Prevalence and correlates of medication reminder app 'use and use intention' among older adults

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ABSTRACT

Background: Medication adherence is relatively poor among older adults. Although there exist medication reminder apps, data on the prevalence and correlates of their 'use and use intention' by older adults are limited.
Objective: To examine the prevalence, and socio-demographic and health correlates of medication reminder app use and use intention among older adults in Singapore.
Methods: Data from a nationally representative survey of 2228 adults aged 62 years and above, who were taking at least one prescription medication, were analysed. Medication reminder app use (in the past one month) and use intention (in the next one month) were self-reported. Bivariate and multivariable logistic regression models were used to identify the correlates of medication reminder app use and use intention.
Results: The prevalence of medication reminder app use and use intention was low at 2.6% (comprising 0.5% for use and 2.1% for use intention). Age, ethnicity, education level, previous participation in information technology/ computer-related courses, comorbidity, health literacy, medication adherence and polypharmacy were correlated with app use and use intention in multivariable analyses.
Conclusion: The very low prevalence of medication reminder app use and use intention among older adults in Singapore and identified correlates point to opportunities to increase the use of such apps.

1. Introduction

Adherence to prescribed pharmacotherapy regimens is crucial to maintain the clinical effectiveness of prescriptions in chronic conditions.[1] High medication adherence contributes to improved health outcomes, decreased medication and hospitalisation costs, and fewer emergency visits among patients with chronic diseases.[2,3] While optimal therapeutic efficacy requires high medication adherence rates, such as 80% and higher in the case of hypertension and cardiovascular diseases, adherence to chronic medications is reported to be only around 50%.[4,5] Older adults, aged 60 years and above, are especially at risk of medication non-adherence; in Singapore, 60% of older adults with at least one chronic illness had medication non-adherence.[6] Poor medication adherence among older adults has been attributed to the higher prevalence of comorbidities, cognitive decline, polypharmacy, and frequent alteration of prescriptions, versus young adults.[7]

Health-related digital applications (apps) on mobile devices, which trigger medication reminders, store pills-taking records and provide medication information, have shown potential in facilitating self-management of chronic diseases and improving medication-taking behaviours.[8–10] A recent review, evaluating the effectiveness of mobile app-based interventions on medication adherence in patients with cardiovascular disease, noted improvements to medication adherence in 9 out of 16 randomised trials.[9] Additionally, qualitative studies have revealed that patients with chronic diseases perceive medication reminder apps to be useful in assisting with medication intake.[11,12] However, research on medication reminder app 'use and use intention', such as its prevalence and correlation with socio-demographic or health factors, focusing on older adults, is limited.[13–15]

Singapore is an excellent setting to study the prevalence and correlates of medication reminder app use and use intention among older adults. First, it has a rapidly ageing population – the proportion of older adults in the population, almost 20% in 2017, is projected to double by 2050.[16] Second, although nearly one in three older adults reported having three or more chronic diseases, more than half of older adults with chronic conditions had medication non-adherence.[6] Third, there is a strong emphasis in Singapore on the wider adoption of digital technology in daily life, including for health purposes.[17]

Thus, we aim to (1) assess the prevalence of medication reminder app use and use intention, and (2) identify the socio-demographic and health correlates of medication reminder app use and use intention among older adults taking prescription medications in Singapore.

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2. Methods

2.1. Data source and analytical sample

Data were from THE SIGNS Study-II, the second wave (conducted in 2019) of "Transitions in Health, Employment, Social Engagement, and Intergenerational Transfers in Singapore Study", a nationally representative longitudinal study of community-dwelling Singapore citizens and permanent residents aged 60 years and older (at baseline in 2016 -2017). Questions on use and use intention of digital technology for health purposes, including medication reminder apps, were asked only in THE SIGNS Study-II from its 2887 participants, aged 62 years and older. Detailed information about THE SIGNS Study-II (approved by the Institutional Review Board at the National University of Singapore (Reference code: B-15-152)) can be found elsewhere.[18] Written informed consent was taken from all participants. After excluding 644 individuals who were not taking any prescription medications (and therefore not asked about medication reminder app use and use intention), and 15 individuals from the 'Others' ethnic group (none of whom indicated medication reminder app use and use intention), the final analytical sample comprised 2228 older adults taking one or more prescription medications.

