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Article in *Informatics for Health and Social Care* · March 2020

DOI: 10.1080/17538157.2020.1755974

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# MHEALTH ADOPTION AMONG SINGAPORE SENIORS

## Seniors and mobiles: A qualitative inquiry of mHealth adoption among Singapore seniors

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Ethics approval:

This study was approved by the IRB of Nanyang Technological University (IRB-2013-12-021).

Funding:

This study was supported by a research grant from the Wee Kim Wee School of Communication and Information, Nanyang Technological University (M4081244.060).

Disclosure statement:

The authors have neither financial interest nor benefit from the direct applications of the study.

Notes:

This is the accepted (pending to journal formatting) version of the article that was accepted on March 20, 2020. Please contact the corresponding author for any updates. You can cite this as: Lin, T.T.C., Bautista, J.R., & Core, R. (in press). Seniors and mobiles: A qualitative inquiry of mHealth adoption among Singapore seniors. *Informatics for Health & Social Care*

# MHEALTH ADOPTION AMONG SINGAPORE SENIORS

## Seniors and mobiles: A qualitative inquiry of mHealth adoption among Singapore seniors

### Abstract

**Objective:** This study examines how seniors in Singapore use mobile devices for healthcare purposes.

**Methods:** Semi-structured interviews with 35 mobile phone users aged between 58 – 82 years old.

**Results:** Seniors regard mobile phones as important personal devices for socialization, security, and emergency purposes. Most of the seniors consider mobile telephony (voice calls and text messaging) as an accessible platform to access healthcare. Perceived usefulness, ease of use, compatibility, technology anxiety, financial cost, and self-efficacy were identified as factors affecting the use of mHealth among seniors. Although a few adopt mHealth applications and mobile Internet for health-information seeking, some younger seniors show enthusiastic attitudes towards its adoption. Additionally, some seniors also have technology anxiety and resistance toward using mHealth applications.

**Conclusion:** Seniors use mobile phones for healthcare purposes in their daily life, and its use involves several facilitators and barriers. Interpersonal training is likely to reduce their anxiety and increase mHealth literacy and adoption. Theoretical and practical implications are discussed.

**Keywords:** mHealth, mobile phone, senior, technology adoption, technology anxiety

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## Introduction

Mobile phones are one of the most adopted technologies in the world. As of December 2019, there are 9.37 billion mobile connections globally from 5.16 billion unique mobile users.<sup>1</sup> While the 2018 global mobile penetration rate is at 67%,<sup>2</sup> Singapore, a prosperous nation in Southeast Asia, has reached more than 100% since 2006<sup>3</sup> and smartphone penetration is at 91% as of 2019.<sup>4</sup> With an advanced mobile technology ecosystem,<sup>5</sup> Singapore provides an environment where mobile phones can be used to improve people's lives, including their health.<sup>6</sup>

While Singapore is experiencing increased mobile phone penetration rates, it is also facing a "silver tsunami" – an increasing population of senior citizens.<sup>7,8</sup> The country is considered as one of the fastest aging countries. Currently, 16% of Singapore residents (i.e., citizens and permanent residents) are aged 65 and above<sup>9</sup> and it is estimated that this will increase to 47% in 2050.<sup>10</sup> Given this situation, it is expected that there will be an increased demand for medical personnel and facilities to meet the healthcare needs of seniors in Singapore.<sup>11,12</sup> Since 2012, the government is building several facilities like senior activity centers, senior care centers and nursing homes as a response to the silver tsunami.<sup>11,13</sup>

Nonetheless, technologies like mobile phones can be used as a strategy to meet seniors' healthcare needs.<sup>11,14</sup> Given the high mobile phone penetration rate in Singapore,<sup>4</sup> it is feasible to leverage mobile technology to enhance seniors' health. For example, some researchers in Singapore have developed mobile health (mHealth) applications that can be used to enhance seniors' safety,<sup>15,16</sup> mental health,<sup>17,18</sup> chronic disease management.<sup>19</sup> On the other hand, seniors can download a variety of mHealth applications that are recommended by several Singapore health organizations like the Ministry of Health<sup>20</sup> and Singapore Health Services.<sup>21</sup>

