded by the research team, generating a first set of provisional codes and then revising and revisiting the raw data. This process was reiterated until a common framework of the data.

The literature review was conducted through the assistance of Nguyen Bao Ngoc. Following write-up, Dr. Hoang Van Minh, Dr. Kim Bao Giang, and Dr. Andy Ellner helped review the document and offer additional insights on how to revise the documents and clarify the data and its presentation.

**Methods**

**Study Design:**
A descriptive study using qualitative methodology was carried out, relying on a combination of semi-structured, in-depth interviews and focus group discussions involving multi-sectorial stakeholders and potential commune health center (CHC) level users. While mHealth projects had been implemented in Vietnam, the questions regarding the utility of mHealth in managing NCDs were unexplored territory and the answers to these questions may be instructive to future design and implementation of mHealth projects in the area. Research in other countries and contexts have proposed theories regarding the relationship between mHealth and receptivity, but rather than impose a pre-existing hypothesis in the absence of a validated quantitative survey and continue assumptions of attitudes, knowledge, and practices within this particular community, this research sought to utilize a focus group and in-depth interview design to assess existing infrastructure and cultural attitudes in order to guide future interventions in the region. Additional quantitative researcher is planned by the broader researcher group at Hanoi School of Public Health and CHILILAB, though within the time constraints of this project, quantitative researcher methods were not integrated.

**Study Site:**
The study occurred in Chi Linh, within the Hai Duong province of northern Vietnam, which includes 3 districts: Sao Đỏ, Phạ Lại, Bến Tầm, and 4 communes, Lê Lợi, An Lạc, Văn An, Hoàng Tiến. Approximately 18,000 households are counted by the census, which is approximately a 60,000 residents.

Choosing Chi Linh was strategic, as the region is a location commonly utilized for research through a long-term affiliation with the Hanoi School of Public Health since 2003. In partnership with the Chi Linh Health and Demographic Surveillance System (CHILILAB HDSS), Chi Linh is the only health and demographic surveillance system in Hai Duong, a northern province of Vietnam. It is one of the few laboratories in the world that links operational research and health interventions with field training. CHILILAB provides longitudinal data on demographic and health indicators for the community of Chi Linh (Tran et al., 2013). CHILILAB objectives include identification of patterns in morbidity/mortality, socioeconomic factors population health, and field-work sites for the implementation of community health intervention strategies as a basis for informing broader health policy.
Areas included the Sao Do CHC within Chi Linh.

**Study Subjects:**

There were two main categories of study subjects: health care stakeholders and potential mHealth users (both CHC staff and patients). Patients were divided based on gender (male vs. female) and NCD status (diagnosed hypertension, diabetes, chronic lung disease, or cancer vs. none of the above diagnosis). All participants were above 18 years of age. To be involved in the FGD, patients and staff must have been residents of the sampled communes. This qualitative study followed a non-probability sampling technique, with an emphasis on convenience sampling, which was chosen given the resource and time limitations of this short study. Research assistants worked in conjunction with local affiliates to contact available patients, well known to the commune health center, with previous research participation to recruit involvement in the study. Sample size was limited by availability.

In-depth interviews included 5 stake-holder groups, including the private sector (such as mobile health intervention organizations), government (representatives from the Ministry of Health), and public sector (health staff representatives at the provincial and district level).

Data collection involved 5 face-to-face interviews with stakeholders, including:

- 1 Head of CHS
- 1 mHealth organization representative
- 1 center for health education and communication representative from MoH
- 1 department of medical consultation and management representative
• 1 diagnostic quality assurance representative from MoH

Sampling Strategy/Size

Sampling strategy involved a non-probability, convenience sampling for the focus groups. In total, there were 29 participants in the focus groups and five in-depth interviews conducted. Twenty-two patients were involved in four separate FGD (5 NCD+ males, 5 NCD- males, 6 NCD+ females, 6 NCD- females). The initial delineations were created to provide homogeneity amongst participants and to facilitate discussion within a reasonable time frame for researchers and participants. Staff (seven participants) within the CHC also represented a separate focus group of potential users.

Focus Group Discussion Break Down

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<thead>
<tr>
<th></th>
<th>+ NCD</th>
<th>- NCD</th>
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<tr>
<td>Males</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Females</td>
<td>6</td>
<td>6</td>
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Study Terms:

Feasibility assesses the willingness of clinicians and participants to utilize mHealth, the practicality of delivering the interventions in the proposed setting, based on existence of required human, material, and technological resources (Pineault, 1986).