2.2. Medication reminder app use and use intention

We operationalised use and use intention as a binary variable (Yes/No) based on two questions: '*In the last one month, have you used an app on a phone or tablet to remind you about when to take your prescription medications*' (response options: Yes, No, Don't know, Refused) and '*How likely are you in the next one month to use an app on a phone or tablet to be reminded about when to take your prescription medications?*' (asked only to those who answered 'No' to the first question; response options: Very likely, Somewhat likely, Somewhat unlikely, Very unlikely, Don't know, Refused). Those who responded 'Yes' to the first question or 'Very likely'/'Somewhat likely' to the second question were taken together as older adults with medication reminder app use and use intention. Use and use intention were combined together for the main analysis as the sample size of each variable was small. Furthermore, the literature suggests that use of technology is highly correlated with intention to use.[19] Nonetheless, in exploratory analysis, presented in Supplementary Tables 1–2 (Appendix B), we also considered the two variables as separate outcomes.

2.3. Potential correlates

Several potential correlates were considered and classified under predisposing, enabling, and need factors in accordance with Andersen's Behavioural Model, which is commonly used for identifying correlates of healthcare service use.[20,21] Predisposing factors included age, gender, ethnicity, education level, and housing type. Enabling factors comprised previous participation in information technology (IT)/computer courses (in the past year), personal mastery, and social networks.[22,23] Need factors included self-rated health, hearing impairment, vision impairment, physical function limitation, comorbidity, health literacy, polypharmacy, and medication adherence. Details on the conceptual framework and potential correlates are provided in the Supplementary Text (Appendix A). Use of smartphones/tablets was not included as an enabling factor because all but one respondent with app use and use intention did not use smartphones/tablets regularly. The analysis limited only to those who used smartphones/tablets regularly is presented in Supplementary Table 3.

2.4. Statistical analysis

The proportion of participants with medication reminder app use and use intention, overall and its distribution by each potential correlate, was first assessed. Unadjusted and adjusted associations of the potential correlates with medication reminder app use and use intention were then ascertained using bivariate and multivariable logistic regression models, respectively. Sampling weights accounting for attrition between the first and second waves of the survey were used for all analyses, which were conducted using Stata/SE 15.0.

3. Results

The prevalence of medication reminder app use and use intention among older adults in Singapore taking prescription medications was 2.6% (comprising 0.5% for app use and 2.1% for app use intention, Table 1). In multivariable analyses, age, ethnicity, education level, previous participation in IT/computer courses, health literacy, comorbidity, medication adherence and polypharmacy were associated with medication reminder app use and use intention.

In the context of predisposing factors, while those aged 80 years or older had lower odds (versus those aged 62–69 years, Odds Ratio [OR] = 0.21 [95% Confidence Interval [CI]: 0.06–0.81]) of medication reminder app use and use intention, those of Indian ethnicity (versus Chinese, 2.21 [1.00–4.86]) and those with secondary or higher education level (versus none or primary, 2.23 [1.07–4.65]) had higher odds.

The only enabling factor associated with app use and use intention was previous participation in IT/computer courses. Those who had attended such courses, versus not, had higher odds (3.53 [1.42–8.28]).

In terms of need factors, older adults with adequate health literacy (versus limited or marginal, 2.63 [1.37–5.02]), with comorbidity (versus without, 2.64 [1.17–5.96]), and those non-adherent to their medications (versus those adherent, 2.07 [1.15–3.71]) had higher odds of medication reminder app use and use intention, while those with polypharmacy (versus without, 0.15 [0.04–0.56]) had lower odds.

In the analysis of app use and use intention as separate outcomes, no potential correlate was associated with app use, while age, ethnicity, previous participation in IT/computer courses, health literacy, comorbidity, medication adherence and polypharmacy were associated with use intention (Supplementary Tables 1–2). Results for the analysis limited to those who used smartphones/tablets regularly were largely consistent with the main analysis (Supplementary Table 3).

