

ORIGINAL RESEARCH:
EMPIRICAL RESEARCH - QUANTITATIVE

Prevalence and predictors of medication non-adherence among older community-dwelling people with chronic disease in Singapore

Suet Mei Chew¹ | Jia Hua Lee² | Su Fee Lim³ | Min Jia Liew³ | Yi Xu³ | Rachel Marie Towle³ 

¹Nursing Division, Singapore General Hospital, Singapore

²Alice Lee Centre for Nursing Studies, National University of Singapore, Singapore

³Regional Health System (Population Health and Integrated Care Office), Singapore General Hospital, Singapore

Correspondence

Rachel Marie Towle, Regional Health System (Population Health and Integrated Care Office), Singapore General Hospital, SingHealth Tower, Level 5, Hospital Drive, Singapore 169608, Singapore.
Email: rachel.marie.towle@sgh.com.sg

Abstract

Aims: To determine the prevalence and predictors of medication non-adherence among older community-dwelling people with at least one chronic disease in Singapore.

Design: A single-centre cross-sectional study.

Methods: The study was conducted in the largest tertiary public hospital in Singapore between May 2019 and December 2019. The community nurses of the hospital recruited a total of 400 community-dwelling older people aged ≥ 60 years old, who were diagnosed with at least one chronic disease and prescribed with at least one long-term medication. Medication non-adherence was assessed using the self-report 5-item Medication Adherence Report Scale, operationalized as a score of < 25 . A list of potential factors of medication non-adherence was structured based on the World Health Organization five-domain framework and collected using a self-report questionnaire.

Results: Sixty percent ($n = 240$) of our participants were non-adherent to their medication regime. Older people who smoked (OR 2.89, 95% CI 1.14–7.33), perceived their medication regime as being complicated (OR 2.54, 95% CI 1.26–5.13), felt dissatisfied with their regime (OR 2.50, 95% CI 1.17–5.31), did not know the purpose of all their medications (OR 2.56, 95% CI 1.42–4.63) and experienced side effects (OR 3.32, 95% CI 1.14–9.67) were found to be predictive of medication non-adherence.

Conclusion: Medication adherence was found to be poor in community-dwelling older people in Singapore. The predictors identified in this study can help guide healthcare professionals in identifying older people who are at risk of medication non-adherence and inform the development of interventions to improve adherence.

Impact: Medication non-adherence, especially in the older population with chronic diseases, constitutes a serious problem as it undermines the efforts to reduce morbidity and mortality associated with the underlying chronic diseases. To improve adherence, our findings propose the importance of assessing the older person's treatment satisfaction, which includes examining the aspects of side effects, effectiveness and convenience. Additionally, we highlight the need to address the older person's medication knowledge deficit.

KEYWORDS

chronic disease, community health nursing, medication adherence, medication non-adherence, older person, patient compliance, predictors

1 | INTRODUCTION

In the management of chronic diseases, the most fundamental frontline intervention is long-term medication therapy. Medication adherence is crucial for the optimal control of chronic diseases, consequently optimizing the public health outcomes. The World Health Organization (WHO) defines medication adherence as the degree to which use of medication by the patient corresponds with the prescribed regimen (Sabaté, 2003). Despite the importance of medication adherence, studies in developed countries reported an alarmingly high proportion of approximately 50% of the population with chronic diseases who failed to adhere. This is a serious concern as medication non-adherence undermines the efforts to reduce morbidity and mortality associated with the underlying chronic diseases, causing increased disease burden and unnecessary healthcare resource utilization (Sabaté, 2003).

As chronic diseases manifest normally as one ages, medication non-adherence becomes a key priority to be addressed in the older population. Non-adherence is a multifactorial problem (Sabaté, 2003). It should not be attributed only to factors related to the individual but also to other aspects such as the medication therapy or healthcare system, which may affect the individual's behaviour and capacity to adhere. Numerous studies were undertaken to identify factors of medication non-adherence; however, the majority examined a specific disease instead of the older population with chronic disease(s) in general (Jing et al., 2008; Leung et al., 2015). Within the local context, there is a dearth of evidence on the prevalence and factors associated with this phenomenon among the older people with chronic diseases in Singapore.

Medication non-adherence can be categorized as primary or secondary non-adherence, depending on the phase non-adherence occurs at (Vrijens et al., 2012). Primary non-adherence is a result of failure to obtain newly prescribed medications at the phase of initiation; secondary non-adherence occurs at the phase of implementation and discontinuation which involves suboptimal implementation or/and early discontinuation of the medication regime (Vrijens et al., 2012). In Singapore, anecdotal reports from community nurses indicated that secondary non-adherence is predominantly more common. With very few local studies being conducted and having one of the most rapidly ageing populations in the world, it is of utmost importance to understand the factors associated with secondary non-adherence among the older people with chronic diseases in Singapore.

2 | BACKGROUND

Contrary to the conventional misconception that the patients themselves are to be held solely responsible, WHO emphasizes the

multifactorial nature of medication non-adherence (Sabaté, 2003). It results from the interplay of five dimensions of factors—socio-economic, patient-related, therapy-related, condition-related and healthcare team and system-related factors (Sabaté, 2003). In this study, we focused on secondary non-adherence; hence, we referred exclusively to secondary non-adherence unless specified otherwise. In studying this phenomenon, we examined older people with chronic disease(s) as a whole instead of focusing on a single disease, as older people nowadays are commonly afflicted with more than one chronic disease (Chan et al., 2018).

Socio-economic factors that have demonstrated significant association with medication non-adherence include age, gender, ethnicity, education level, financial status, marital status and absence of social support network (Gerber et al., 2010; Lam et al., 2007; Leung et al., 2015; Mentz et al., 2018; Sabaté, 2003). However, the present evidence on the impact of socio-economic factors remains inconclusive, especially in the context of developed countries (Sabaté, 2003). Patient-related factors refer to patients' knowledge, attitudes, perceptions and resources. Factors shown to be predictors of non-adherence include dependence in activities of daily living, negative beliefs about the medications, consumption of complementary and alternative medication, cognitive impairment, depressive symptoms, self-perceived poor health, alcoholism and lack of self-perceived need for treatment (Cooper et al., 2005; Lam et al., 2007; Leung et al., 2015; Mentz et al., 2018; Park et al., 2018; Phillips et al., 2016).

Therapy-related factors relate to the drug regime or an individual drug, involving factors ranging from cost, side effects to dosing regime and ease of use. Some strong determinants of non-adherence are complicated drug regime, polypharmacy, experiencing side effects, the need to cut tablets, frequent change of drug regime and specific types of medications such as anti-arrhythmic and anti-asthmatic drugs (Gautério-Abreu et al., 2016; Ingersoll & Cohen, 2008; Lam et al., 2007; Mansur et al., 2008; Mentz et al., 2018; Park et al., 2018; Roy et al., 2017). On the other hand, condition-related factors represent disease-specific concerns or problems encountered by patients. Associated factors include the severity of symptoms and comorbidities such as stroke and diabetes (Leung et al., 2015; Sabaté, 2003). The impact of healthcare team and system is the least-researched. Predictors of non-adherence in this domain include lack of medication review, absence of community healthcare service in medications packing, lack of financial subsidy for medications purchase and lack of follow-up post discharge (Cooper et al., 2005; Lam et al., 2007; Leung et al., 2015; Mansur et al., 2008; Sabaté, 2003).