Acceptability refers to how the intended individual recipients, both targeted individuals and those involved in implementing programs, react to the intervention, based on personal knowledge, beliefs, values, and interests (Peters, 2002).

Study Variables:

Patients in focus groups were asked about their age, status of NCD (either yes or no), education status, level of income, average number of times patient frequented clinic, and type of cell phone. These variables were chosen as an initial basis for evaluating the type of cell phone access patient utilized, to understand the demographics of the participants, and as a basis for understanding the patient’s interaction with the public health care system.

Study Indicators/Topics:

In order to assess the two objectives related to 1) feasibility and acceptability of mHealth technology in NCD and 2) factors related to acceptable mHealth intervention, interview guides focused on 3 sub-topics:

1) Current awareness and satisfaction around NCD education and management of NCDs
2) Existing knowledge of mHealth
3) Expectations and barriers to mHealth implementation

In order to assess feasibility, potential users provided opinions on the current state of NCD management, along with deficits or challenges to NCD in 3 broad categories (prevention, diagnosis, treatment).
Inquiry on current knowledge of and expectations towards mHealth was conducted in order to assess factors related to the acceptability of mHealth interventions. To inform future SMS / mHealth interventions, questions were asked related to current SMS/mobile phone usage, elements of an acceptable message, and acceptable financing systems.

**Data Collection:**

**Duration:**
Length of in-depth interviews varied from 33 minutes to 75 minutes. Individual semi-structured interviews and focus group discussions took place over a period of 6 weeks.

**Techniques:**
Data collection occurred via semi-structured in-depth interviews, along with focus-group discussions based on topics and themes (as above).

**Data Collectors:**
All interviews were conducted in Vietnamese by a native Vietnamese researcher with previous research experience affiliated with Hanoi Medical University and Hanoi School of Public Health.

**Training:**
Interviews were originally written in English, translated into Vietnamese, and then back-translated into English for comprehension and consistency. While review of other feasibility studies were conducted, this particular set of interview questions was not based on any pre-existing / validated studies. Questions were revised by research advisors and data collectors. A pilot session of the initial questions occurred in Ha Nam, a province outside of Hanoi with a group of 10 sample participants, 5 for CHC staff and 5 patients (female, a mixed cohort of NCD and non NCD patients). Following the session, the focus group discussions and interview content was revisited and revised in a panel discussion amongst the group of researchers responsible for conducting and gathering interview questions to identify confusion amongst the questions.

**Data Management & Analysis:**

Interviews/focus groups were audio recorded and transcribed immediately following interviews. Transcripts were reviewed for thematic analysis within 1-2 weeks of the interview by the researcher and the research assistant. Open coding occurred over a 2-month period in a 2-phase process. Provisional codes were initially generated to form initial themes. Secondary review of the transcripts occurred within 1-2 months of the interview, with emergent themes compared to previous interview data and between stakeholder groups to identify, develop, and confirm overarching themes. Codes and themes were compared, with discrepancies reviewed and compared with the original transcripts to ensure consistency. When no new codes were added to the codebook, data saturation was assumed. No statistical software was utilized.

**Consent:**
Voluntary and informed consent was obtained verbally prior to initiation of data collection. Participants were informed that there were no consequences to refusing participation.
Interview questions were originally written in English, translated into Vietnamese, and then back-translated into English for comprehension and consistency.

**Ethical Considerations:**

The research protocol was submitted to the Hanoi School of Public Health for approval. Ethical clearance to carry out this study was granted by Hanoi School of Public Health based on application No. 015-292/DD-YTCC.

Eligible participants were invited to participate in the study; informed consent to participate in the study was obtained prior to commencing the study. Participation was entirely voluntary and confidential. There were no consequences to individuals who declined participation.

**Results**

**General characteristics of study subjects**

A total of 34 participants were interviewed, comprised of 5 in-depth interviews and 29 focus group discussions. Of stakeholder and health staff interviewed, experience in the participant's field ranged from 10 years to 28 years. All CHC staff owned a smartphone.

