Original Article

Public attitudes towards mobile health in Singapore: a cross-sectional study

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Background: Smartphone-mediated mobile health (mHealth) may assist patients with medication adherence, and disease monitoring. This study aimed to describe awareness and usage of, and attitudes towards, mHealth among the public in Singapore who own a smartphone. It also aimed to identify factors that influenced the above in the study population.

Methods: An online cross-sectional survey was administered via convenience sampling in November 2017. Participants were included if they were at least 18 years old and owned a smartphone. No identifiable data was collected. Responses were summarized using descriptive statistics. Multiple logistic regression analysis was used to identify factors associated with awareness and usage of, and attitudes towards, mHealth.

Results: Participants (n=199) were mostly of Chinese ethnicity (84.4%), female (64.8%), young (mean age 33.7 years), and generally healthy (86.9% reported no chronic medical conditions). On average, participants were aware of 4.4 out of 7 mHealth functions and used 2.2 functions. Managing appointments, and fitness/diet tracking were the most well-known (93.5% and 82.4% respectively), and widely used (80.6% and 59.8% respectively) functions. A simple interface, data security, and being free to use, were rated as the most important factors influencing participants' willingness to use mHealth. Most (64.3%) participants were keen to learn to use mHealth in future, 49.7% believed mHealth could help improve their health, but only 13.1% were willing to pay for it. Being employed (OR 3.71) was associated with higher mHealth usage, adjusted for baseline smartphone usage. Participants living in non-subsidized housing were more keen to try (OR 3.18), and willing to pay (OR 3.36) for mHealth.

Conclusions: Participants generally held positive attitudes towards mHealth, although usage was low. Lack of willingness to pay, and socioeconomic factors, are potential barriers to the widespread adoption of mHealth. Future research specifically involving patients is needed.

Keywords: Mobile health (mHealth); Singapore; smartphone; health knowledge; attitudes; practice

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Introduction

Mobile health (mHealth), specifically in the form of smartphone applications (apps), is expected to empower patients and potentially improve public health outcomes in the present and near future. For example, by addressing medication adherence, chronic disease monitoring, etc. (1,2). Even simple interventions like mobile phone text reminders have been reported to increase the odds of medication adherence, and reduce frequency of missed

appointments (3,4). Small studies across a range of chronic conditions have suggested potential for improved disease management with mHealth; though large-scale long-term evidence for clinical outcomes is still lacking (5). For example, a recent randomized controlled trial of a smartphone app reported no difference in blood pressure control at 12 weeks between the intervention arm and controls (6). Regardless, with anticipated advances in data analytics, artificial intelligence and smartphone technology, mHealth is expected to play an increasingly larger role in public healthcare in future.

Singapore is a multi-ethnic city state in South East Asia (population: 5.6 million) (7). It has one of the highest mobile phone penetrations (149.8% in 2016) and information technology (IT) connectivity in the world (with 84% of individuals reported to be internet users); coupled with an integrated and technology driven public healthcare system (8,9). According to the World Health Organization's 3rd Global Survey on eHealth, most mHealth program types were already established in Singapore, with several of them at the national level (10). In theory, these features put Singapore in prime position to take advantage of new developments in mHealth to benefit public health.

However, apart from the technical prerequisites, cultural practices and attitudes influence the adoption and implementation of new technologies and innovations. These attitudes also seem to vary significantly between countries and populations. For example, a study in Iran concluded that majority of older people had negative attitudes towards the use of mobile phones as teaching aids (11). Even smartphone-owners tended to mostly use the basic functions. On the contrary, a study among stroke patients in the USA suggested that increased aged was associated with the willingness to use mHealth—despite a relatively low smartphone prevalence of 35% (12).