4. Discussion

This study is the first to provide a nationally representative prevalence estimate (2.6%) of medication reminder app use and use intention among older adults in Singapore taking prescription medications, as well as its correlates. In terms of predisposing factors, those oldest-old were less likely, whereas older adults of an ethnic minority (Indian) and those with secondary or higher education were more likely to have medication reminder app use and use intention. This is consistent with the literature – higher use of health-related apps among those of younger ages (versus older) and higher (versus lower) education has been reported by studies from the United States, China, and Germany.[13–15] Among enabling factors, previous participation in IT/computer courses increased the odds of medication reminder app use and use intention. Relatedly, previous studies have highlighted that computer training helps older adults in improving their access to internet-based health information.[24,25] With reference to need factors, older adults with more chronic diseases, with medication non-adherence, higher health literacy, and without polypharmacy were more likely to have medication reminder app use and use intention. Prior studies have also found that individuals with more chronic diseases and with good health literacy are more likely to use health-related apps.[15,26] The cross-sectional design of our study may have resulted in the contradictory finding of higher odds of app use and use intention among individuals with medication non-adherence, versus those adherent. It is possible that those non-adherent recognised their non-conformity to medication regimens, and subsequently used or were considering the use of medication reminder apps.

We suggest three possible reasons for the low prevalence of medication reminder app use and use intention. First, studies have found that such apps have complex interfaces, and user-unfriendly and dense usage instructions,[27,28] which may make app sign-up and navigation difficult for

Table 1

Medication reminder app use and use intention among older Singaporeans: Prevalence, and unadjusted and adjusted association with predisposing, enabling, and need factors.

Characteristics	n (Weighted column %)	Medication reminder app use and use intention		
		n (Weighted row %)	Bivariate	Multivariable
			Odds Ratio (95% Confidence Interval)	
Total	2228 (100.0)	57 (2.6)		
Predisposing factors				
Age (years)				
62–69	751 (36.2)	34 (4.2)	Ref.	
70–79	838 (40.4)	20 (2.3)	**0.55 (0.30–0.98)***	0.74 (0.39–1.41)
80 or older	639 (23.4)	3 (0.4)	**0.09 (0.03–0.31)*****	**0.21 (0.06–0.81)***
Gender				
Male	1034 (46.7)	25 (2.5)	Ref.	
Female	1194 (53.3)	32 (2.6)	1.05 (0.60–1.83)	1.40 (0.78–2.51)
Ethnicity				
Chinese	1674 (83.3)	36 (2.4)	Ref.	
Malay	306 (9.9)	10 (3.2)	1.35 (0.65–2.79)	1.45 (0.67–3.15)
Indian	248 (6.8)	11 (4.3)	1.88 (0.94–3.78)	**2.21 (1.00–4.86)***
Education level				
None or Primary	1351 (60.6)	17 (1.2)	Ref.	
Secondary or higher	877 (39.4)	40 (4.7)	**4.19 (2.30–7.65)*****	**2.23 (1.07–4.65)***
Housing type				
1–2 room government-built flats	189 (7.8)	3 (1.4)	Ref.	
3-room government-built flats	553 (25.2)	12 (2.1)	1.47 (0.39–5.58)	1.36 (0.35–5.31)
4–5 room government-built flats/Private housing	1486 (66.9)	42 (2.9)	2.01 (0.59–6.90)	1.35 (0.36–5.07)
Enabling factors				
Previous participation in IT/computer courses (in past one year)				
No	2141 (95.7)	49 (2.3)	Ref.	
Yes	87 (4.3)	8 (8.9)	**4.20 (1.86–9.53)****	**3.53 (1.46–8.57)****
Personal mastery				
First tertile	969 (43.0)	21 (2.1)	Ref.	
Second tertile	1138 (51.6)	33 (3.0)	1.48 (0.83–2.63)	1.34 (0.71–2.52)
Third tertile	121 (5.4)	3 (2.4)	1.13 (0.31–4.34)	0.57 (0.14–2.33)
Social Networks				
First tertile	766 (34.6)	16 (2.1)	Ref.	
Second tertile	754 (33.7)	15 (2.2)	1.06 (0.50–2.22)	0.78 (0.35–1.76)
Third tertile	708 (31.8)	26 (3.5)	1.70 (0.88–3.28)	0.71 (0.32–1.60)
Need factors				
Self-rated Health				
Excellent/Very good	399 (18.1)	17 (4.3)	Ref.	
Good	926 (39.9)	24 (2.5)	0.57 (0.29–1.11)	0.58 (0.28–1.22)
Fair/Poor	903 (41.9)	16 (1.8)	**0.41 (0.20–0.84)***	0.85 (0.34–2.14)
Hearing impairment				
No	1592 (70.9)	48 (2.9)	Ref.	
Yes	636 (29.1)	9 (1.7)	0.56 (0.27–1.16)	1.05 (0.46–2.37)
Vision impairment				
No	1490 (66.3)	45 (3.0)	Ref.	
Yes	738 (33.7)	12 (1.7)	0.54 (0.28–1.06)	0.86 (0.41–1.82)
Physical function limitation				
No	1106 (51.1)	39 (3.6)	Ref.	
Yes	1122 (48.9)	18 (1.5)	**0.40 (0.22–0.72)****	0.68 (0.33–1.37)
Health literacy				
Limited/marginal	1538 (69.6)	21 (1.3)	Ref.	
Adequate	690 (30.4)	36 (5.5)	**4.56 (2.58–8.07)*****	**2.63 (1.37–5.02)****
Comorbidity				
No	418 (19.9)	9 (2.0)	Ref.	
Yes	1810 (80.1)	48 (2.7)	1.39 (0.65–2.98)	**2.64 (1.17–5.96)***
Polypharmacy				
No	1656 (75.0)	54 (3.3)	Ref.	
Yes	572 (25.0)	3 (0.4)	**0.12 (0.04–0.43)****	**0.15 (0.04–0.56)****
Medication adherence				
Adherent	1706 (76.7)	33 (2.1)	Ref.	
Not adherent	522 (23.3)	24 (4.2)	**2.04 (1.17–3.58)***	**2.07 (1.15–3.71)***

