Frailty and Healthcare Utilisation Across Care Settings Among Community-Dwelling Older Adults in Singapore

Lixia Ge (lixia_ge@nhg.com.sg)
National Healthcare Group https://orcid.org/0000-0001-8080-7020

Chun Wei Yap
National Healthcare Group

Bee Hoon Heng
National Healthcare Group

Woan Shin Tan
National Healthcare Group

Research article

Keywords: frailty, healthcare utilisation, community-dwelling older adults

Posted Date: May 19th, 2020

DOI: https://doi.org/10.21203/rs.3.rs-27446/v1

Version of Record: A version of this preprint was published on October 6th, 2020. See the published version at https://doi.org/10.1186/s12877-020-01800-8.

Abstract

Background Frailty is frequently found to be associated with increased healthcare utilisation in western countries, but little is known in Asian population. This study was conducted to investigate the association between frailty and healthcare utilisation by care setting among community-dwelling older adults in Singapore.

Methods We conducted a six-month look-back and six-month post-baseline analysis of healthcare utilisation. Data from a longitudinal population-based survey were linked with healthcare utilisation data obtained from an administrative database.

Baseline frailty status was measured using the five-item FRAIL scale, which is categorised into three groups: robust (0), pre-frail (1–2), and frail (3–5). Healthcare utilisation included government primary care clinic visits, specialised outpatient clinic visits, emergency department visits, day surgery and hospitalisations. Multivariable logistic and negative binomial regression were applied to examine the associations between frailty with healthcare utilisation, controlling for other confounding variables.

Results In our sample of 701 older adults, 64.8% were of robust health, 27.7% belonged to the pre-frail category, and 7.6% were frail. Compared to the non-frail group, frail individuals had a higher rate of specialised outpatient clinic visits (incidence rate ratio (IRR): 2.8, 95% confidence interval (CI): 1.2-6.5), emergency department visits (IRR: 3.1, 95%CI: 1.1-8.1), day surgeries done (IRR: 6.4, 95%CI: 1.3-30.9), and hospitalisations (IRR: 6.7, 95%CI: 2.1-21.1) in the six-months before the baseline and in subsequent six months (IRR: 3.3, 95%CI: 1.6-7.1; 6.4, 2.4-17.2; 5.8, 1.3-25.8; 13.1, 4.9-35.0; respectively). Frailty was also significantly associated with an increased in the number of specialised outpatient clinic visits, emergency department visits and hospitalisations in 6 months before and after baseline, with controlling for covariates.

Conclusions Among community-dwelling adults, frailty was positively associated with the likelihood and the number of specialised outpatient clinic visits, emergency department visits, day surgeries and hospitalisations but no significant associations were observed with primary care utilization. The positive association was significant at 6-month before and after the baseline.

As frailty is a potentially reversible health state with early screening and intervention, providing preventive activities that delay the onset or progression of frailty should have the potential effect on delaying secondary and tertiary care needs.

Background

Frailty can be defined as ‘a state of vulnerability to adverse outcomes resulting from the accumulation of deficits associated with clinical effects’ [1], and has been shown to be a common phenomenon among older adults [2]. A recent systematic review that gathered data from 21 studies and over 61,500 community-dwelling older adults found that the overall weighted average prevalence of frailty was 10.7%

(ranged 4.0–59.1%) [2]. With the absolute number of people aged 60 years and over expected to reach 2 billion in 2050 [3], the burden of frailty will increase [4].