In Singapore, however, despite the available technology, little is known about attitudes towards mHealth in general. As early as 2011, acceptance of using mobile phones to seek health information among Singaporean women was described using a technology acceptance model (13). The authors identified an "intention-behavior gap", and suggested that technical and design issues affected the conversion of intentions into behaviors. In 2015, Goh *et al.* described the short-term usage trajectories of a diet tracking app among type 2 diabetes mellitus patients, and identified some factors that affected their consistency of app usage (14). Recently, Zhang *et al.* demonstrated improved knowledge on coronary heart disease among Singaporean working adults using a smartphone-based educational program (15). However, this was a short 4-week pilot study. Apart from these studies, there is limited research on this topic in the local context—be it among the public, or within specific patient groups.

This study aims to describe current knowledge, practices and attitudes towards mHealth among members of the public in Singapore who already own a smartphone. It also attempts to identify factors that influence the above in the study population. Acknowledging and understanding these attitudes and behaviors will allow future mHealth solutions to be optimized to ensure greater public awareness and usage of mHealth in Singapore.

Methods

Study design

The study was designed as a cross-sectional survey to be administered via convenience sampling across a 2-week period in November 2017. Participants were included if they were at least 18 years of age, and reported owning a smartphone. The survey was anonymous, and no identifiable personal data were collected. Participants were encouraged to respond honestly by study team members, though their responses were not monitored. As participation in the study was voluntary and no identifiable information was collected, exemption from full Institutional Review Board review was granted.

Survey development & pretesting

The survey instrument included multiple choices, modified Likert scales, and yes/no questions. There were no compulsory open-ended questions. The survey was developed based on tools used in similar cross-sectional studies pertaining to mHealth, though discretion was exercised to ensure relevance to a Singapore context. mHealth functions were grouped broadly into 7 categories, which were loosely based on categories used in the WHO's 3rd Global Survey on eHealth: managing appointments, accessing health records, health information/education, fitness and diet tracking, disease monitoring, medication management, and contacting healthcare professionals. Survey questions were organized into 4 sections: (I) participant demographics, and background information pertaining to smartphone use; (II) awareness of general mHealth functions; (III) usage of general mHealth functions; (IV) attitudes towards mHealth in general, and factors influencing receptivity towards mHealth apps.

Simplicity was a guiding principle, to ensure that participants with a basic understanding of written English (equivalent to an elementary level) would be able to understand and complete the survey in 10 minutes with no assistance.

Survey items were pretested one-on-one with ten participants (including middle-aged and elderly participants) via a print-out of the proposed survey instrument. Modifications were made based on feedback to improve ease of understanding, and the survey instrument was uploaded to an online platform. A second round of pretesting with the online instrument was done among four participants to ensure readability on both personal computer, and mobile platforms.

Participants & survey administration

A convenience sampling method was used in view of practical challenges. Potential participants were offered participation in the online survey via online social media platforms, and at several public locations with high pedestrian traffic. The study objectives and risks were explained to them by a study investigator, and the link to an online anonymous survey was shared with them. The use of an online survey selected for participants who were minimally comfortable with computer or mobile device usage. Agreeable participants could choose where, and when to complete and submit their responses, though they were encouraged to do so within 24 hours. They were neither explicitly discouraged nor encouraged to share the survey link with others.

Statistical analysis

Descriptive statistics for categorical data were reported using frequencies and percentages. Subgroup analyses were conducted based on responses to section (I) of the survey (demographics and background smartphone usage), to assess whether they had an influence on responses on sections (II) to (IV) of the survey (awareness and usage of, and attitudes towards, mHealth). Responses for sections (II), (III), and (IV) were converted to numerical scores for each participant, and their means were compared between subgroups. For example, mHealth awareness was scored based on the number of "yes" responses across the 7 categories to derive a score out of 7.

Univariate dichotomous subgroup analyses were conducted using independent samples *t*-test to compare mean scores across responses. Factors identified as statistically significant were then compared using a multiple logistic regression to identify the factors that were independently associated with the outcomes after adjustment. All tests were two-sided and a P value of <0.05 was considered statistically significant. As subgroup analyses were considered hypothesis-generating, no adjustments were made for multiple comparisons.