Overall, medication non-adherence is often caused simultaneously by more than one factor, usually related to problems from different domains. The impact of these five interacting domains on non-adherence may be attributed to how they affect individual's

perceptions and motivation to adhere based on the self-perceived risk-benefit ratio (Sabaté, 2003). In order to inform the planning of efficient interventions to tackle non-adherence, identification of the associated factors using this five-dimensional framework is needed. As findings from previous studies on prevalence and predictors of medication non-adherence may not be generalizable to local context due to differences in culture and healthcare system, we aimed to address these gaps in this study.

3 | THE STUDY

3.1 | Aims

The aims of the study were to determine the prevalence and predictors of medication non-adherence among older community-dwelling people with at least one chronic disease in Singapore.

3.2 | Design

We conducted a cross-sectional survey study over a period of eight months (May 2019 to December 2019) in the largest tertiary public hospital in Singapore. Data were collected based on self-reported responses of participants to a questionnaire administered by community nurses. All community nurses involved in the study received training by the research team to ensure standardization of study procedures to reduce systematic error.

3.3 | Participants

We employed the convenience sampling method to recruit participants based on the following inclusion criteria:

- (i) community-dwelling older people aged ≥ 60 years old;
- (ii) diagnosed with at least one chronic disease;
- (iii) enrolled under the 'Hospital-to-Home' programme or the Community Nursing programme situated at the Community Nurse Posts;
- (iv) had yet to receive any medication management intervention from the community nurses;
- (v) prescribed with at least one long-term medication for the management of chronic disease(s); and
- (vi) orientated to time, place, and person at discharge when the survey was conducted.

We excluded older people with a diagnosis of dementia or known cognitive impairment documented in their electronic medical records as they were unable to give us their consent for this study.

Participants were recruited by community nurses who were enrolled under either one of the two main community programmes. The first was the 'Hospital-to-Home' programme which included

patients recently discharged to home from our hospital. The average length of hospital stay was around 8 days. Patients received visits from community nurses at their home within 5 days after their discharge and continued with regular home visits and telephone calls for up to six months. The second group consisted of older people living in the southeast region of Singapore where our hospital has set up the Community Nursing Programme. The community nurses reviewed them at the older person's home or at the Community Nurse Posts sited in the community. In both groups, the community nurses assisted the patient in their chronic disease management through monitoring of their medical conditions, medication adherence assessment and consolidation, health coaching and care coordination.

Sample size was calculated based on the average estimate of 50% of population being non-adherent in developed countries, as reported by the WHO (Sabaté, 2003). We projected a total sample of 380 participants to achieve a confidence level of 95% and a margin of error of 5%.

3.4 | Data collection

Recruitment was done by the community nurse during the first home visit for both groups. The questionnaire was used as a structured interview and the community nurses recorded all responses on the questionnaire. The community nurses did not record who declined the study participation and their reasons for non-response.

The outcome variable was the self-reported medication adherence, measured using the five-item Medication Adherence Report Scale (MARS-5). The scale comprises five questions which measure both intentional and unintentional medication non-adherence (Horne & Weinman, 2002). Item 1, "I forget to take my medication", relates to unintentional medication non-adherence which is primarily associated with the individual's inadequate capacity or resources to adhere (Clifford et al., 2008). The remaining items are questions concerning intentional non-adherence, which include 'changing of dosages', 'stopping', 'skipping dosages' and 'using medication less than what is prescribed'. Intentional non-adherence is deliberate and dependent upon the individual's motivation (Clifford et al., 2008). The scoring of these five items uses a 5-point Likert scale, ranging from 'always' (1 point) to 'never' (5 points). We defined medication non-adherence as a total score of less than 25 points.

Apart from the MARS-5, we included a questionnaire related to the potential predictors of medication non-adherence based on the WHO five-domain framework (Sabaté, 2003). This questionnaire comprised a total of 32 items concerning socio-economic factors (nine items), patient-related factors (13 items), therapy-related factors (four items), healthcare team and system factors (one item) and condition-related factors (five items). For self-perceived health status, we asked participants to rate their physical and mental health, respectively, in the past six months using a 5-point Likert scale, from 'excellent' to 'very poor'. Presence of depressive

symptoms was measured using the Geriatric Depression Scale 15-item (GDS-15), with higher scores indicating more severe depression (Ishihara & Terada, 2011). Physical functioning was measured using Clinical Frailty Scale (CFS) and the modified Barthel index (Collin et al., 1988). As it would take relatively longer time to assess GDS-15 and Barthel index, the data on these two measures were only collected by the second group of nurses (i.e. the community nurses at the Community Nurse Posts) who have already been using them routinely as part of their standard assessment.

3.5 | Ethical considerations

This study adhered to the ethical guidelines of the 1975 Declaration of Helsinki. Approval was granted by the ethical review board of the institution, the SingHealth Centralised Institutional Review Board (reference number 2019/2298). The board approved the taking of informed consent in the form of implied consent which did not require a written consent. The community nurses proceeded to administer the anonymous questionnaire only after the older person verbalized being agreeable to participate. No personally identifiable information was collected.

3.6 | Data analysis

Data were analysed using the statistical package IBM SPSS version 25.0 for Windows (IBM Corp, 2017). Descriptive analyses summarized the socio-demographic and potential associated variables as well as MARS-5. We performed univariate and multivariate regression analyses to identify the predictive factors of medication non-adherence. Univariate analyses included Mann-Whitney U test (nonparametric test due to non-normality of all continuous variables) and χ^2 tests to determine relationships of the potential variables with medication adherence. We included only variables with a *p* value of <.10 in univariate analysis in the construction of the multivariate logistic regression model using the 'Enter' selection method. The factors in the final model with *p* value of <.05 were identified as predictors. The Hosmer-Lemeshow test was used to evaluate the goodness of fit of the regression model. Additionally, we repeated these univariate and multivariate analyses specifically only on participants recruited from the Community Nurse Posts with the inclusion of two more variables, namely the GDS-15 and modified Barthel index.

3.7 | Validity and reliability

We selected MARS-5 as the community nurses are currently using it as the standard assessment instrument for all their clients. This instrument has been utilized extensively and was validated in many previous studies in populations of various chronic diseases. It demonstrated acceptable internal reliability, with Cronbach's alpha ranged from 0.67 to 0.89 (Chan, Horne, Hankins, & Chisari, 2020;

Salt, Hall, Peden, & Horne, 2012). In a study of people with hypertension, the tool demonstrated criterion-related validity based on a significant positive association between adherence and blood pressure control (Chan et al., 2020).

Aligned with the WHO multidimensional framework, various factors were integrated in a questionnaire to evaluate the interactional effect on patients' ability to adhere to treatment (Sabaté, 2003). Many studies were guided by the component variables of the WHO five-dimensional framework to identify the influencing factors of adherence among patients with chronic diseases including circulatory system disorders, endocrine and metabolic diseases, and nervous system disorders (Fernandez-Lazaro et al., 2019; Sabaté, 2003).