In Singapore, 21.4% of the total population consisted of individuals aged 60 years and above in 2019 [5], which is projected to reach 40% by year 2050 [6]. Such drastic rise in both the number and proportion of older population inevitably translate into a surge in the number and proportion of frail individuals [7], which brings various challenges to health care and healthcare delivery as they are recognised as intensive users of health care services [8]. To forge a frailty-ready healthcare system, Singapore has re-organised its public healthcare system from six regional healthcare systems (RHS) into three integrated clusters to allow each cluster to have a fuller range of assets, capabilities, services and networks across different care settings to meet the challenges of population ageing and further care needs [9]. Each RHS is responsible for care integration and providing care to the population in a specific geographical region. Based on self-reported incidence of healthcare resource utilisation, cross-sectional studies in international literature have found frailty to be associated with an increased likelihood of general practice (adjusted odds ratios (OR): 2.1–4.4), specialist (OR 1.3–1.8), emergency department (OR 2.5–6.2) and inpatient (OR 2.1–3.3) service utilisation [8, 10–12]. These findings were also supported by the results from prospective cohort studies [13–15] as well as panel studies [16].

Innovative projects have been implemented to address the needs of the frail elderly in Singapore [17] but a deeper understanding of the frail older population and their patterns of healthcare utilisation is necessary for better resource planning and intervention prioritisation in public healthcare. Most studies investigating the associations between frailty and healthcare utilisation have been conducted in North American and European countries. As healthcare systems and access to care varies across countries, examining the association between frailty and healthcare utilisation using Singapore data will provide insights in an Asian setting where health seeking behaviours and utilisation patterns could differ.

The assessment of frailty are typically determined based on the actual or estimated status of the person at the point of assessment without accounting for the presence of acute conditions, as these might sway the determination of frailty status [18] and contribute to the variation in the magnitude of association between frailty and healthcare utilisation in different settings. While individuals who have been frail over a period of time may have had persistently higher healthcare utilisation during retrospective and prospective observation periods, those whose frailty status were caused by transient conditions might only have temporarily higher healthcare utilisation for a short period of time. In prior studies, the associations between frailty and healthcare utilisation were explored using either retrospective or prospective data in different population. There is a scarcity of research that examined their associations using both retrospective and prospective utilisation data. As such, little is known about how the magnitude of association differs in different period. This study aims to investigate the association of frailty and healthcare utilisation in community-dwelling older adults with utilisation data collected in two different periods: 1) 6 months before the frailty assessment at baseline, and 2) 6 months after the baseline assessment.

Methods

Study participants

Older adults aged 60 years and over (n = 701) who agreed to use their National Registration Identity Card (NRIC) number to link with utilisation database were sampled from the longitudinal Population Health Index (PHI) study conducted in the Central Region of Singapore with the baseline data collected during November 2015 to November 2016. The survey methodology of the baseline PHI study has been described elsewhere [19–21].

The PHI study was approved by the ethics review committee of the National Healthcare Group (Domain Specific Review Board, Reference Number: 2015/00269). Written informed consent was obtained from all individual participants after they were being informed about the study objectives and the safeguards put in place so that confidentiality of the collected data is maintained.

Frailty assessment

Frailty was determined using the revised five-item FRAIL scale (Fatigue, Resistance, Ambulation, Illnesses, & Malnutrition) with the “Malnutrition” replacing the “Loss of weight” in the original FRAIL scale (Fatigue, Resistance, Ambulation, Illnesses, & Loss of weight) [22, 23]. Each item is scored either 0 or 1. The revised FRAIL scale is scored from 0 (best) to 5 (worst) and is translated into three categories: robust (0), pre-frail (1–2), and frail (3–5). Similar to other studies [22, 23], we have operationalised the FRAIL scale based on information obtained from specific questions included in the PHI survey questionnaire. “Fatigue” was measured by asking how often they felt tired with responses of “more than half the days” or “nearly every day” scored 1. “Resistance” was assessed by asking their difficulty in walking up and down one flight of stairs without using handrail, and “Ambulation” was measured by asking their difficulty in walking around one floor of home or several blocks without aids; “quite a lot” or “cannot do” responses were each scored as 1. “Illness” was scored 1 for those who reported 5 or more illnesses out of 14 illnesses. “Malnutrition” was scored 1 if BMI < 18.5 or MNA screening score < 8 or MNA total score < 17. A complete description of the revised FRAIL scale items’ scoring criteria is provided in Table 1.