Results

Participant characteristics

Across the 2-week survey period, a total of 199 eligible participants submitted responses (3 responses from participants aged below 18, and 4 responses from participants who declared not owning a smartphone, were excluded). Most of the participants were female (64.8%), of Chinese ethnicity (84.4%), and declared they were conversant in English (97.5%). The mean (standard deviation) age of the participants was 33.7 (13.9) years. Most of the participants were employed full-time (62.3%), and single (57.8%); though a significant proportion was married (39.2%). About half of the participants had attained a degree or diploma as their highest education level (54.8%), and most of them lived in public government-subsidized housing (78.9%) (*Table 1*).

A large majority of participants reported having no chronic medical conditions (86.9%), and no hospitalizations in the past year (88.9%). Of the 26 participants who reported having at least one chronic medical condition, 13 of them had at least 3 follow-up visits for their chronic conditions every year (50%). Although only 26 (13.1%) of participants reported having a chronic medical condition, 41 (20.6%) reported taking at least one regular medication daily; with only about half of them reporting taking their regular medications either "always" or "usually" (51.2%). A minority of participants reported using traditional medicines (14.6%) or supplements (37.2%) regularly.

Of the participants, 197 (99%) reported being able to independently make calls or use Short Message Service (SMS). More than 90% of them reported using their smartphone for sending/receiving emails, alarms and time management, entertainment, social media and communication apps. On average, each participant reported being able to use 6.9 out of 8 smartphone functions listed in the survey (i.e., smartphone usage score) (*Table 2*).

General mHealth awareness, usage, and attitudes

Managing appointments (93.5%), and fitness and diet

Table 1 Baseline demographic & medical characteristics of participants

Characteristics	Respondents (%)[†] (n=199)
Demographic characteristics	
Sex	
Male	70 (35.2)
Female	129 (64.8)
Age (years), mean ± SD	33.7±13.9
Ethnicity	
Chinese	168 (84.4)
Malay	17 (8.5)
Indian	8 (4.0)
Others, or not reported	6 (3.0)
Languages (spoken/written)	
English	194 (97.5)
Mandarin	168 (84.4)
Malay	39 (19.6)
Marital status	
Single	115 (57.8)
Married	78 (39.2)
Divorced	4 (2.0)
Widowed	2 (1.0)
Employment status	
Employed (full-time)	124 (62.3)
Employed (part-time)	20 (10.1)
Unemployed/retired	55 (27.6)
Educational level	
Degree/diploma	109 (54.8)
Secondary or pre-university	71 (35.7)
Primary or below	19 (9.5)
Residential status	
Public housing	157 (78.9)
Private housing	42 (21.1)
Medical characteristics	
Chronic conditions	
None	173 (86.9)
1 to 3	24 (12.1)
More than 3	2 (1.0)
Hospitalizations (in the past year)	
None	177 (88.9)
1 to 2	19 (9.5)
3 or more	3 (1.5)
Chronic disease visits (per year), n=26[‡]	
None	6 (23.1)
1 to 2	7 (26.9)
3 or more	13 (50.0)
Regular follow up locations	
No regular visits	166 (83.4)
Polyclinic	11 (5.5)
Private GP/family doctor	12 (6.0)
Specialist, public hospital	11 (5.5)
Specialist, private	5 (2.5)
Regular medications (daily)	
None	158 (79.4)
1 to 3	39 (19.6)
More than 3	2 (1.0)
Compliance, n=41[§]	
Always/usually	21 (51.2)
Sometimes/rarely	20 (48.8)
Others (regular)	
Traditional medicines use	29 (14.6)
Supplements use	74 (37.2)

[†], unless otherwise specified; [‡], only including participants reporting chronic conditions; [§], only among participants who reported taking regular medications. GP, general practitioner.

tracking (82.4%) were the mHealth functions with the highest awareness among participants. Less than half were aware of disease monitoring (43.2%) and medication management (43.2%) as mHealth functions. The mean (SD) mHealth awareness score (out of 7) was 4.41 (2.2) (*Table 3*).