The Geriatric Depression Scale 15-item (GDS-15) is a short form from the original 30-item questionnaire (Ministry of Health & Singapore, 2010). It has been used extensively with the older population in acute, community and long-term care facilities and is a recommended diagnostic tool by the Ministry of Health, Singapore. The validity and reliability have been supported through clinical practice and previous studies, with a reported 92% sensitivity and 89% specificity when evaluated against diagnostic criteria. The validation study by Sheikh and Yesavage (1986) showed that both questionnaires were successful in differentiating depressed from non-depressed older people with a high correlation ($r = 0.84$, $pi < .001$).

CFS is a judgment based fragility tool evaluating comorbidity, function and cognition. It is a well validated tool that has been used extensively across studies involving older people (Koenig et al., 1988). Inter-rater reliability has been reported, with a weighted kappa coefficient of 0.76 (95% CI: 0.68–0.85) (Koenig et al., 1988). It has also been validated as an outcome hospital and community dwelling older people (Koenig et al., 1988).

The modified Barthel index is a measure of physical disability used to access behaviour relating to activity of daily living for people with disabling conditions. Studies report excellent internal consistency within its 10 items (Cronbach's alpha = 0.90) (Shah et al., 1989). Good test-retest and inter-rater reliability have been reported as well, and has demonstrated predictive validity. It has excellent convergent validity with other ADL measures (Blostein et al., 1997; Fricke & Unsworth, 1997).

4 | RESULTS

4.1 | Sample characteristics

A total of 400 participants were recruited over the period of 8 months. In the first group, under the 'Hospital-to-Home' programme, 212 participants were recruited. In the second, under the Community Nursing Programme, 188 participants were recruited. The socio-demographic information and data of the factors related to medication non-adherence are summarized in Table 1. The mean age of the total sample 76.19 years old (SD 8.47), ranging from 60 to 97 years old. Slightly more than half were female ($n = 224$,

TABLE 1 Comparison of variables between adherent and non-adherent participants

Variables	Total sample (N = 400) n (%)	Adherent group (n = 160) n (%)	Non-adherent group (n = 240) n (%)	p value
Socioeconomic factors				
Age				
60–80years old	271 (67.8)	110 (68.8)	161 (67.1)	.727
>80 years old	129 (32.3)	50 (31.3)	79 (32.9)	
Female	224 (56.0)	89 (55.6)	135 (56.3)	.902
Ethnicity				
Chinese	307 (76.8)	128 (80.0)	179 (74.6)	.639
Malay	54 (13.5)	19 (11.9)	35 (14.6)	
Indian	32 (8.0)	11 (6.9)	21 (8.8)	
Others	7 (1.8)	2 (1.3)	5 (2.1)	
Living status				
Alone	89 (22.3)	38 (23.8)	51 (21.3)	.556
With family/friend/maid/tenant	311 (77.8)	122 (76.3)	189 (78.8)	
Employment status				
Working full-time/part-time	46 (11.5)	15 (9.4)	31 (12.9)	.277
Not working	354 (88.5)	145 (90.6)	209 (87.1)	
Primary carer				
Self	225 (56.3)	90 (56.3)	135 (56.3)	1.000
Others	175 (43.8)	70 (43.8)	105 (43.8)	
Having financial concern regarding medications	58 (14.5)	14 (8.8)	44 (18.3)	.008 [*]
Residential status				
Purchased	257 (64.3)	107 (66.9)	150 (62.5)	.371
Rented	143 (35.8)	53 (33.1)	90 (37.5)	
Education level				
Primary or no formal education	308 (77.0)	117 (73.1)	191 (79.6)	.271
Secondary school	68 (17.0)	33 (20.6)	35 (14.6)	
Tertiary and above	24 (6.0)	10 (6.3)	14 (5.8)	
Patient-related factors				
Smoking				
Smoker	38 (9.5)	8 (5.0)	30 (12.5)	.001 [*]
Ex-smoker	69 (17.3)	19 (11.9)	50 (20.8)	
Non-smoker	293 (73.3)	133 (83.1)	160 (66.7)	
Alcohol consumption				
Non-drinker	361 (90.3)	149 (93.1)	212 (88.3)	.113
Drinker	39 (9.8)	11 (6.9)	28 (11.7)	
Perception of medication regime being complicated				
Strongly disagree and disagree	196 (49.0)	106 (66.3)	90 (37.5)	<.001 [*]
Neutral	97 (24.3)	36 (22.5)	61 (25.4)	
Agree and strongly agree	107 (26.8)	18 (11.3)	89 (37.1)	
Dissatisfied with current medication regime	62 (15.5)	13 (8.1)	49 (20.4)	.001 [*]
Impaired hearing (uni-/bilateral)	62 (15.5)	24 (15.0)	38 (15.8)	.822
Vision affecting taking of medications	35 (8.8)	6 (3.8)	29 (12.1)	0.004 [*]
Knowledge of the purpose of each medication				

(Continues)

TABLE 1 (Continued)

Variables	Total sample (N = 400) n (%)	Adherent group (n = 160) n (%)	Non-adherent group (n = 240) n (%)	p value
“I know every single medication”.	209 (52.3)	110 (68.8)	99 (41.3)	<.001 [*]
“I know some of them only”	122 (30.5)	27 (16.9)	95 (39.6)	
“I don't know any”	69 (17.3)	23 (14.4)	46 (19.2)	
Involvement in managing and taking of own medications				
“I manage and take on my own”	264 (66.0)	111 (69.4)	153 (63.7)	.047 [*]
“Someone packs and manages but I will take on my own”	70 (17.5)	19 (11.9)	51 (21.3)	
“Someone manages and administers to me”	66 (16.5)	30 (18.8)	36 (15.0)	
Self-perceived physical health status				
Excellent and good	152 (38.0)	78 (48.8)	74 (30.8)	.001 [*]
Fair	182 (45.5)	64 (40.0)	118 (49.2)	
Poor and very poor	66 (16.5)	18 (11.3)	48 (20.0)	
Self-perceived mental health status				
Excellent and good	208 (52.0)	99 (61.9)	109 (45.4)	.005 [*]
Fair	156 (39.0)	49 (30.6)	107 (44.6)	
Poor and very poor	36 (9.0)	12 (7.5)	24 (10.0)	
Clinical Frailty Scale score, median (IQR)	4.0 (2.0)	4.0 (2.0)	4.0 (2.0)	.219
Barthel index score, median (IQR)	20.0 (2.0)	20.0 (1.0)	20.0 (2.0)	.483
Geriatric Depression Scale score, median (IQR) ^a	1.0 (4.0)	1.0 (3.0)	2.0 (6.0)	<.001 [*]
Condition-related factors				
Diabetes	185 (46.3)	56 (35.0)	129 (53.8)	<.001 [*]
Chronic heart failure	97 (24.3)	25 (15.6)	72 (30.0)	.001 [*]
Stroke	50 (12.5)	20 (12.5)	30 (12.5)	1.000
Hypertension	346 (86.5)	130 (81.3)	216 (90.0)	.012
Number of chronic diseases, median (IQR)	3 (2.0)	3 (1.0)	3 (2.0)	<.001 [*]
Therapy-related factors				
Medication regime frequency				
Once or twice a day	304 (76.0)	130 (81.3)	174 (72.5)	.045 [*]
Three or more times a day	96 (24.0)	30 (18.8)	66 (27.5)	
Experiencing side effects	32 (8.0)	5 (3.1)	27 (11.3)	.003 [*]
Having trouble in swallowing medications	21 (5.3)	5 (3.1)	16 (6.7)	.120
Healthcare team and system-related factors				
Receiving financial subsidy for medications purchase	112 (28.0)	31 (19.4)	81 (33.8)	.002 [*]

Note: Qualitative data are represented by number of participants, with the corresponding column percentages. Quantitative data are represented by median and interquartile range (IQR) (due to non-normality of the data).