**Table 1: Focus Group Participant Characteristics**

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<td>- age range: 25 – 62 years</td>
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<tr>
<td>- education range: 7/10 to 12/12 education.</td>
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<tr>
<td>- income range: 1 million VND to 3 million VND per month</td>
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<tr>
<td>- occupation:</td>
</tr>
<tr>
<td>- 15/22 in agriculture</td>
</tr>
<tr>
<td>- 7/22 were merchants and laborers</td>
</tr>
<tr>
<td>- Simple vs. smart phone ownership:</td>
</tr>
<tr>
<td>- Simple: 12/22</td>
</tr>
<tr>
<td>- Smart phone: 10/22</td>
</tr>
<tr>
<td>- Average number of visits to CHC:</td>
</tr>
<tr>
<td>- 1 – 1.5 times / month</td>
</tr>
<tr>
<td>- NCD status range</td>
</tr>
<tr>
<td>- Zero</td>
</tr>
<tr>
<td>- 3 (hypertension, diabetes, previous cancer diagnosis)</td>
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Those diagnosed with NCDs visited the CHC more frequently.

**Objective 1: Feasibility and acceptability of mHealth**

- Current experience and challenge of NCD management
In evaluation of the initial objective regarding the feasibility of mHealth, questions were raised about the current management of NCD management. Providers and patients were asked to evaluate existing patient knowledge of NCDs, mHealth, and to reflect on the cultural approach to health management.

From the perspective of CHC staff, the difficulty of addressing and improving NCDs related to balancing priorities in a resource-limited setting and the difficulty of beginning reform, given the existing separate tiers of disease prevention, education, management, and treatment.

Within the clinic, time management amongst limited staff is a barrier to improving NCD specific improvements; as discussed by the CHC leadership, "there are 5-6 staff, who are managing 22-23 programs and projects; at this clinic, each staff is responsible for at least 5-7 programs at any given point."

In terms of support resources for clinicians, the lack of sufficient English language skills amongst staff, along with the absence of clinical decision making tools are additional barriers to improving the ability of clinicians to provide care.

Logistical challenges to managing NCDs included the use of paper and pen to monitor and track patient files, the human resource limitation of providing mostly in-person direct counseling, and the absence of a systematic and centralized method to connect patient information over time and within public, government systems.

Two staff comments reflective of this attitude are included: 
"Currently, between the different tiers of management and prevention, there is no real connection to manage patient information, especially for patients with NCDs."
"...in our patient files, we can only manage about several hundred patients, but in reality, there must be thousands of patients [with this diagnosis..."

Staff recognized the limited scope of their NCD disease prevention, given competing responsibilities and the limited incentives for screening/life style prevention. Consequently, CHC staff must seek to integrate and introduce screening and patient education into common practices for those already diagnosed with an NCD. As one staff member remarks, “…what we do is to include and integrate risk factor prevention into the eye exams… we try our best to blend activities to achieve the outcomes we want.” –CHC staff during FGD (CHC 02)

Consequently broad dissemination of information is limited, including barriers such as regional terrain and clinic availability. While respondents with health issues all reported a desire for active dialogue, many were limited by the clinics of Hai Duong, which are located in the mountains and can be separated by up to 12 km between each clinic.

Amongst patients in focus groups, participants were aware of NCDs as a developing issue; however, patients reported the difficulty of identifying one clear source of information: with overhead speakers, patients reported desensitization; with TV/radio, there was report of inconsistency of messages and no room for dialogue; with word-of-mouth and social networks, health anecdotes have the risk of perpetuating inaccurate health information. With all of these methods of communication, there is no direct exchange / real time dialogue with heath staff. In an increasing complicated information age, desire for accurate health information is high. As a patient described, “When it comes to health news, people find information through many different channels, but the kind of health information that is accurate and reliable, that is what's missing."
Existing barriers to mHealth implementation include: knowledge of and willingness to accept mHealth interventions (categorized as user readiness here), a health care system lacking centralized coordination of information, need for political/legal support, and cultural practices related to health care and cell phone uses.

While cell phone penetration and the coverage of the electrical grid were abundantly available, the associate practices regarding cell phone uses and patient attitudes regarding the health care system reflected a different type of barrier. As the head of the CHC commented, “...it seems like everyone has a cell phone, some people even have 2 cell phones. But how do we get people to understand how to communicate health concerns utilizing their cell phones, that’s a project that requires undertaking.”