Table 1
FRAIL scale items.

Item	Criteria
Fatigue	1. “Over the last 2 weeks, how often have you been bothered by feeling tired or having little energy?” 0 = Not at all, 1 = Several days, 2 = More than half the days, 3 = Nearly every day Responses of “2” or “3” are scored as 1 and all others as 0. or 2. “Over the last 4 weeks, how often have you been bothered by getting tired very easily?” 0 = Not at all, 1 = Several days, 2 = More than half the days, 3 = Nearly every day Responses of “2” or “3” are scored as 1 and all others as 0.
Resistance	1. Stairs in Activities of Daily Living 1 = Unable to climb stairs, 2 = Assistance is required in all aspects of stair climbing, 3 = Able to ascent/descend but is unable to carry walking aids, and needs supervision and assistance, 4 = Generally no assistance is required, 5 = Able to go up and down a flight of stairs safely without help or supervision Responses of “1”, “2” or “3” are scored as 1 and all others as 0. or 2. “How much difficulty do you have in going up & down a flight of stairs without using handrail?” 5 = None, 4 = A little, 3 = Some, 2 = Quite a lot, 1 = Cannot do Responses of “1” or “2” are scored as 1 and all others as 0.

The revised FRAIL scale score ranges from 0 (best) to 5 (worst).
0: Robust, 1–2:Pre-frail, 3–5: Frail

Item	Criteria
Ambulation	1. Ambulation in Activities of Daily Living 1 = Dependent in ambulation, 2 = Constant presence of one or more assistants is required during ambulation, 3 = Assistance is required with reaching aids and/or their manipulation. One person is required to offer assistance, 4 = Independent in ambulation but unable to walk 50 yards/metres without help, or supervision is needed for confidence or safety in hazardous situations, 5 = Must be able to use crutches, canes, or a walker, and walk 50 metres/yards without help or supervision. Responses of “1”, “2”, “3” or “4” are scored as 1. or 2. “How much difficulty do you have in walking around one floor of your home, taking into consideration thresholds, doors, furniture, and a variety of floor coverings?” 5 = None, 4 = A little, 3 = Some, 2 = Quite a lot, 1 = Cannot do Responses of “1” or “2” are scored as 1 and all others as 0. or 3. “How much difficulty do you have waling several blocks?” 5 = None, 4 = A little, 3 = Some, 2 = Quite a lot, 1 = Cannot do Responses of “1” or “2” are scored as 1 and all others as 0.
Illnesses	“Have you ever been told to have any of these conditions by a Western-trained doctor?” The conditions include diabetes, high blood pressure, high blood cholesterol, heart failure, stroke / Transient Ischaemic attacks, asthma, chronic bronchitis/ emphysema/COPD, chronic kidney disease, cancer, osteoarthritis/gout/rheumatoid arthritis, osteoporosis, dementia/Alzheimer’s, schizophrenia, Parkinson) 1 = Yes, 0 = No Responses of “1” are scored as 1.
Malnutrition	1. Body Mass Index < 18.5 or 2. Screening score of the Mini Nutritional Assessment < 8 or total score < 17
The revised FRAIL scale score ranges from 0 (best) to 5 (worst).	
0: Robust, 1–2:Pre-frail, 3–5: Frail	