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However, despite the availability of mHealth services that can be used by seniors in Singapore to manage their health, it is unclear how they use their mobile phones for health purposes in their everyday life. Past studies focusing on this group of people in Singapore have utilized quantitative methods (e.g. survey) to examine factors related to intention to use mHealth applications or services.<sup>6,22</sup> To complement previous works, this study conducts a qualitative inquiry to examine how seniors in Singapore use their mobile phones for health purposes and identify factors associated with its use. Overall, the findings of this study will provide insights on how seniors can appropriate their mobile phones to manage their health.

### **Literature Review**

#### *mHealth and Seniors*

The World Health Organization defines mHealth as the “medical and public health practice supported by mobile technologies, which involve the use of SMS, camera/video, internet access, sensing, and mobile applications via wireless networks (e.g., 3G/4G, GPS, and Bluetooth)”.<sup>23</sup> mHealth has the potential to enhance healthcare by serving as a practical channel to promote healthy behaviors or improve disease management.<sup>24,25</sup> With the growing adoption of smartphones globally,<sup>26</sup> mHealth provides a great opportunity to improve health communication in all levels of society.<sup>27-29</sup> For instance, studies show that the use of basic mobile telephony such as voice calls and text messaging are useful for medication adherence,<sup>30,31</sup> chronic disease management<sup>32,33</sup> and rehabilitation.<sup>34,35</sup> Overall, the goal of mHealth is to help improve health outcomes in all segments of the population.<sup>36-39</sup>

Nowadays, mHealth is also characterized by the use of mHealth applications that can be operated using smartphones.<sup>40,41</sup> It is estimated that there are at least 325,000 mHealth

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applications that can be downloaded by iOS and Android smartphone users.<sup>42</sup> A large portion of these applications focuses on wellness management, disease management, self-diagnosis, medication reminders, electronic patient portals, and physical medicine and rehabilitation.<sup>43</sup> Although younger people and those with higher education and income are more likely to utilize mHealth applications,<sup>40,45</sup> such technology provides greater benefits to senior populations especially to those with chronic diseases.<sup>32,46,47</sup>

A United Nations study suggests that the world is aging rapidly and governments need to address seniors' healthcare needs.<sup>48</sup> The increasing demand for medical personnel and facilities for senior healthcare is considered one of the greatest healthcare challenges in rapidly aging societies.<sup>12</sup> To help mitigate the potential negative impact of the silver tsunami, a growing body of research have been conducted to understand how mobile phones and mHealth applications can meet the healthcare needs of seniors. For instance, mHealth applications for seniors with chronic diseases have been developed to improve disease management.<sup>49-53</sup> As seniors tend to have mobility problems, several mHealth applications have also been made to prevent them from falls and injury.<sup>16,54,55</sup> Others have created mHealth applications by improving seniors' mental health<sup>17,18,56</sup> as well as medication administration.<sup>51,57</sup> Overall, these findings support the idea that mHealth has the potential to improve health outcomes among seniors.

### *Overview of mHealth for Seniors in Singapore*

Although mHealth development varies from one country to another,<sup>58</sup> Singapore-made mHealth applications for seniors have been developed since 2010.<sup>15-18</sup> However, it is only recently that the Singapore government, through its Ministry of Health, has created plans that recognize the role of mHealth on healthcare delivery among Singapore seniors. For instance, complementing

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Singapore's *Smart Nation* initiative (an initiative where technology will be used as a leverage to improve citizens' lives),<sup>59</sup> the government released the *Successful Ageing Action Plan* in 2016.<sup>60</sup> In this action plan, the government recognizes the role of mobile platforms as drivers of social and physical support. To realize this, the report indicates that the government will invest in aging-related research in different disciplines, including mHealth.