This was similar to mHealth usage, where managing appointments (80.6%), and fitness and diet tracking (59.8%) were the most reported functions. A minority of participants reported using smartphones for disease monitoring (23.3%)

Table 2 Baseline smartphone usage characteristics of participants

Baseline smartphone usage	Respondents (%)† (n=199)
Independently call or text	197 (99.0)
Smartphone use	
Sending & receiving E-mails	189 (95.0)
Alarms & time management	180 (90.5)
Entertainment	190 (95.5)
Social media/communication apps	196 (98.5)
Reading news	146 (73.4)
Online shopping/ordering	142 (71.4)
Transport & navigation	179 (89.9)
Banking & electronic payments	153 (76.9)
Use score (out of 8), mean ± SD	6.9±1.5

†, unless otherwise specified. Note: the "smartphone use score" is a count of the number of functions (out of the 8 surveyed) a respondent regularly (and independently) uses his or her smartphone for. The ability to call or text independently is not considered part of the smartphone use score as these functions can be performed on older GSM-only handphones without internet connectivity.

Table 3 Mobile health awareness and usage among participants

Mobile health functions	Awareness, n (%)†	Usage, n (%‡)†
Managing appointments	186 (93.5)	150 (80.6)
Accessing health records	115 (57.8)	38 (33.0)
Health information or education	133 (66.8)	63 (47.4)
Fitness or diet tracking	164 (82.4)	98 (59.8)
Disease monitoring	86 (43.2)	20 (23.3)
Medication management	86 (43.2)	21 (24.4)
Contacting healthcare providers	109 (54.8)	45 (41.3)
Average score (out of 7), mean ± SD	4.41±2.2	2.18±1.9

†, unless otherwise specified; ‡, usage percentage reported as proportion of participants who were aware of that specific mHealth function. Respondents who declared being unaware of a specific function were defaulted to 'non-users'. The questions were phrased as "Are you aware that you can use your mobile device for this purpose?" and "Do you use your mobile device for this purpose?" for awareness and usage respectively.

and medication management (24.4%). The mean (SD) mHealth usage score (out of 7) was 2.18 (1.9) (*Table 3*).

Participants were asked whether they felt each of the seven functions were useful, and these were then converted to scores (out of 1) to allow for comparison (very useful: 1 point; somewhat useful 0.5 point; not useful at all: 0 points). Managing appointments had the highest overall 'usefulness score' (0.75). On average, the mean mHealth 'usefulness' score across all seven functions was 0.70 (*Table 4*).

Participants were asked to rate how much they agreed or disagreed with three statements, and their responses were converted to scores (out of 1) to allow for comparison (agree: 1 point; neither agree nor disagree: 0.5 point; disagree: 0 point). About half of the participants (49.7%) agreed that mHealth had the potential to make them healthier, mean 'health improvement score' 0.73. Most of the participants (64.3%) agreed that they were keen to learn about and try mHealth solutions in future, average mHealth 'receptivity score' 0.82. However, only a minority of participants (13.1%) agreed that they would be willing to pay for mHealth solutions, mean 'willingness of pay' score 0.38 (*Table 5*).

Participants were also asked to rate how important they felt six features were in influencing their receptivity to using mHealth. Most participants felt that having a simple interface (71.9%), data security and privacy (71.4%), and being free to download and use (67.8%) were very important. Only a minority of participants felt that automatic login (29.6%) was very important (*Table 6*).

Factors influencing mHealth awareness, usage, and attitudes

Univariate analyses suggested that lower mHealth awareness scores were associated with age 50 years and above (3.32 *vs.* 4.70, P=0.002), Chinese ethnicity (4.27 *vs.* 5.22, P=0.026), being married (3.87 *vs.* 4.77, P=0.007), and having a lower smartphone use score (2.76 *vs.* 4.61, P<0.001). After adjustment using binary logistic regression, only a higher smartphone use score was significantly associated with an awareness score of at least 6 (OR: 1.69, P<0.001). Age, ethnicity, and marital status were no longer statistically significant (*Table 7*).