Abbreviation: IT: Information Technology.

95% confidence intervals of odds ratio estimates in bold face do not include 0 (zero).

***p-value<0.001, **p-value<0.01, *p-value<0.05.

older adults with lower educational attainment. A review on apps with a medication list functionality reported that some apps had a poor interface and did not provide sufficient instructions on how to record medication-taking histories and set medication reminders.[27] Polypharmacy may exacerbate such issues, which could possibly explain why it was found to be associated with a lower likelihood of app use and use intention in our study. Second, most medication reminder apps use English as the default or only

language.[27,29–31] Singapore has four official languages (English, Chinese, Malay and Tamil); yet 44% of Singaporeans aged 65–74 years, 66% of those aged 75–84 years, and 80% of those aged 85 years and older are not literate in English.[29] Thus, language barriers may be a factor limiting app use and use intention among older Singaporeans, particularly among the oldest-old. Third, concerns related to confidentiality of information in health-related apps could be a contributor.[32] Previous studies in

Singapore have reported privacy concerns as a significant barrier to wider adoption of technology, especially in healthcare.[32,33]

Testing the ease of use of medication reminder apps by older adults as a part of the development phase of such apps, particularly sub-groups identified in this study as being less likely to have app use and use intention, offering language options, highlighting how the apps protect personal data, or offering offline or anonymous usage may increase the use of such apps in Singapore.

4.1. Policy implications

The provision of digital training to older adults may be useful in promoting medication reminder app use, given that app use and use intention was higher for those with previous participation in IT/computer courses. Singapore has initiated a 'Seniors Go Digital' program in 2020, with a focus on helping older adults use digital devices for communication, accessing government services, making e-payments and managing mobile banking.[34] In future, training on the use of health-related apps may be considered for inclusion. Publicity and awareness campaigns may also help older adults differentiate between health-related apps that are affiliated with healthcare institutions and approved by regulators and those that are not.[35] Furthermore, policymakers in Singapore may consider developing guidelines for certification of health-related apps, including medication reminder apps, and persuade such apps to be older adult-friendly.

4.2. Strengths and limitations

The use of nationally representative data in our study is a strength. However, the study has its limitations. First, the cross-sectional data neither provided temporal changes in medication reminder app use and use intention, nor allowed for causal inference in the context of the identified correlates. Future longitudinal studies will help in addressing this limitation. Second, we combined app use and use intention into a single outcome variable in our main analysis due to their low individual numbers. Finally, our survey question for assessing use captures recent app use but does not allow an understanding of whether this usage is regular or long-term.

5. Conclusion

In this cross-sectional study using nationally representative data from Singapore, only 2.6% of adults aged 62 years and above taking prescription medications had medication reminder app use and use intention. The very low prevalence of medication reminder app use and use intention, and identified socio-demographic and health correlates, among older adults in Singapore point to opportunities to increase the use of such apps.

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Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.rcsop.2022.100150.

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