Regional variation in health care practices is significant. In urban hospitals, there exist newly piloted programs with text-messaging systems to follow-up and provide reminders of appointments for hospitalized patients. However, even in the same institution, there may be multiple software/programs, without any centralized system to ensure consistency throughout Vietnam’s districts or provinces. As described by a health policy stakeholder in the Ministry of Information and Communications, “…It may be necessary to integrate [the management software]… for example, just at Bach Mai hospital there are 17 departments with 17 separate software programs…”

Among stakeholders, knowledge of mHealth varied from individuals incorrectly identifying “mHealth” as referring to mental health to those aware of various programs for providing health information utilizing cell phone technology. This broad difference in pre-existing awareness of mHealth amongst CHC staff was reflected in patient attitudes as well. Nonetheless, both stakeholders at the MoH and patients acknowledge the importance of financial stability, which afford time to "look at cell phones and read text messages" as a basis for allowing patients to be concerned with preventative health.

Amongst patients with NCDs, for both males and females, there was reluctance to adopting mHealth, resulting from lack of literacy (5/6 female patient with NCDs), visual impairments (6/6 female patient with NCDs and 5/5 male patients with NCDs), lack of knowledge on how to use / send text-messages (6/6 female patients with NCDs).

As one patient summarized regarding feasibility of mHealth in management of NCDs, “…there are people who can’t even turn on their phones. All they can do is answer calls: it’s the most widely-used function… Text messages are definitely difficult, especially for older age groups. Like… it could be that somebody’s kid buys them an iPhone, but he can’t do anything with it except answer calls.”

Of the 6 female patients without NCDs, 5 commented on the cultural barriers to managing NCDs. Patients discussed the chronic and progressive nature of NCDs, the difficulty of making life-style changes when immediate danger is not apparent, and the need for basic economic stability prior to worrying about prevention of illnesses. While 3/5 male patients without NCDs were receptive to the idea of mHealth, they reported disinterest in adopting the technology while healthy. As one female patient without NCDs patient summarized, “...I may be peri-menopausal and there may be risks for osteoporosis, I may need to take this medication or that, but I will only think about it when it becomes a full-blown illness.”
Users also expressed a clear desire for direct consultation, with physical examination. Of the 11 patients with NCDs, 4/5 males and 4/6 females reported the difficulty of foregoing a physical exam, stating "a phone cannot replace a doctor."

The market for SMS messages within in Vietnam is also fraught with spam messages; amongst patient groups, for both males/female and those with/without NCDs, a common theme was the difficulty of separating legitimate, validated text messages from advertisements.

**Objective 2: Factors related to acceptable mHealth (appropriate messages & financial considerations)**

Both CHC staff and patients shared a recognition of how effective use of mHealth could be more efficient, to save both time for travel and waiting for consultations, as well as improving the reach of information.

Patients were the main source of information regarding prioritizing the type of content, modality, and possible financing models for SMS, with responses reflecting different priorities depending on the participant’s NCD status.

Patients surveyed showed a generalized awareness of important risk factors in preventing NCDs (4/5 males without NCDs discussed their preference for information regarding alcohol/tobacco use, diet, and exercise as it related to prevention). Patients with NCDs (7/11) acknowledged the broader application of providing preventive health information to the general public, as well as their personal preference to have direct consultations at the clinic for their specific NCD/illness.

Amongst males with NCDs, there was a dismissal of medication reminders (3/5 respondents), citing instead the patient's responsibility to adhere to medications: “If someone already has an illness, like me, then they don't need a reminder [for medications].”

Patients with NCDs discussed how preventive information can be more efficiently disseminated via one-way SMS. Two-way SMS may incur patient costs. For patients with NCDs, there was also preference for direct dialogue with a CHC staff; as one patient summarized, "I would rather ask the doctor treating me. They can answer me directly, so I trust them. Sharing information over the SMS, I don’t trust.” Patients without NCD affirmed the concerns about cost to send 2-way SMS messages.

Of the 11 patients with NCDs, ten reported their willingness to receive messages indefinitely, so long as the content was validated and utilized correct Vietnamese spelling.

While participants expressed sentiments that health-related SMS would be better if it were free of charge, most (10/11 with NCDs) also supported payment at the baseline cost, assuming the information in the SMS was deemed relevant and worth the investment. As one patient summarized, "All the messages must be reviewed, approved, with a person responsible for the contents, (the message must be easy to read, easy to understand, and correct in all circumstances).” Moreover, both patients with and without NCDs independently proposed the idea of signing up for a pre-paid package of health information on a monthly basis (resembling the internet packages in Vietnam), so long as the information was validated and there was reputable support of using these materials.
Discussion

To our knowledge, this is the first qualitative study to examine the attitudes of health care workers and patients on the possibility of utilizing mHealth in chronic disease education and management in Vietnam. In terms of current NCD management, focus groups with CHC staff report the difficulty of managing NCDs among other priorities, particularly as the staff has limited specialized training, there are difficulties of reaching patients who have transportation limitations in the mountainous terrain of Hai Duong, and the absence of a centralized system to monitor and track NCDs. Patients discussed an awareness of the broad risk factors for chronic and progressive diseases such as NCDs, but expressed a desire for a concrete and clear source of information. While Vietnam’s rising economic status supported the idea of using technology to address resource limitations, this research has found significant barriers to user acceptance in rural Vietnam.