Healthcare utilisation

The retrospective 6-month and prospective 6-month healthcare utilisation were obtained from RHS database [24]. The RHS database contains linked National Healthcare Group (NHG) polyclinic visit records, specialist outpatient clinic visit records and hospital discharge records from three government hospitals - Tan Tock Seng Hospital (TTSH), Khoo Teck Puat (KTPH) and Institute of Mental Health (IMH),

chronic disease management system (CDMS) records and mortality records from local registries. The healthcare utilisation data were categorised according to main healthcare settings into polyclinics, specialized outpatient clinics (SOC), emergency departments (ED), day surgery (DS) and hospitalisations. Primary care use refers to any doctor consultation and technical visits made by the individual to any of the public-funded nine linked NHG Polyclinics. SOC visits refer to any visit to the specialists in outpatient clinics located within three government hospitals. Similarly, ED attendances refer to visits to the emergency rooms of these acute care hospitals and hospitalisations refer to inpatient episodes with at least one overnight stay at these hospitals. The survey data and healthcare utilisation data were linked using NRIC numbers which were removed thereafter for data analysis.

Other variables

We controlled for the confounding effects of covariates to examine the independent effect of frailty on the rates of healthcare utilisation in different settings. These covariates included demographic factors (age, gender (male / female), Chinese (yes / no), marital status (single / married / widowed or divorced), living arrangement (alone / with others)) [8, 25] and smoking status (non-smoker / past smoker / current smoker) [16]. Highest education level (no formal education / primary / secondary or above) and self-perceived money sufficiency for basic living needs (sufficient / insufficient) were also included as control variables as they are enabling factors which influence individuals' health seeking behaviours and healthcare utilisation [8, 26, 27].

Multimorbidity and disability, which are related to but also distinct from frailty [28, 29], were commonly adjusted in studies examining the association between frailty and healthcare utilisation [8, 13]. We controlled for multimorbidity as a dichotomous variable (yes / no) which was defined as the presence of two or more of the following 17 chronic conditions: dyslipidemia, high blood pressure, diabetes, chronic kidney disease, heart attack / ischemic heart disease, heart failure, stroke / transient ischemic attack, asthma, chronic bronchitis / emphysema / chronic obstructive pulmonary disease, cancer, osteoarthritis / gout / rheumatoid arthritis, osteoporosis, depression, anxiety disorder, schizophrenia, dementia / Alzheimer's, and Parkinson's disease [20]. Disability, which was determined based on whether assistance was required in any of the ten activities of daily living (ADLs) (yes / no) measured using the Modified Barthel Index [30], was also controlled in the models.

Statistical analysis

Characteristics of the study population were described using mean and standard deviation (SD) for continuous variables, and frequency and percentages for categorical variables. Mean and SD were used to describe healthcare utilisation for every frailty group. To examine the differences in characteristics and utilisation across frailty groups, one-way Analysis of Covariance (ANOVA) tests (normally distributed) or Kruskal-Wallis H tests (non-normally distributed) were performed for continuous variables, and chi-squared tests were conducted for categorical variables.

Healthcare utilisation by settings are count variables characterised by a point mass at zero followed by a right-skewed, discrete distribution, and non-negative values [35, 36]. Given the over-dispersion of data (the

conditional variance is larger than the conditional mean), a negative binomial distribution was chosen over a Poisson regression [37]. Healthcare utilisation in five settings formed five different dependent variables analysed independently, and the three-level frailty category (robust, pre-frail, frail) was the independent variable of interest. We further adjusted for control variables including demographic factors (age, gender, ethnic group, marital status, living arrangement,), socioeconomic status (highest education level, self-perceived money sufficiency), smoking status, multimorbidity, and disability status. The results were presented as incidence-rate ratios (IRRs) and their corresponding 95% confidence interval (CI). All analyses were performed using Stata/SE 16.1. A p value of less than 0.05 was set as the level of significance.

Results

Characteristics of study population

Our sample comprised 701 older adults. Their mean age was 70.5 years (SD 8.2). The majority were of Chinese ethnicity (84%), female (57%) and were living with others (81%). The prevalence of multimorbidity was 70% among this population. The proportion of prefrail and frail individuals measured using the revised FRAIL scale was 27.7% and 7.5% respectively (Table 2).