^aData only available participants recruited from Community Nurse Posts, n = 193.

*p < .100.

56.0%). The majority were Chinese (n = 307, 76.8%), not working (n = 354, 88.5%) and not living alone (n = 311, 77.8%). Less than a quarter (n = 92, 23%) received secondary or tertiary levels of education. Out of 400 participants, less than half were adherent to medications, with a full score of 25 on the MARS-5 (n = 160, 40.0%).

Table 1 presents also the descriptive statistics and the univariate comparison of the adherent and non-adherent group. A total of 16 variables were significantly associated with non-adherence:

- (i) one socio-economic factor (financial concern regarding medications),
- (ii) eight patient-related factors (smoking, perception of the medication regime being complicated, dissatisfied with medication regime, vision affecting medications taking, knowledge of purpose of own medications, managing own medications, self-perceived physical and mental health),
- (iii) three condition-related factors (diabetes, chronic heart failure and number of chronic diseases),

TABLE 2 Self-reported score of the Medication Adherence Report Scale 5-item (MARS-5)

MARS-5	Mean (SD)	Median (Min–Max)
MARS-5 total score	21.75 (4.22)	24.0 (5.0–25.0)
Sub-score related to unintentional adherence ^a	4.19 (1.07)	5.0 (1.0–5.0)
Sub-score related to intentional adherence ^b	17.56 (3.57)	20.0 (4.0–20.0)
		<i>n</i> (%)
Number of unintentional non-adherent participants ^c		189 (47.3)
Number of intentional non-adherent participants ^d		195 (48.8)
Number of unintentional and intentional non-adherent participants		144 (36.0)

^aDenotes item 1 in MARS-5 (Medication Adherence Report Scale 5-item).

^bDenotes items 2–4 in MARS-5.

^cBased on cut-off score of 5, unintentional non-adherent if score <5.

^dBased on cut-off score of 20, intentional non-adherent if score <20.

- (iv) three therapy-related factors (medication regime frequency, side effects and number of medications), and
- (v) one healthcare-related factor (financial subsidy for medication purchase).

Additionally, GDS-15 score, which was only collected from the group of participants in the Community Nursing Programme, reported a significant association with medication non-adherence.

Table 2 summarizes the MARS-5 score of the total sample. Mean score was 21.75 ± 4.22, with score as low as 5 (i.e., the lowest possible score). Based on item 1 score related to unintentional non-adherence, 47.3% (*n* = 189) reported non-adherence in this aspect. On the other hand, 48.8% (*n* = 195) reported intentional non-adherence. Approximately one third (*n* = 144) reported both intentional and unintentional non-adherence.

4.2 | Predictors of medication non-adherence

Table 3 presents the multivariate regression model of the factors significant at $p < .10$ with the respective adjusted odds ratio. Five factors emerged as explanatory predictors of non-adherence, which included smoker ($p = .025$), perceived complicated medication regime ($p = .009$), feeling dissatisfied with medication regime ($p = .018$), no full knowledge of purpose of medications ($p = .002$), and experiencing side effects ($p = .028$). The model accounted for 30.2% (adjusted R^2) of the variance. Multicollinearity of all explanatory variables was checked, with acceptable tolerance of >0.4 (Chan, 2004b), which lay between 0.523 and 0.905. Additionally, the magnitude of the standard error of each variable was acceptable, falling within the acceptable range of 0.001–5.0 (Chan, 2004a). Hosmer–Lemeshow goodness of fit test indicated that ‘the model fits’ ($p = .149$).

This model showed that as compared to non-smokers, smokers were 2.9 times more likely to be non-adherent. Older people were more likely to be non-adherent if they agreed or strongly agreed that their medication regime was complicated (2.5 times greater than those who didn't perceive so), if they felt dissatisfied with their current regime (2.5 times greater than those who didn't feel

so), if they knew the purpose of only some medications (2.6 times greater than those who knew every single medication), and if they experienced side effects (3.3 times greater than those who didn't experience).

Specifically, for participants recruited from the Community Nursing Programme, similar univariate and multivariate analyses were repeated with the additional data of GDS-15 and modified Barthel index score. GDS-15 demonstrated a significant association at univariate comparison, with a higher GDS-15 associated with non-adherence. This variable, along with 12 other variables that reported significant association, were entered into the regression model. However, only one factor remained significant, which was knowing the purpose of only some medications ($p = .030$, OR 2.829, 95% CI 1.108–7.220), with an adjusted R^2 of 28.6%.

5 | DISCUSSION

The medication non-adherence rate among community-dwelling older people in our study was generally high at 60%. A breakdown of the items in MARS-5 based on the type of medication non-adherence indicated almost similar occurrence rate of intentional and unintentional non-adherence. Our findings concurred with several previous studies conducted overseas, where self-reported medication non-adherence rate ranged approximately 60%–70%. (Al-Hajje et al., 2015; Mentz et al., 2018; Roy et al., 2017). However, two studies conducted in Hong Kong, which has a predominantly Chinese population similar to Singapore, reported lower non-adherence rate at 10% and 37%, respectively (Lam et al., 2007; Leung et al., 2015). Of note is the heterogeneity of the adherence measurement instruments in these studies, using other self-reporting tools or more objective measures such as pill count.