Aside from the *Successful Ageing Action Plan*, the government also noted the role of mHealth in their *Healthcare Manpower Plan 2020*.<sup>61</sup> Accordingly, mHealth applications will be used to increase seniors' access to healthcare services. Specifically, the plan reported its trial of the *Match-A-Nurse* mobile application that can be used by seniors to book for home nursing services from nurses within their vicinity.

Nonetheless, before these government action plans, the Ministry of Health has been active in promoting mHealth applications. For instance, in 2015, the Ministry of Health launched the HealthHub website that gives users access to several Singapore-made mHealth applications.<sup>62</sup> Although these mHealth applications are not exclusively tailored for seniors, most of them are applicable for them. Some of these mobile applications include *ActiveSG*, *AICare Link*, *KneeBuddy*, *Health Buddy*, *Healthy 365* and *Mobile E-care Locator*.<sup>63</sup>

Based on the details mentioned above, Singapore seniors not only have access to voice calls and text messaging but to the latest trends in mHealth such as mHealth applications. However, it is important to note that seniors are laggards when it comes to technology adoption.<sup>64,65</sup> As such, it is crucial to determine how they use their mobile phones for healthcare purposes and what factors can influence its adoption.

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### *Factors Associated with Seniors' Use of mHealth*

Several studies suggest that there are various factors associated with seniors' use of mHealth. A brief discussion of these factors is essential for the fact that some of them may be relevant to the results of this study.

First, studies have shown that there are factors that might facilitate seniors to utilize mHealth. For example, Deng et al.<sup>66</sup> found that psychological factors such as perceived value, positive attitudes and perceived behavioral control were positively related to intention to use mHealth applications. Moreover, several studies have shown that perceived ease of use<sup>6,67-70</sup> and perceived usefulness<sup>6,46,67,69-72</sup> were associated with seniors' intention to utilize mHealth applications. Another important factor to consider is that mHealth should be compatible with existing habits or lifestyles of seniors.<sup>6,49,73</sup> Finally, subjective norm was also found to positively predict seniors' intention to utilize mHealth.<sup>6,71,74</sup>

Second, several factors might also serve as barriers to seniors' use of mHealth. For instance, one of the most common barriers include technology anxiety.<sup>46,56,66,68,69,71,72</sup> Similarly, others noted that memory impairment because of aging can serve as a barrier when using mHealth applications.<sup>46,68,69,72,75</sup> Finally, scholars suggests that seniors are concerned with battery depletion and financial cost when using mHealth applications via smartphones.<sup>46,74,75</sup>

### **Research Questions**

Following the discussions above, this study aims to answer two research questions:

RQ1: How do seniors use their mobile phones for healthcare purposes?

RQ2: What factors influence seniors' adoption of mobile phones for healthcare purposes?



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## Method

### *Sampling and Interviewee Profile*

A total of 35 senior mobile phone users were interviewed between March and April 2014. All interviewees were recruited using snowball sampling method. Participants were either recruited from the researchers' professional contacts ( $n = 3$ ) or referred by senior centers ( $n = 24$ ) or by Singapore's Health Promotion Board ( $n = 8$ ). Most of the participants were female ( $n = 26$ ) and their average age was 67.80 ( $SD = 5.81$ , range = 58 – 82). Interviewees were classified into younger (58 to 65 years old,  $n = 15$ ) and older (66 to 82 years old,  $n = 20$ ) seniors to examine differences in their perceptions toward mHealth. In terms of education, most had primary ( $n = 12$ ) followed by those with secondary ( $n = 10$ ) and tertiary ( $n = 9$ ) level of education. Maximum variation sampling<sup>76</sup> was also utilized by interviewing former blue-collar workers and well-educated seniors with high income and occupational prestige (see Appendix A). At the time of the interview, a majority were diagnosed with chronic conditions such as hypercholesterolemia (46%) and hypertension (43%).