Univariate analyses suggested that lower mHealth usage scores were associated with age 50 years and above (1.54 *vs.* 2.35, P=0.006), Chinese ethnicity (2.04 *vs.* 2.94, P=0.014), not being employed (1.75 *vs.* 2.35, P=0.039), not having a diploma or degree (1.83 *vs.* 2.48, P=0.015), and having

Table 4 Participants' perceived usefulness of mobile health

Mobile health attitudes	Not useful at all[†]	Somewhat useful[†]	Very useful[†]	Usefulness score[‡]
Managing appointments	6 (3.0)	89 (44.7)	104 (52.3)	0.75
Accessing health records	10 (5.0)	108 (54.3)	81 (40.7)	0.68
Health information/education	7 (3.5)	107 (53.8)	85 (42.7)	0.70
Fitness/diet tracking	11 (5.5)	94 (47.2)	94 (47.2)	0.71
Disease monitoring	9 (4.5)	103 (51.8)	87 (43.7)	0.70
Medication management	12 (6.0)	101 (50.8)	86 (43.2)	0.69
Contacting healthcare providers	11 (5.5)	104 (52.3)	84 (42.2)	0.68
Mean ± SD[‡]				0.699 ± 0.24

[†], reported as n (%); [‡], the 'usefulness score' is a weighted average computed by assigning scores of 0, 0.5, or 1 to the possible responses ("not useful at all", "somewhat useful", and "very useful" respectively). A higher score implies a more favourable attitude towards the usefulness of the specific mHealth function. The mean usefulness score of all the functions is a measure for participants' attitude towards usefulness of mHealth in general.

Table 5 Participants' attitudes towards mobile health

Statements	Disagree[†]	Neither[†]	Agree[†]	Score[§]
I think mobile health has the potential to make me healthier	9 (4.5)	91 (45.7)	99 (49.7)	0.73
I am keen to learn about and try new mobile health solutions in future	2 (1.0)	69 (34.7)	128 (64.3)	0.82
I would be willing to pay for mobile health solutions	75 (37.7)	98 (49.2)	26 (13.1)	0.38

[†], reported as n (%); [§], this score is a weighted average computed by assigning scores of 0, 0.5, or 1 to the possible responses ("disagree", "neither agree nor disagree", and "agree" respectively). A higher score implies a higher level of agreement with the statement.

Table 6 Factors influencing participants' receptiveness to using mobile health solutions

Factors	Not important at all[†]	Somewhat important[†]	Very important[†]	Importance score[‡]
Free to download and use	2 (1.0)	62 (31.2)	135 (67.8)	0.83
Simple interface	4 (2.0)	52 (26.1)	143 (71.9)	0.85
Multiple language support	7 (3.5)	76 (38.2)	116 (58.3)	0.77
Data security & privacy	2 (1.0)	55 (27.6)	142 (71.4)	0.85
Minimal data-entry	6 (3.0)	94 (47.2)	99 (49.7)	0.73
Automatic login	31 (15.6)	109 (54.8)	59 (29.6)	0.57

[†], reported as n (%); [‡], the 'importance score' is a weighted average computed by assigning scores of 0, 0.5, or 1 to the possible responses ("not important at all", "somewhat important", and "very important" respectively). A higher score implies more importance ascribed to that factor by respondents collectively.

a lower smartphone use score (0.67 *vs.* 2.37, P<0.001). After adjustment using binary logistic regression, Chinese ethnicity (OR: 0.36, P=0.026), employment status (OR: 3.71, P=0.022), and smartphone use score (OR: 1.77, P=0.004), were significantly associated with a mHealth usage score of at least 4. Highest attained education was no longer statistically significant (*Table 7*).