To date, the optimal cut-off threshold score of MARS-5 remains inconclusive (Tommelein et al., 2014). A validation study of MARS-5 in people with chronic obstructive pulmonary disease reported a positive predictive value of only 42% with threshold score of 25; however, upon lowering score from 25 to 20, sensitivity dropped significantly (Tommelein et al., 2014). We adopted the cut-off threshold

TABLE 3 Predictors of medication non-adherence: Logistic regression model

Variables	Odds ratio (95% CI)	p value
Having financial concern regarding medications	0.932 (0.418–2.078)	.863
Smoking		
Smoker	2.894 (1.144–7.326)	.025 [*]
Ex-smoker	1.600 (0.831–3.082)	.160
Non-smoker	–	–
Perception of medication regime being complicated		
Strongly disagree and disagree	–	–
Neutral	1.620 (0.871–3.013)	.127
Agree and strongly agree	2.544 (1.262–5.130)	.009 [*]
Dissatisfied with medication regime	2.495 (1.173–5.305)	.018 [*]
Vision affecting taking of medications	2.245 (0.805–6.262)	.122
Knowledge of the purpose of each medication		
"I know every single medication".	–	–
"I know some of them only".	2.564 (1.421–4.626)	.002 [*]
"I don't know any".	1.074 (0.489–2.361)	.859
Involvement in managing and taking of own medications		
"I manage and take on my own".	–	–
"Someone packs and manages but I will take on my own".	1.289 (0.626–2.657)	.491
"Someone manages and administers to me"	0.586 (0.276–1.245)	.164
Self-perceived physical health status		
Excellent and good	–	–
Fair	0.900 (0.480–1.690)	.744
Poor and very poor	1.174 (0.482–2.861)	.724
Self-perceived mental health status		
Excellent and good	–	–
Fair	1.266 (0.683–2.346)	.454
Poor and very poor	0.861 (0.309–2.396)	.774
Diabetes	1.395 (0.825–2.359)	.214
Chronic heart failure	1.486 (0.760–2.908)	.247
Number of chronic diseases	1.051 (0.848–1.302)	.650

(Continues)

TABLE 3 (Continued)

Variables	Odds ratio (95% CI)	p value
Medication regime frequency		
Once or twice a day	–	–
Three or more times a day	0.936 (0.504–1.738)	.835
Experiencing side effects	3.316 (1.137–9.673)	.028 [*]
Number of prescribed medications	1.048 (0.980–1.120)	.170
Receiving financial subsidy for medications purchase	1.510 (0.845–2.696)	.164

Note: Predicted outcome: Medication non-adherence (i.e., Medication Adherence Report Scale 5-item score <25). Reference category is indicated by the dash sign (–). Nagelkerke R^2 of the above model 0.302. * $p < .05$.

score of 25, similar to several other studies (Gialamas et al., 2009; Lee et al., 2017).

The predictors of medication non-adherence identified in our study were smoker, experiencing side effects, perception of medication regime as complicated, feeling dissatisfied with the regime, and deficient in the knowledge regarding the purpose of all medications. Being a smoker predicted medication non-adherence. This concurs with Lam et al.'s study (2007) which found a significant association between smoking and non-adherence, although the factor did not remain significant as predictor in the study. Our finding reflects the consensus drawn by the WHO panel on adherence behaviour, highlighting that engagement in a health-compromising behaviour may reflect the behaviour of one type or another, in this case being medication non-adherence (Sabaté, 2003). Similar to smoking, excessive alcohol consumption, which is also a health-compromising behaviour, was found to increase the odds of non-adherence by 3.6 times in a large cross-national study (Cooper et al., 2005). However, alcohol consumption was not found to be significant in our study, possibly because the higher proportion of non-drinkers than non-smokers in our sample.

The older person's experience of side effects from medications was found, unsurprisingly, as a predictor of non-adherence. This is supported by several other studies, which have identified that the presence or fear of side effects predicted non-adherence (Gautério-Abreu et al., 2016; Lam et al., 2007; Park et al., 2018). Although the older person may know that the effective management of their chronic diseases requires long-term adherence, the benefits of doing so are not immediately tangible. Therefore, especially when they experience side effects, the cost outweighs the benefit, diminishing their motivation to follow the medication regime.

Understanding the purpose of only some instead of every single medication predicted non-adherence. Although no statistical significance was reported in the group who possessed no knowledge about the purpose of their medications, we witnessed expectedly a much higher proportion of non-adherence. This finding aligns with

previous studies, which highlighted that individuals' understanding of the purpose of their medications influenced their motivation to adhere (Al-Hajje et al., 2015; Nakata et al., 2019; Roy et al., 2017). The older person's ability or extent of understanding is contextual upon his or her cultural capital, which refers to his or her social assets, such as education and intellect (Nakata et al., 2019). The majority of the older people in our study had possibly lower cultural capital as they may have less access to health information via digital means as compared to adults, rendering them clueless to the medications they were taking in the event if no education from the healthcare team was provided. Cultural capital is also linked to education level; however, education level was insignificant in our study.

The older person's perception of their regime being complicated was another predictor, consistent with several studies which confirmed regime complexity being predictive of non-adherence (Ingersoll & Cohen, 2008; Lam et al., 2007; Malhotra et al., 2001; Morisky et al., 2008). The complexity of the regime may be attributable to increased dosage frequency, polypharmacy and specific dietary or timing restrictions. In fact, polypharmacy is a well-established problem among the older people as more become affected by multiple chronic diseases and are consequently treated with multiple medications (Sabaté, 2003). The burden of having to remember and consume the vast array of medications over an extended period of time may overwhelm the older people and cause them to perceive their regime being complicated, in turn affecting their adherence. This is common especially in older people who have memory difficulties or cognitive impairment (Al-Hajje et al., 2015; Cooper et al., 2005; Leung et al., 2015). Community-based interventions may be beneficial to improve medication adherence among the older people, especially those who perceive high complexity in their treatment regime (Sabaté, 2003). Informal or formal support received by the older people from ongoing community programmes enable the exchange of valuable experiences of managing with the chronic disease and its treatment (Gast & Mathes, 2019).

Lastly, the older person's dissatisfaction with their medication regime was predictive of non-adherence in our study, which concurs with previous studies (Atkinson et al., 2004; Morisky et al., 2008; Park et al., 2018). Treatment satisfaction was, in turn, found to be determined by three main factors: the effectiveness of treatment, side effects and convenience (Atkinson et al., 2004). An instrument to measure treatment satisfaction, which was developed based on these three domains, accounted for up to 60% of variation in medication non-adherence across groups of various chronic disease (Atkinson et al., 2004). The authors emphasized that healthcare professionals should assess their clients' treatment satisfaction as dissatisfaction served as a warning sign of non-adherence (Atkinson et al., 2004).

We did not find any significant predictors from the condition-related, healthcare team and system-related and socio-economic domains. Factors such as age, employment status and education level were insignificant, possibly attributable to the homogeneity of our sample that the majority were middle-old (mean age of 76 years), belonging to the generation with limited schooling opportunities in

the past. High-cost or financial constraint with medications purchase was frequently highlighted as cause of non-adherence (Malhotra et al., 2001; Park et al., 2018); however, our study did not identify it as a predictor. This could be attributed to the availability of various financial schemes in Singapore towards supporting the older people in obtaining the prescribed medications. Apart from the cost, past studies have highlighted the impact of certain disease type on adherence. For example, diabetic medications have potentially more unpleasant side effects hence higher risk of non-adherence; while people with hypertension adhere poorly as they do not typically experience any marked clinical symptoms (Malhotra et al., 2001; Phillips et al., 2016). None of the condition-related factors were significant as explanatory predictors, possibly because older people were commonly diagnosed with multiple comorbidities and were plagued consequently with polypharmacy.