### *Interview Procedures*

After obtaining written and verbal consent, the researchers conducted semi-structured interviews using open-ended questions related to seniors' ownership of mobile phones and its use for healthcare purposes. Interviews were mostly conducted in community centers while some were conducted in other locations where interviewees preferred to meet such as coffee shops or food centers. Conversations were conducted using a mix of Mandarin and English and lasted within 30 minutes. Seniors were also asked to watch two short videos about mHealth applications (a general health application and a chronic disease monitoring application). Based on the

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interviewees' health situation, the researchers also selected one of three chronic disease monitoring applications (i.e., a heart disease application, a blood pressure monitoring app, or a diabetes monitoring app) for demonstration. Subsequently, questions were asked about their perceptions of these applications including their potential adoption. Throughout the interviews, probing questions were also asked to explore and clarify some of their responses. After each interview, USD 8 was given as an incentive for their participation in the study. All interviews were audio-recorded, transcribed verbatim and translated to English. The researchers received ethical clearance from the university's Institutional Review Board before data collection (IRB-2013-12-021).

### *Data Analysis*

To analyze data, the researchers performed qualitative thematic analysis with the aid of NVivo 11. Initially, English-translated interview transcripts were thoroughly read and systematically coded line-by-line. Codes were derived inductively (i.e. based on interview data)<sup>77,78</sup> and were constantly refined, collated and compared with each other until themes emerged.<sup>76</sup> Representative quotes were added in portions of the results to demonstrate the study's credibility.<sup>79</sup>

## **Results**

### *Ownership and General Use of Mobile Phones*

Most of the seniors own a smartphone device (66%). Interestingly, smartphone ownership is higher among younger (87%) than older seniors (50%). Almost half (49%) have postpaid subscription and a majority (66%) noted that they pay their own mobile phone bills. Around 51%

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do not have any data plan while only 35% can connect to the internet using 3G or 4G. Asked on how they usually use their mobile phones, a majority indicated that they frequently use it for voice calls (43%) followed by text messaging (34%), mobile instant messaging (23%), taking pictures (23%) and sending or receiving emails (17%).

For these seniors, their mobile phone was an instrumental device for them to keep in touch with family members since some of them do not live with their children.

*[My daughter] is currently in the US... I have a lot of groups you know, in my WhatsApp. My family has one group, so everything they send, all will see, especially for making appointments. (Interviewee 25, Female, 64)*

Moreover, they also noted that they always bring their mobile phones when going out of their homes. This is for the fact that bringing it with them provides means to coordinate their everyday activities and create a sense of security.

*If I'm going out with my friend and timing and all these things. You know, if I'm going to run late, I can just call them: 'Hey, I will be late for a few minutes' or whatever it is. And with that, you have the comfort that should you get lost, or should you get miscommunicated, there is a way out.' (Interviewee 23, Female, 66)*

### *Seniors' Use of Mobile Phones for Healthcare Purposes (RQ1)*

Despite having smartphones, most of the seniors tend to utilize basic mobile phone features for healthcare purposes (e.g. voice calls and text messaging). Nonetheless, some could use more advanced features such as using their smartphones to search for health information online or utilize mHealth applications.

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### Voice Calls

Most seniors tend to use their mobile phones to make voice calls. In this study, most of the seniors indicated that they use their mobile phones to make voice calls to their doctors or family members concerning their health. Interestingly, one participant with a heart disease shared how he intends to use voice calls during health emergencies.

*“If anything happens to me at the roadside, I will contact my family or my wife...or I will contact directly to NUH [National University Hospital]”* (Interviewee 4, Male, 66)

### Text Messaging

Text messaging was the second most utilized function of using the mobile phone for health-related purposes. For most seniors, mobile phones were instrumental for their healthcare as they used it to receive and reply text-based appointments and reminders from clinics or hospitals.