After adjustment, only higher smartphone use score was associated with participants agreeing that mHealth is useful (OR: 1.26, P=0.028). Participants living in private housing

Table 7 Logistic regression analysis of factors influencing awareness, usage, and attitudes towards mHealth

Outcome	Factors[†]	OR	P value
mHealth awareness score ≥6 (out of 7) (n=36)	Age (years)[‡]	1.02	0.257
	Chinese ethnicity	0.51	0.105
	Married	0.57	0.203
	Smartphone use score[‡]	1.69	<0.001
mHealth usage score ≥4 (out of 7) (n=11)	Age (years)[‡]	1.00	0.620
	Chinese ethnicity	0.36	0.026
	Employment	3.71	0.022
	Education (diploma/degree)	0.88	0.765
	Smartphone use score[‡]	1.77	0.004
Agree that mHealth has potential to improve health (n=99)	Housing (private)	2.12	0.038
	Smartphone use score[‡]	1.10	0.329
Keen to learn about and try new mHealth solutions in future (n=128)	Chinese ethnicity	0.36	0.252
	Mandarin language	0.67	0.644
	Housing (private)	3.18	0.008
	Smartphone use score[‡]	1.33	0.007
Willing to pay for mHealth (n=26)	Housing (private)	3.36	0.006

[†], only factors identified as statistically significant in univariate analysis were included in the multiple logistic regression models. Subsequently, P values <0.05 were considered statistically significant (factors in bold). Odds-ratio (OR) >1 implies a positive relationship with the outcome, OR <1 implies a negative relationship with the outcome. [‡], for age and smartphone use score, the ORs are in relation to a one unit increase in the factor (i.e., a 1-year increase in age, or a 1 unit increase in smartphone use score).

were more likely to agree that mHealth had the potential to improve health (OR: 2.12, P=0.038). Participants living in private (non-subsidized) housing (OR: 3.18, P=0.008), and with higher smartphone scores (OR: 1.33, P=0.007), were more likely to be receptive to learning or trying mHealth in future. Living in private housing was also significantly associated with a higher willingness to pay for mHealth (OR 3.36, P=0.006) (*Table* 7).

Discussion

The survey process obtained a diverse, albeit somewhat skewed sample. Females seemed overrepresented, which could indicate a difference in willingness to complete the survey. Although young people were overrepresented (sample median age 28, versus Singapore residents' median age of 40.5 in 2017), this may be explained by the targeting of people who own a smartphone (7). The respondents were relatively healthy, with only a minority reporting chronic medical conditions.

The respondents appeared to have relatively high awareness, but a comparatively low usage of mHealth (on average, they were aware of 4.4 functions out of 7, but used only about 2.2 functions themselves). Most of them were aware of appointment management, and fitness or diet tracking functions, and these were the most popularly used mHealth functions as well. Singapore has an established system of booking appointments electronically, especially in the public healthcare sector. High profile campaigns by the Health Promotion Board to encourage Singaporeans to monitor their physical activity and diet using smartphones (e.g., National Steps Challenge) likely contributed to the high awareness of such functions (16). In this relatively healthy sample, medication management and disease monitoring were the least popular, in terms of both awareness and usage (as might be expected). Health promotion or disease prevention might be more relevant for them.

After adjusting for baseline smartphone usage, participants who were employed were more likely to use mHealth, which could be indicative of their higher spending

power. Perhaps counterintuitively given their relatively higher socioeconomic status, participants of Chinese ethnicity seemed less likely to use mHealth. This might be due to a preference for mHealth apps in Mandarin, or simply due to a skewed sampling of ethnic minorities; who may have been somewhat underrepresented (15.6% *vs.* Singapore residents' minority proportion 25.8%) in this sample. This contrasts with an American study which reported that minorities were less likely to engage in a mHealth medication adherence program for diabetics (17). On the other hand, Serrano *et al.* suggested that Hispanics were more willing to exchange medication reminders via mobile devices compared to non-Hispanic whites (18). Clearly, the influence of ethnicity on mHealth usage merits further study. Application developers may also need to consider the diversity in Singapore to better target their products (for example, by having multilingual support).