5.1 | Study implications

The five predictors identified in our study were either patient-related or therapy-related factors. Considering the predictive role of side effects, complexity of and dissatisfaction towards medication regime, we propose that nurses or physicians in-charge assess the older people on these factors using validated instruments, such as Treatment Satisfaction Questionnaire for Medication (Atkinson et al., 2004). Based on the conceptual framework of this questionnaire, all questions represent all three aforementioned predictors. A poor satisfaction score should warrant follow-up actions such as medication review and switching to fixed-dose combination therapy if possible. In recent years, with the shift from hospital-centric care into the community, adherence-promoting measures are implemented among older community-dwelling people. These include assistance or education to the older people or caregiver in medications packing by community nurses in order to help ameliorate the complexity of medication regime.

The present educational attainment profile of the older people in Singapore shows that the majority is generally not highly educated; thus, they may not have the cultural capital to equip themselves with accurate knowledge about their medications (Visaria et al., 2019). Knowledge deficit in their medications may cause them to adhere poorly, or even substitute or mix them with complementary and alternative medicine. In fact, anecdotal reports from community nurses indicated that many older people were inclined to consume such medicine, which may introduce both pharmacological and adherence risks (Alfian et al., 2016). A study conducted in Singapore reported that the prevalence of complementary and alternative medicine use was as high as 76%, out of which 74% did not report it to their physicians (Lim et al., 2005). We propose that healthcare professionals should assess the older person's medication knowledge to ensure they are aware of the purpose, common side effects and the risk of drug interactions if they take complementary and alternative medicine concurrently with their prescribed regime.

Lastly, in older smokers who are unable to adhere to smoking cessation therapy, our findings suggest that their non-adherence in this aspect may reflect medication non-adherence as well. Therefore, healthcare professionals should be aware of the higher risk of non-adherence in smokers and provide health counselling against health-compromising behaviours.

An area of strength of this study is the broad selection of its target population. It is pragmatic to examine medication non-adherence in older people with chronic diseases as a whole, instead of focusing on a specific type of disease. This is because at least one in three older people in Singapore is being diagnosed with three or more chronic diseases (Chan et al., 2018). We only exclude cognitively impaired older people as it can be reasonably expected that their profile of adherence barrier differs from the cognitively intact older people.

5.2 | Limitations

Firstly, due to the nature of a cross-sectional study, the temporality assumption (i.e., the occurrence of medication non-adherence is after the explanatory variables) cannot be guaranteed. One of the potential limitation of this study is the use of convenience sampling to recruit participants from the hospital at home programme and the community nursing programme; thus, the findings may not be generalized to all other community-dwelling older adult population (Connelly, 2013). Regrettably the bias of the convenience is unknown because the community nurses did not record any data regarding those who declined study participation. Future research using a cohort study design is needed to validate the prediction model. Secondly, we adopted a self-report instrument to measure medication adherence, which may be affected by recall bias or social desirability bias. No single measure has been identified as the gold standard. Due to manpower limitation, we used only MARS-5 since it is inexpensive, most practical and is currently used by all community nurses in their routine assessment. We recommend future research to adopt triangulation of adherence measurement methods, such as pill count, measurement of physiological parameters corresponding with the target drug, in addition to self-reporting (Farmer, 1999). Novel technologies, such as electronic blister packs, can also be considered.

Our adjusted R^2 was 30.2%; the remaining 69.8% variation could be explained by other factors which we did not include, as we needed to maintain data quality by limiting the length of our questionnaire. Potential factors include the quality of life, physician-client relationship, use of complementary and alternative medicines, poor memory, and perception of need for medications (Sabaté, 2003). Data on depression score (i.e., GDS-15), which is a recognized predictor of non-adherence, were only collected for approximately half of our sample.

Lastly, our findings may not be generalizable to the overall older population of the country. The sample in our study were either the older people residing in the southeast region of Singapore (for those enrolled under the Community Nursing Programme) or older people recently discharged from our hospital (for those enrolled under

the 'Hospital-to-Home' programme). Hence, this may have excluded older people residing in other regions of Singapore and older people of higher financial status who visit private hospitals instead.

6 | CONCLUSION

The medication non-adherence rate reported by the older people in our study was far from optimal. Considering the rapidly ageing population and increasing prevalence of chronic diseases in Singapore, it is of utmost priority to address this worrying issue. Our findings have established several predictors that can help inform healthcare professionals of the characteristics to look out for in identifying older people at risk of medication non-adherence. These factors include smoking, experiencing side effects, knowledge deficit on the purpose of all medications, perception of medication regime as being complicated, and feeling dissatisfied with the regime. Additionally, such knowledge enables the strategizing of targeted interventions to improve medication adherence. Our findings highlight the importance of assessing the older person's treatment satisfaction, which involves examining the aspects of side effects, effectiveness and convenience. Our findings also suggest that providing adequate medication knowledge (including the use of unconventional therapies) may help reduce non-adherence. Future improvement plans such as incorporating an assessment tool or a care pathway can be included into the nurse's daily workflow.

ACKNOWLEDGEMENTS

We would like to highlight the substantial contributions of the following nurse representatives who have helped in collecting data and collating all data collection forms: Ms. Regina Wang Jingying, Ms. Sharon Mak Lee Hua, Ms. Stephanie Lam Tzen Mei, Ms. Nur Fadillah binte Ahmad, Ms. Suhaila binte Samsudin, Ms. Nadiyah binte Norzaini, and Ms. Roskalrinna binte Mohamed Khalid. Additionally, our utmost appreciation goes to all SingHealth Southeast Community Nurses and 'Hospital-to-Home' Community Nurses who were involved in this project, without whom the research could not have been completed. We would also like to thank Dr. Chan Yiong Huak for his statistics-related advice. Lastly, we are grateful to all our elderly participants who have so readily participated.

CONFLICT OF INTEREST

No conflict of interest has been declared by the authors.

DATA AVAILABILITY STATEMENT

Author elects to not share data.

PEER REVIEW

The peer review history for this article is available at <https://publons.com/publon/10.1111/jan.14913>.