*“The hospital tends to send text messages and they don’t call. That was started by Alexandra Hospital. I think it is an even more better service because there is always a big queue [for appointments]. They will just ask you to give them a mobile number. You can go for a walk, when it is your turn, they will just text you.”* (Interviewee 1, Male, 69)

### Mobile Instant Messaging

Aside from SMS-based text messaging, some interviewees have used mobile instant messaging applications as part of their health activities. For example, interviewee 28 (Female, 68) created a WhatsApp (a mobile instant messaging application) group to motivate her friends to exercise every morning because she believed that this strategy could improve their physical and mental

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health. She is also using Whatsapp to encourage group members to share videos of their exercises.

*“When they (group members) are doing certain exercises, it’s so lovely, so I say ... use a smartphone to capture it and send it to all of us. So, we have been doing that, and the group became more cohesive, more friendly.”* (Interviewee 28, Female, 68)

### Searching Health Information Online

Among our interviewees, only three (8.5%) were using their smartphones to search for health information online. In general, these seniors tend to be younger and have higher educational attainment. One interviewee shared her experience of searching for health information online using a smartphone.

*“I normally just go to Google. I go there and search. I search whatever I want to type and then there are a lot of things. I just click on the thing and just read through it. I don’t use a certain website”* (Interviewee 29, Female, 68)

### mHealth Applications

Among 35 respondents, only six (17%) well-educated seniors had used mobile health applications previously. Four of them used general health information applications; one utilized a blood pressure monitoring app; and one used a pharmaceutical app to check potential side effects of medications. Among the interviewees, some enjoyed the ways that these applications expanded their health routines, but others disliked it. For instance, interviewee 24 (Female, 62) found iDat – the Health Promotion Board’s interactive diet and activity tracker – to be tedious.

*“You have to religiously key in everything you eat.”* (Interviewee 24, Female, 62)

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Similarly, interviewee 26 (Male, 60) tend to experience laziness when using a blood pressure app as he did not always enter his data consistently.

*“I am just lazy. Maybe I should delete it one day.”* (Interviewee 26, Male, 60)

In contrast, interviewee 25 (Female, 64) enthusiastically used several health and fitness mobile applications. She showed the mHealth application that allowed her to compete with the numbers of steps taken daily with her husband and pregnant daughter in California.

*“They (FitBit mHealth app) will tell you the distance you walk, how many calories you burn. Then they will send an email to tell you: ‘Congratulations on earning your badge. You have walked the distance required.’ Then they will tell you your most active day, your least active day. Because you have to achieve ten thousand steps a day, and then you have to climb ten floors a day.”* (Interviewee 25, Female, 64)

In terms of demonstrating general health applications and disease-specific applications to seniors, their reactions varied from complete disinterest to acceptance. Specifically, 13 had a positive reaction, 12 had a mixed reaction (they were somewhat interested, but also expressed some reservations about the applications) and 10 had a negative reaction. Overall, most of the seniors conveyed they can use mHealth applications if the benefits of its use were explained with adequate instructions provided.

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### *Factors Influencing Seniors' Adoption of Mobile Phones for Healthcare Purposes (RQ2)*

#### Perceived Usefulness

Davis<sup>80</sup> defined perceived usefulness as the belief that using a particular technology can enhance work performance and personal needs. In this study, perceived usefulness of mHealth is characterized when such technology can meet the health needs of seniors. Based on the interviews, most seniors were motivated to engage with mHealth if this can meet their needs. Among the 13 respondents who responded positively to the mHealth application demonstrations, several regarded that such technology can be used to better manage their health. For example, interviewee 24 (Female, 62) thought that using a self-care health app could empower seniors.

*“I think they (mHealth apps) can help the patient to know exactly what was actually wrong to lead them to this particular illness, and so how to take any corrective measures, and how to prevent it from getting worse. In this case that you want to help yourself, you will not be so lost and dependent on doctors.”* (Interviewee 24, Female, 62)

Some even strongly recommended that seniors should download a general mobile health application. Interviewee 26 (Male, 60) found such app beneficial and healthful because “*when you need it, it's just there.*” Similarly, interviewee 19 (Female, 69) liked a specific mHealth application because it provides a convenient way to seek health information. 72-year-old Interviewee 8 showed her willingness to learn the use of mHealth applications because of their usefulness for health. Moreover, several seniors who did not use the Internet to gather health information previously believed that mHealth applications could greatly improve their well-being and chronic disease management by using personal mobile phones.