As mobile health interventions have been applied and researched more extensively in the developed world, reviewing literature related to the principles of success in more resource-abundant settings are helpful in the context of this particular study. Interventions based on behavior change theory are more effective, with tailored information, including real-time feedback and expert consultation are most likely to be useful to participants (Zhao et al 2016). With respect to this particular research, concerns regarding the accuracy of information, the rapidity of response rate, the degree of personalized information appears consistent with previously conducted research regarding mHealth in LMICs. Moreover, while patients conceded the possible value of utilizing mHealth to connect to health providers, the preference expressed was for expert consultation and direct consultation. Patients may have access to more technology and cell phones, but there is a lag in cultural changes adapting to Vietnam’s relatively new LMIC status. In particular, these differences are exaggerated within a rural Vietnamese province, where there may be literacy limitations.

Patient attitudes regarding the difficulty of verifying legitimate texts from the competing effect of spam reflects previous research regarding the effect of attrition, suggesting instead that patient-initiated communication involving individually tailored messages were more effective at maintaining use of new technology (Marshall et al 2013).

While it is true that this project focused on the use of SMS on simple phones as opposed to applications utilized on smartphones, far fewer technical limitations (mobile network coverage, web-based access, electricity, and maintenance of mobile phones) were identified than in other studies on the use of mHealth technology in LMIC countries (Woods et al 2012).

To unify a central theme amongst all surveyed participants, one of the largest barriers to addressing NCD management is the difficulty of managing multiple programs in a resource-constrained setting. While it is true that Vietnam was one of the first southeast Asian countries to establish a national program on NCDs in 2002, the government utilized a disease specific, vertical program which have separate national specialty hospitals / institutes and separation of disease diagnosis and treatment (National Cancer Control Program, 2010; Master Plan for Diabetes Mellitus Control and Prevention, 2010; National Hypertension Program, 2008; National Mental Health Program, 2002). Thus, any significant successful introduction of mHealth will likely rely on government-directed efforts, rather than short-term trials based on external funding. While the technical availability of cell phones, electricity, and data coverage makes mHealth a plausible means to improve access, significant barriers to introduction remain.

In examining the availability of mHealth/eHealth in the industrialized world, which has enjoyed much longer access and use of this technology, previous research has suggested slow uptake and adoption, secondary to sociotechnical, organizational, and cultural barriers (Jennett and Andruchuk, 2001;
Cresswell and Sheik, 2013). In well-integrated and well-developed health systems, such as the UK, digital health remains a market with limited penetration, despite plausible policy drivers (Gov.UK, 2015). One global survey of the health system in the UK in 2017 suggests that interoperability is a significant limitation, which may not be a technical issue of software design, but rather a consequence of multiple organizations facing barriers at the centralized macro system level as well as the individual user; one consequence of this may be the need for more initiatives that engage extensively with end-users and incentivize professionals (Lennon et al. 2017).

To apply this idea to this research, implementation of mHealth in a rural northern Vietnamese province for the management of NCDs would not be particularly feasible or acceptable, with the largest barriers being resource limitations in the absence of centralized support for mHealth/eHealth, cultural preference for direct consultation, and user limitations such as literacy and visual impairment.

Overall, research and evidence on this topic particularly in rural areas remains scarce. While both CHC staff and patients have identified the need for NCD reform, the direction of change must come from a centralized governmental source, which can prioritize appropriate policies. However, successful implementation must involve significant end-user feedback to inform the process of shaping the product.

**Limitations**

This is the first study linking mHealth and NCDs in rural Vietnam, which improves our understanding of how mHealth can address population-specific needs. These findings are likely to be relevant and generalizable to other rural settings in Vietnam, resource-limited regions with possible physical and cultural barriers to regular access of health care and accurate health information. Though, the study was small and utilized non-randomized sampling method, which may have introduced bias; participation was selected based on convenience/availability and likely does not reflect the characteristics of the whole population. Moreover, the site of research, which was done through affiliation with CHILILAB / Hanoi School of Public Health, with significant experience in participating research may not reflect the broader patient population and its frequency of interacting with the health system.