The effect of gender or sex on mHealth usage and receptiveness is still unclear. In the Singaporean study by Goh *et al.*, female patients were more likely to more likely to be consistent users of the app than males (14). Female stroke patients were reported as being more receptive toward mHealth blood pressure monitoring (12). Conversely, among oncology patients in Germany, males were more receptive to app-assisted cancer care (19). However, our study did not identify any significant differences between males and females. A plausible hypothesis is that gender differences are less significant in a relatively younger study population (such as ours).

Although mHealth usage was not particularly high, our results suggest positive attitudes towards mHealth; average usefulness score of mHealth computed to be 0.7 out of 1, about half agreed it might improve their health, and 64% reported being willing to try or learn about mHealth. Perhaps surprisingly, age did not appear to affect attitudes towards mHealth significantly. However, various studies have reported on negative attitudes among the elderly towards mobile or digital interventions such that the impact of age cannot be disregarded (11,18-20). Participants ranked data security and privacy, and having a simple interface, as the most important factors influencing their receptiveness towards mHealth.

Despite their apparently positive attitudes, only a minority (13.1%) were willing to pay for mHealth. This is reasonable considering that about 90% of mHealth apps are free to use for consumers (21). Participants living in non-subsidized private housing (a proxy for socioeconomic status) were more willing to pay for mHealth solutions. They were also more likely to agree that mHealth could improve their health, and were more receptive to using or learning Health. This has potential implications for healthcare policies or business decisions pertaining to mHealth. Out-of-pocket payments could inadvertently exclude people with poorer health and socioeconomic status from mHealth solutions. Thus, development of effective mHealth solutions might require public funding, or alternative means of monetization.

Apart from demographic factors and attitudes, the variable quality of available mHealth apps needs to be acknowledged. Previous research has attempted to systematically evaluate the quality of some of these apps, particularly medication adherence apps. Dayer *et al.* highlighted that most of these apps were targeted to consumers (rather than healthcare professionals), and considered that a limitation of the market at the time (22). Santo *et al.* found majority of these lacking in desirable features, but did identify some high-quality apps which could be of value (23). The effectiveness of these apps in actually improving adherence in coronary heart disease patients is being studied (24). Healthcare professionals, including physicians, pharmacists, nurses, and allied professionals, should actively evaluate such apps and consider how these may be integrated into practice.

The results of this pilot study suggest that demographic and socioeconomic factors influence Singaporeans' awareness, usage of, and attitudes towards for mHealth. Hence, despite the promise, for mHealth to be an effective tool for public health purposes (e.g., improving preventive care, improving disease outcomes), the social determinants that influence its use need to be acknowledged and understood. This is pertinent given the pressure for scarce resources to be used effectively in public health. Future well-designed studies, especially with systematic sampling among groups who could benefit most from mHealth, such as patients of chronic diseases, are necessary to further knowledge in this area.

This study has several key limitations. Firstly, convenience sampling could have led to a non-representative sample. Secondly, being a self-reported survey could have compromised the quality of data, as participants' interpretations may vary, and there was no means to verify whether their answers were accurate. However, it was hoped that anonymity allowed participants to be more honest. Thirdly, the survey instrument used has not been independently validated. Finally, the small sample size and cross-sectional design of the study means that these

findings should be interpreted as exploratory or hypothesis-generating.

Conclusions

In conclusion, this cross-sectional survey reported on the general awareness and usage of mHealth among generally healthy smartphone-owning residents in Singapore. Participants in general held positive attitudes towards mHealth. However, lack of willingness to pay, and effects of socioeconomic and demographic factors, are potential barriers to the widespread adoption of mHealth solutions. Further research is necessary to inform the use of mHealth for public health goals in Singapore.

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Footnote

Conflicts of Interest: The authors have no conflicts of interest to declare.

Ethical Statement: As participation in the study was voluntary and no identifiable information was collected, exemption from full Institutional Review Board review was granted. Informed consent was obtained and participation was voluntary.

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