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### **Perceived Ease of Use**

Perceived ease of use refers to the degree to which a technology can be used with less difficulty or effort.<sup>80</sup> In this study, most of the interviewees mentioned that using their mobile phone to perform voice calls and text messaging as part of their daily healthcare management was relatively easy to perform. One reason for this is that seniors are highly accustomed to using voice calls and text messaging in their everyday routine.

However, several of them acknowledged that advanced smartphone functions such as using mobile applications and browsing health information via the internet took time to learn. In response to the mHealth application demonstrations, most of the interviewees perceived that it is not simple to use. Such reactions are more pronounced among older seniors since most of them had less experience with using technologies such as computers.

### **Self-Efficacy**

Self-efficacy refers to one's capability to execute behaviors that are necessary to produce an outcome.<sup>81</sup> In the context of using technologies for health purposes, it is essential that an individual has the adequate capability (e.g., knowledge and skills) in using modern technologies like computers, the Internet and mobile phones.<sup>82</sup> In this study, 12 seniors have the capacity to use the internet to search for health information and services using desktop or laptop computers. In contrast, only a few seniors could use their smartphones to find health information or use mHealth applications. This indicates that most seniors seem to have greater self-efficacy in using the Internet to search for health information on desktop or laptop computers than mobile phones. Nonetheless, it is apparent that those who have the skills in using their mobile phones to search



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for health information and use mHealth applications are also adept in using desktops/laptop computers.

### Technology Anxiety

Venkatesh<sup>83</sup> describes technology anxiety as the fear or anxiety related to the possibility of using computer technology. More often, seniors experience technology anxiety as most of them lived when computers were not an essential part of daily life.<sup>84</sup> Consequently, technology anxiety serves as a barrier for them to learn new technologies like mHealth applications.<sup>66</sup>

Based on our findings, most seniors stated that they did not feel apprehensive about adopting new technologies. In fact, most of them would ask for help if they experienced any problems. However, beyond their statements, it is possible that the interviewees might have given socially desirable answers to save face. Nonetheless, several interviewees complained about their unpleasant experiences in learning to use a mobile phone. For example, interviewee 23 (Female, 66) was initially anxious to learn how to use a smartphone because it made her feel stupid.

*“My grandson, when he uses his iPad, he just knows the password and he just goes into the system and he just plays. And me, I look so stupid [when I use my smartphone].”*

(Interviewee 23, Female, 66)

### Lifestyle Compatibility

Although using mobile phones for voice calls and text messaging were part of these seniors' everyday routine, some think that using mHealth applications were incompatible with their lifestyle. For two of the oldest respondents, both of whom suffer from multiple co-morbidities,

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they are not interested in using mHealth applications since they perceived them as incompatible with their life. For example, one interviewee resisted using any mHealth app because he is already receiving professional healthcare with multiple doctors.

*“Because I have more (health information) than I am required to [understand]... I am taken care of by nine doctors. So, you understand, and I have a [health] program done by them personally.”* (Interviewee 2, Male, 82)

Similarly, interviewee 10 (Male, 79), who has diabetes, high blood pressure, and heart disease, showed no interest in the applications as he felt skeptic with Western medicine, and he disliked new technologies.

### Financial Cost

Whether using their mobile phones for health-related matters or not, financial cost remains to be a major concern among seniors. Some respondents who do not have smartphones mentioned that cost was a barrier for them to utilize mHealth. For instance, interviewee 3 (Female, 67) said she would like to use mHealth applications if only she could afford to have a smartphone. Since not all seniors have incomes that enable them to purchase a smartphone, some were only able to have a smartphone because it was a gift from friends, family, or charitable organizations. For example, interviewee 2 (Female, 82) was only able to receive a smartphone because it was given to her by a charitable organization.