Study results, while not broadly generalizable, may be useful in guiding future mHealth interventions. While previous studies may have examined a specific product, this research sought to illicit underlying opinions and perception about cell phones as a means to deliver health information, particularly amongst those afflicted with NCDs. The study's limitation includes absence of triangulation, which would have improved data validity through the use of mixed methodology and multiple data analysis, including software. With a single researcher, data saturation is disputable and novel themes and concepts may have emerged from additional interviews.

This research has highlighted some of the key needs and difficulties related to accessing health information through cell phones, a novel approach towards addressing knowledge disparity and gaps in patient practices in resource-limited settings. Particularly with regards to patient preferences in terms of the type of text messages to be received and the difficulties of implementing SMS messaging in the context of competing sources of information, this may guide additional research as well as pilot interventions.
Follow-up research to quantify the extent of the perceived barriers to mHealth implementation would be useful in prioritizing the goals of mHealth design, development, and implementation. Potential users expressed a preference for calling; future research may consider the acceptability of call-based interventions, the scope and reach of a mHealth intervention, and how to optimize patient outcomes.

**Conclusion**

In summary, there are significant difficulties in the management of NCDs, which have significant overlapping risk factors and comorbidities, which may complicate the use of disease-specific vertical programming as exists in Vietnam. Given the resource-limited practice of health care, health care providers often have to independently prioritize many competing priorities, of which prevention of NCDs is only one. As Vietnam improves its economic status and the penetration of cell phone rises, mHealth has been considered and introduced into a number of pilot programs, ranging from abortion vouchers to emergency disaster alert systems, but its feasibility and acceptability in improving NCD education and management in a rural area does not yet seem feasible. In accordance with research in developed countries as well as other LMICs regarding acceptability, any mHealth program would only supplement the physical care of a physician-team.

Fundamentally, this research raises questions about the readiness of implementing mHealth in rural provinces, including user readiness in terms of technical competence, literacy, and visual impairment. While many of these cultural limitations may become less evident with time, the absence of clear government policies regarding centralized tracking systems and mHealth programs may halt any short-term mHealth initiatives. Thus, any long-term, effective programming will require governmental support and direction. Historically, Vietnam has been a country which has been enormously successful at introducing rapid change through government-led initiatives, including significant health system gains regarding maternal health, vaccinations, and decreasing infectious diseases. In order to introduce successful mHealth / eHealth, government policies supporting and guiding that process would be crucial for success. As Vietnam has shown remarkable ability to adapt and implement radical change, it continues to hold great potential for addressing complicated resource limitations with prudent strategies in order to better prevent and manage NCD and other health problems within Vietnam’s diversifying population.
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Annex 1:

Summary outline of main themes/topics as it relates to study objectives

Objective 1: Feasibility and acceptability of mHealth
   a. Current experience and challenge of NCD management
      i. Management of NCD is limited
         1. Limited methods to track & manage NCDs
         2. Limited sources of NCD health information
         3. Patients have limited knowledge/interest
         4. Existing infrastructure is limited
   b. Current barriers to mHealth implementation
      i. Existing knowledge of mHealth
         1. Willingness to utilize mHealth
      ii. Human resources
         1. Lack of patient technical skill (how to read/send SMS)
         2. Lack of literacy
         3. Lack of technical training of health staff
      iii. Cultural context:
         1. Distrust of SMS due to spam
         2. Curative mentality towards health care
         3. Lack of trust and interest
      iv. Healthcare context:
         1. Overwhelmed health system
         2. No centralized program
         3. Political/legal support

Objective 2: Factors related to acceptable mHealth (appropriate types of messages & financial considerations)
   c. Expectations of mHealth implementation
      i. Efficiency
         1. Information broadly disseminated with less monetary / time investment
         2. Increased access to health systems
   d. Areas of NCD primary care with room for mHealth implementation
      i. Education on prevention / of risk factors
      ii. Treatment/management not acceptable
         1. requires more health care system interaction
   e. Elements of an acceptable SMS message
      i. Format:
         1. Easy to understand
         2. Short messages
         3. Factually correct (credible, validated, legally accountable)
         4. Personalized
      ii. Method:
1. 1-way SMS

   iii. Topics:
       1. Prevention/risk factors awareness
       2. Appointment reminders
       3. No interest in medication reminders

f. Financial considerations
   i. Interest in free of charge
   ii. Willing to pay if content is credible / validated