ORCID

Rachel Marie Towle  <https://orcid.org/0000-0002-5266-7574>

REFERENCES

- Alfian, S., Sukandar, H., Arisanti, N., & Abdulah, R. (2016). Complementary and alternative medicine use decreases adherence to prescribed medication in diabetes patients. *Annals of Tropical Medicine and Public Health*, 9(3), 174. <https://doi.org/10.4103/1755-6783.179108>
- Al-Hajje, A., Awada, S., Rachidi, S., Zein, S., Bawab, W., El-Hajj, Z., Bou Zeid, M., Yassine, M., & Salameh, P. (2015). Factors affecting medication adherence in Lebanese patients with chronic diseases. *Pharmacy Practice*, 13(3). <https://doi.org/10.18549/Pharm Pract.2015.03.590>
- Atkinson, M. J., Sinha, A., Hass, S. L., Colman, S. S., Kumar, R. N., Brod, M., & Rowland, C. R. (2004). Validation of a general measure of treatment satisfaction, the Treatment Satisfaction Questionnaire for Medication (TSQM), using a national panel study of chronic disease. *Health and Quality of Life Outcomes*, 2(1), 12. <https://doi.org/10.1186/1477-7525-2-12>
- Blostein, P. A., Jones, S. J., Buechler, C. M., & Vandongen, S. (1997). Cognitive screening in mild traumatic brain injuries: Analysis of the neurobehavioral cognitive status examination when utilized during initial trauma Hospitalization. *Journal of Neurotrauma*, 14, 171–177. <https://doi.org/10.1089/neu.1997.14.171>
- Chan, A., Malhotra, R., Manap, N. B., Ting, Y. Y., Visaria, A., Cheng, G. H. L., ... Maulod, A. (2018). Transitions in health, employment, social engagement and intergenerational transfers in Singapore study (THE SIGNS Study)—I: Descriptive statistics and analysis of key aspects of successful ageing. ScholarBank@NUS Repository. <https://doi.org/10.25722/w8ye-r177>
- Chan, Y. H. (2004a). Biostatistics 202: Logistic regression analysis. *Singapore Medical Journal*, 45, 149–153.
- Chan, Y. H. (2004b). Biostatistics 201: Linear regression analysis. *Singapore Medical Journal*, 45, 55–61.
- Chan, A. H. Y., Horne, R., Hankins, M., & Chisari, C. (2020). The medication adherence report scale: a measurement tool for eliciting patients' reports of nonadherence. *British Journal of Clinical Pharmacology*, 86(7), 1281–1288. <https://doi.org/10.1111/bcp.14193>
- Clifford, S., Barber, N., & Horne, R. (2008). Understanding different beliefs held by adherers, unintentional nonadherers, and intentional nonadherers: Application of the Necessity-Concerns Framework. *Journal of Psychosomatic Research*, 64(1), 41–46. <https://doi.org/10.1016/j.jpsychores.2007.05.004>
- Collin, C., Wade, D. T., Davies, S., & Horne, V. (1988). The Barthel ADL index: A reliability study. *Disability and Rehabilitation*, 10(2), 61–63. <https://doi.org/10.3109/09638288809164103>
- Connelly, L. M. (2013). Limitation section. *Medsurg Nursing*, 22(5), 325.
- Cooper, C., Carpenter, I., Katona, C., Schroll, M., Wagner, C., Fialova, D., & Livingston, G. (2005). The AdHOC study of older adults' adherence to medication in 11 countries. *The American Journal of Geriatric Psychiatry*, 13(12), 1067–1076. <https://doi.org/10.1097/00019442-200512000-00006>
- Farmer, K. C. (1999). Methods for measuring and monitoring medication regimen adherence in clinical trials and clinical practice. *Clinical Therapeutics*, 21(6), 1074–1090. [https://doi.org/10.1016/S0149-2918\(99\)80026-5](https://doi.org/10.1016/S0149-2918(99)80026-5)
- Fernandez-Lazaro, C. I., García-González, J. M., Adams, D. P., Fernandez-Lazaro, D., Mielgo-Ayuso, J., Caballero-García, A., Moreno Racionero, F., Córdova, A., & Miron-Canelo, J. A. (2019). Adherence to treatment and related factors among patients with chronic conditions in primary care: A cross-sectional study. *BMC Family Practice*, 20(1), 132. <https://doi.org/10.1186/s12875-019-1019-3>
- Fricke, J., & Unsworth, C. (1997). Inter-rater reliability of the original and modified Barthel index, and a comparison with the functional independence measure. *Australian Occupational Therapy Journal*, 44, 22–29. <https://doi.org/10.1111/j.1440-1630.1997.tb00750.x>
- Gast, A., & Mathes, T. (2019). Medication adherence influencing factors—An (updated) overview of systematic reviews. *Systematic Reviews*, 8, 112. <https://doi.org/10.1186/s13643-019-1014-8>
- Gautério-Abreu, D. P., Santos, S. S. C., da Silva, B. T., Gomes, G. C., Cruz, V. D., & Tier, C. G. (2016). Prevalence of medication therapy adherence in the elderly and related factors. *Revista Brasileira de Enfermagem*, 69(2), 335–342. <https://doi.org/10.1590/0034-7167.20166902171>
- Gerber, B. S., Cho, Y. I., Arozullah, A. M., & Lee, S. Y. D. (2010). Racial differences in medication adherence: A cross-sectional study of medicare enrollees. *American Journal Geriatric Pharmacotherapy*, 8(2), 136–145. <https://doi.org/10.1016/j.amjopharm.2010.03.002>
- Gialamas, A., Yelland, L. N., Ryan, P., Willson, K., Laurence, C. O., Bubner, T. K., Tideman, P., & Beilby, J. J. (2009). Does point-of-care testing lead to the same or better adherence to medication? A randomised controlled trial: The PoCT in general practice trial. *Medical Journal of Australia*, 191(9), 487–491. <https://doi.org/10.5694/j.1326-5377.2009.tb02910.x>
- Horne, R., & Weinman, J. (2002). Self-regulation and self-management in asthma: Exploring the role of illness perceptions and treatment beliefs in explaining non-adherence to preventer medication. *Psychology and Health*, 17(1), 17–32. <https://doi.org/10.1080/08870440290001502>
- IBM Corp. (2017). SPSS statistics for windows, version 25. Armonk, NY.
- Ingersoll, K. S., & Cohen, J. (2008). The impact of medication regimen factors on adherence to chronic treatment: A review of literature. *Journal of Behavioral Medicine*, 31, 213–224. <https://doi.org/10.1007/s10865-007-9147-y>
- Ishihara, T., & Terada, S. (2011). Geriatric Depression Scale (GDS). *Nihon Rinsho Japanese Journal of Clinical Medicine*, 69(Suppl 8), 455–458. https://doi.org/10.1300/j018v05n01_09
- Jing, J., Grant, E. S., Vernon, M. S., & Shu, C. L. (2008). Factors affecting therapeutic compliance: A review from the patient's perspective. *Therapeutics and Clinical Risk Management*, 4(1), 269–286. <https://doi.org/10.2147/tcr.m.s1458>
- Koenig, H. G., Meador, K. G., Cohen, H. J., & Blazer, D. G. (1988). Self-rated depression scales and screening for major depression in the older hospitalized patient with medical illness. *Journal of the American Geriatrics Society*, 35(8). <https://doi.org/10.1111/j.1532-5415.1988.tb07171.x>
- Lam, P. W., Lum, C. M., & Leung, M. F. (2007). Drug non-adherence and associated risk factors among Chinese geriatric patients in Hong Kong. *Hong Kong Medical Journal*, 13(4), 284–292.
- Lee, C. S., Tan, J. H. M., Sankari, U., Koh, Y. L. E., & Tan, N. C. (2017). Assessing oral medication adherence among patients with type 2 diabetes mellitus treated with polytherapy in a developed Asian community: A cross-sectional study. *British Medical Journal Open*, 7(9), e016317-10. <https://doi.org/10.1136/bmjopen-2017-016317>
- Leung, D. Y. P., Bai, X., Leung, A. Y. M., Liu, B. C. P., & Chi, I. (2015). Prevalence of medication adherence and its associated factors among community-dwelling Chinese older adults in Hong Kong. *Geriatrics & Gerontology International*, 15(6), 789–796. <https://doi.org/10.1111/ggi.12342>
- Lim, M. K., Sadarangani, P., Chan, H. L., & Heng, J. Y. (2005). Complementary and alternative medicine use in multiracial Singapore. *Complementary Therapies in Medicine*, 13(1), 16–24. <https://doi.org/10.1016/j.ctim.2004.11.002>
- Malhotra, S., Karan, R. S., Pandhi, P., & Jain, S. (2001). Drug related medical emergencies in the elderly: Role of adverse drug reactions and non-compliance. *Postgraduate Medical Journal*, 77(913), 703–707. <https://doi.org/10.1136/pmj.77.913.703>
- Mansur, N., Weiss, A., Hoffman, A., Gruenewald, T., & Beloesesky, Y. (2008). Continuity and adherence to long-term drug treatment by geriatric patients after hospital discharge: A prospective cohort study. *Drugs and Aging*, 25(10), 861–870. <https://doi.org/10.2165/00002512-200825100-00005>
- Mentz, R. J., Greiner, M. A., Muntner, P., Shimbo, D., Sims, M., Spruill, T. M., Banahan, B. F., Wang, W., Mwasongwe, S., Winters, K., Correa, A., Curtis, L. H., & O'Brien, E. C., & O'Brien, E. C. (2018). Intentional and unintentional medication non-adherence in African Americans:

- Insights from the Jackson Heart Study. *American Heart Journal*, 200, 51–59. <https://doi.org/10.1016/j.ahj.2018.03.007>
- Ministry of Health, Singapore. (2010). Functional screening for older adults in the community HPB. MOH Clinical Practice Guidelines 1/2010.
- Morisky, D. E., Ang, A., Krousel-Wood, M., & Ward, H. J. (2008). Predictive validity of a medication adherence measure in an outpatient setting. *Journal of Clinical Hypertension*, 10(5), 348–354. <https://doi.org/10.1111/j.1751-7176.2008.07572.x>
- Nakata, C., Izberk-Bilgin, E., Sharp, L., Spanjol, J., Cui, A. S., Crawford, S. Y., & Xiao, Y. (2019). Chronic illness medication compliance: A liminal and contextual consumer journey. *Journal of the Academy of Marketing Science*, 47(2), 192–215. <https://doi.org/10.1007/s11747-018-0618-1>
- Park, H. Y., Seo, S. A., Yoo, H., & Lee, K. (2018). Medication adherence and beliefs about medication in elderly patients living alone with chronic diseases. *Patient Preference and Adherence*, 12, 175–181. <https://doi.org/10.2147/PPA.S151263>
- Phillips, L. A., Cohen, J., Burns, E., Abrams, J., & Renninger, S. (2016). Self-management of chronic illness: The role of 'habit' versus reflective factors in exercise and medication adherence. *Journal of Behavioral Medicine*, 39(6), 1076–1091. <https://doi.org/10.1007/s10865-016-9732-z>
- Roy, N. T., Sajith, M., & Bansode, M. P. (2017). Assessment of factors associated with low adherence to pharmacotherapy in elderly patients. *Journal of Young Pharmacists*, 9(2), 272–276. <https://doi.org/10.5530/jyp.2017.9.53>
- Sabaté, E. (2003). Adherence to long-term therapies: Evidence for action. World Health Organization website: https://www.who.int/chp/knowledge/publications/adherence_report/en/
- Salt, E., Hall, L., Peden, A. R., & Horne, R. (2012). Psychometric properties of three medication adherence scales in patients with rheumatoid arthritis. *Journal of nursing measurement*, 20(1), 59.
- Shah, S., Vanclay, F., & Cooper, B. (1989). Improving the sensitivity of the Barthel index for stroke rehabilitation. *Journal of Clinical Epidemiology*, 42, 703–709. [https://doi.org/10.1016/0895-4356\(89\)90065-6](https://doi.org/10.1016/0895-4356(89)90065-6)
- Sheikh, J. I., & Yesavage, J. A. (1986). Geriatric Depression Scale (GDS): Recent evidence and development of a shorter version. *Clinical Gerontologist: The Journal of Aging and Mental Health*, 5(1–2), 165–173. https://doi.org/10.1300/J018v05n01_09
- Tommelein, E., Mehuys, E., Van Tongelen, I., Brusselle, G., & Boussery, K. (2014). Accuracy of the Medication Adherence Report Scale (MARS-5) as a quantitative measure of adherence to inhalation medication in patients With COPD. *Annals of Pharmacotherapy*, 48(5), 589–595. <https://doi.org/10.1177/1060028014522982>
- Visaria, A., Malhotra, R., & Chan, A. (2019). Changes in the profile of older singaporeans: Snapshots from 2009 and 2016 – 2017. <https://www.duke-nus.edu.sg/docs/librariesprovider3/research-policy-brief-docs/care-special-issue-1---changes-in-the-profile-of-older-singaporeans.pdf>
- Vrijens, B., De Geest, S., Hughes, D. A., Przemyslaw, K., Demonceau, J., Ruppard, T., Dobbels, F., Fargher, E., Morrison, V., Lewek, P., Matyjaszczyk, M., Mshelia, C., Clyne, W., Aronson, J. K., & Urquhart, J. (2012). A new taxonomy for describing and defining adherence to medications. *British Journal of Clinical Pharmacology*, 73(5), 691–705. <https://doi.org/10.1111/j.1365-2125.2012.04167.x>

How to cite this article: Chew, S. M., Lee, J. H., Lim, S. F., Liew, M. J., Xu, Y., & Towle, R. M. Prevalence and predictors of medication non-adherence among older community-dwelling people with chronic disease in Singapore. *Journal of Advanced Nursing*, 2021;00:1–12. <https://doi.org/10.1111/jan.14913>

The *Journal of Advanced Nursing (JAN)* is an international, peer-reviewed, scientific journal. *JAN* contributes to the advancement of evidence-based nursing, midwifery and health care by disseminating high quality research and scholarship of contemporary relevance and with potential to advance knowledge for practice, education, management or policy. *JAN* publishes research reviews, original research reports and methodological and theoretical papers.

For further information, please visit *JAN* on the Wiley Online Library website: www.wileyonlinelibrary.com/journal/jan

Reasons to publish your work in *JAN*:

- High-impact forum: the world's most cited nursing journal, with an Impact Factor of 2.561 – ranked 6/123 in the 2019 ISI Journal Citation Reports © (Nursing; Social Science).
- Most read nursing journal in the world: over 3 million articles downloaded online per year and accessible in over 10,000 libraries worldwide (including over 6,000 in developing countries with free or low cost access).
- Fast and easy online submission: online submission at <http://mc.manuscriptcentral.com/jan>.
- Positive publishing experience: rapid double-blind peer review with constructive feedback.
- Rapid online publication in five weeks: average time from final manuscript arriving in production to online publication.
- Online Open: the option to pay to make your article freely and openly accessible to non-subscribers upon publication on Wiley Online Library, as well as the option to deposit the article in your own or your funding agency's preferred archive (e.g. PubMed).