On the other hand, some interviewees stated that they would only consider using a mHealth application if they could be assured that they can get it for free. Interviewee 21 (Male, 68) explained that he is worried about hidden costs associated with using these applications.

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Some of them also said that they did not have the money to purchase hardware that was needed to effectively use chronic disease monitoring applications. For instance, interviewee 17 (Female, 63) liked the blood pressure application that was shown to her, however, she could not use that application without a blood pressure cuff. Moreover, interviewee 23 (Female, 66), who is diagnosed with diabetes, pointed out that financial cost might deter seniors from using a glucose tracking application. She would be willing to pay for the mHealth solutions at a reasonable price but not many seniors could afford the recurring payment.

### **Discussion**

This study conducted in-depth interviews with 35 seniors and results show that they are using their mobile phones to manage their health in various ways. Although most of these seniors are smartphone users, most tend to use basic mobile telephony (e.g. voice calls, text messaging) for health purposes and only a few of them are using mHealth applications. However, the results of the application demonstrations indicate that a majority tend to have positive reactions with the use of mHealth applications.

The results show that most of the seniors have smartphones and younger seniors (65 and below) tend to have higher ownership rates than older seniors (66 and above). In general, the high smartphone ownership among the interviewees indicates that mobile technologies can be used as a feasible technology to provide healthcare services among senior populations.<sup>54,66</sup>

Although smartphones provide additional functionalities (e.g. access to mobile internet and mobile applications), the results suggest that seniors tend to use basic mobile phone functions, such as voice calls and text messaging, for both general and health-related purposes. Consistent with previous work, voice calls and text messaging are the top two functions for mobile phone

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use among seniors<sup>65,85,86</sup> A potential explanation on why these functions are mostly used is because seniors are familiar with performing these easy-to-use functions in their daily life.<sup>65,85,86</sup> This indicates that some mHealth interventions should still consider utilizing basic functions, such as voice calls and text messaging, to elicit greater acceptance among seniors. On the other hand, some interviewees who can utilize advanced smartphone functions (e.g., mobile instant messaging applications, mobile Internet, mHealth applications) for health purposes tend to be well-educated with greater self-efficacy. These functions can be added on top of basic functions when delivering health information.<sup>87</sup>

The results also uncovered several factors that were associated with seniors' mHealth use, including perceived usefulness,<sup>6,46,67,69-72</sup> perceived ease of use,<sup>6,67-70</sup> financial cost,<sup>46,74,75</sup> lifestyle compatibility,<sup>6,49,73</sup> and technology anxiety.<sup>46,56,66,68,69,71,72</sup> Consistent with previous work, self-efficacy was found as a key factor when assessing seniors' potential use of mHealth.<sup>56</sup> Following Davis' Technology Acceptance Model,<sup>80</sup> it is crucial that mHealth should be perceived to be useful and easy to perform for it to be acceptable. For example, this can be performed by providing seniors with adequate instructions on how to use a mHealth application and emphasizing the benefits of its use. Such instructions are highly important to encourage those with high technology anxiety and low technology self-efficacy to use mHealth applications. Similar to past studies,<sup>69,73</sup> it is important that mHealth should be compatible with the belief and lifestyle of seniors. Although a mHealth application might be useful and easy to use, seniors might not readily use it if it contradicts their lifestyle or belief. Finally, it is important to note that seniors have concerns with technical issues (i.e., battery depletion and the small screen size) when using smartphones for mHealth purposes.<sup>65,88</sup> These concerns can be mitigated by providing seniors with adequate assistance and technical support.

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## Implications, Limitations and Future Research Directions

### *Implications*

The results of this study provide several theoretical and practical implications. Theoretically, this study provides an in-depth qualitative analysis of how mHealth is utilized by seniors in Singapore. By doing qualitative research, this study complements past studies<sup>6,22</sup> that utilized a quantitative approach to examine factors influencing the use of mHealth among seniors in Singapore. In addition, with the increasing adoption of smartphones in Singapore, the results provide valuable insights on how this technology is currently used by seniors. We also contribute knowledge since this study identified relevant factors that can influence the use of mHealth among this group of people.

Moreover, the findings provide several practical contributions. As this study dealt with seniors, the results can help policymakers in Singapore to develop strategies on how to leverage on the growing use of smartphones by seniors. For example, relevant government agencies can provide incentives to those using mHealth applications. By providing incentives, they will be able to help increase the adoption of mHealth applications among seniors in Singapore.

Moreover, the government can also provide disadvantaged seniors with mobile phones and other subsidies to enhance access to mHealth as part of their social security benefits. Governments can also enhance their community and senior centers by providing internet connectivity. This is based on a Pew Research Center study that emphasized that one of the motivations for seniors to go online is to search for health information.<sup>89</sup> Other services such as face-to-face coaching (e.g., peer counseling program or community wellness program) can also be implemented within these centers to teach seniors how to find quality health information via mobile internet and use mHealth applications for various needs. Similarly, governments in rapidly aging countries should

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strongly support research and development on mHealth to develop culturally appropriate and acceptable mHealth services for seniors.

The results also provide practical information to application developers who are keen on creating mHealth applications for seniors. Based on the findings, developers should note that their application should be perceived to be useful, easy to use and compatible with the lifestyle of seniors. At the same time, they should also mitigate technical issues by optimizing the application's battery consumption to reduce perceptions that the application is causing mobile phones to run out of battery. Moreover, for a multi-ethnic society like Singapore, developing mHealth applications in various language modes is necessary to serve all seniors.

### *Limitations and Future Research Directions*

Although this study provided valuable insights, there are several limitations in the study that should be recognized. First, since the study was a qualitative study among seniors in Singapore, the results are not fully transferable to seniors outside Singapore. Future research can be conducted to expand the scope of the study by conducting cross-country comparisons with seniors from other countries.

Second, this study only found a few seniors who were using mHealth applications. Future studies can build upon the results of this study and conduct research among several seniors in Singapore that are using their smartphones to access mHealth applications. Such research is crucial considering that privacy issues may arise when health and personal information are collected in exchange for using free mHealth applications.<sup>90</sup>

Finally, although this research seeks variations among our interviewees, this study did not focus on seniors who are less healthy, less wealthy, less independent, and more disengaged from

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social networks. Future research can explore these mobile have-nots as they are likely to be late majorities or laggards of mHealth who may have different considerations in mHealth adoption.

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### Appendix A. Education and job details

ID	Education	Job (R = Retired)
1	Secondary	Business owner
2	Secondary	R - Sales
3	Primary	R - School Attendant
4	Secondary	R - Safety Coordinator
5	Secondary	R - Secretary
6	Tertiary	R - Nurse
7	Secondary	R - (unspecified)
8	Secondary	R - Nurse
9	Secondary	R - Telephone operator
10	Primary	R – Pharmacist
11	Unspecified	R - (unspecified)
12	Primary	Housewife
13	Primary	Housewife
14	Tertiary	Property agent
15	Secondary	R - Clerk
16	Primary	Housewife
17	Unspecified	R - Factory worker
18	Primary	R - Housekeeper
19	Primary	R - Fruit seller
20	Unspecified	R - Factory worker
21	Unspecified	R - Taxi driver
22	Primary	R - Cleaner
23	Tertiary	R - Financial advisor
24	Tertiary	Service industry
25	Secondary	R - Senior finance executive
26	Tertiary	R - Flight engineer
27	Tertiary	R – Business owner
28	Secondary	R - Health Assistant
29	Tertiary	R - Administrator
30	Tertiary	Nurse
31	Tertiary	R - Account Manager
32	Primary	Housewife
33	Primary	Housewife
34	Primary	R - Tailor
35	Primary	Housewife