Table 2
Characteristics of participants at baseline by frailty status, n (%)

Characteristic	Overall (N = 701)	Robust (n = 454, 64.8%)	Prefrail (n = 194, 27.7%)	Frail (n = 53, 7.5%)	p-value
Age, mean ± SD	70.5 ± 8.2	68.3 ± 6.6	73.1 ± 8.6	79.1 ± 9.8	*< 0.001*
Female (n, %)	397 (56.6)	245 (54.0)	122 (62.9)	30 (56.6)	*0.111*
Chinese	591 (84.3)	398 (87.7)	153 (78.9)	40 (75.5)	*0.003*
Marital status					*0.001*
Single	88 (12.6)	64 (14.1)	21 (10.8)	3 (5.7)	
Married	410 (58.5)	279 (61.5)	107 (55.2)	24 (45.3)	
Divorce/widowed	203 (29.0)	111 (24.4)	66 (34.0)	26 (49.1)	
Highest education					*< 0.001*
No formal education	245 (35.0)	123 (27.1)	92 (47.4)	30 (56.6)	
Primary	124 (17.7)	85 (18.7)	30 (15.5)	9 (17.0)	
Secondary or higher	332 (47.4)	246 (54.2)	72 (37.1)	14 (26.4)	
Living alone	131 (18.7)	90 (19.8)	36 (18.6)	5 (9.4)	*0.185*
Self-reported money insufficiency	113 (16.1)	53 (11.7)	45 (23.2)	15 (28.3)	*< 0.010*
Smoking status					*0.047*
Non-smoker	527 (75.2)	349 (76.9)	144 (74.2)	34 (64.2)	
Current smoker	63 (9.0)	41 (9.0)	19 (9.8)	3 (5.7)	
Past smoker	111 (15.8)	64 (14.1)	31 (16.0)	16 (30.2)	

The percentages were reflected as column percentages.

Characteristic	Overall (N = 701)	Robust (n = 454, 64.8%)	Prefrail (n = 194, 27.7%)	Frail (n = 53, 7.5%)	p-value
Multimorbidity	487 (69.5)	276 (60.8)	161 (83.0)	50 (94.3)	*< 0.001*
Assistance required in any ADLs	107 (15.3)	9 (2.0)	58 (29.9)	40 (75.5)	*< 0.001*
The percentages were reflected as column percentages.					

Comparing the profile across the three frailty categories (Table 2), we showed that those who were frail were significantly older, and had a higher proportion with multimorbidity, and required assistance in any ADLs. A significantly lower proportion of those who were frail were single, of Chinese ethnicity; and a higher proportion had no formal education, and perceived that they had insufficiency financial means for their daily needs.

Association between frailty and healthcare utilisation

Healthcare utilisation in the 6-months before baseline

Compared to older adults in robust health, significantly higher proportions of SOC and ED visits, day surgery utilisation as well as hospitalisations were observed in those who were pre-frail and frail (Table 3). The mean number of SOC visits, ED visits and hospitalisations also increased corresponding with the increase of frailty levels (all $p < 0.001$). Pre-frail older adults were the dominant users of the polyclinic services among the older population with about 42% having polyclinic visits.

After adjusting for all covariates including multimorbidity and disability, the logistic regression results showed that frailty was statistically associated with the adjusted odds of SOC visits, ED visits, day surgery and hospitalisations in 6-months before baseline. Relative to the robust group, individuals who were frail had 2.8 times the rate of SOC visits; had 3.1 times the rate of ED visits; and had a rate 6.4 times and 6.7 times greater for day surgeries done and hospitalisations respectively (Table 3). Pre-frail individuals had 1.6 times and 2.1 times the rate of SOC visits and hospitalisations respectively compared to their robust counterpart.

Table 3
Associations between frailty and healthcare utilisation in different settings in 6-months before baseline

Healthcare setting	Frailty	Yes, n (%)	Mean ± SD	Adjusted IRR[c] (95% CI)
Polyclinics	**Robust (n = 454)**	148 (32.6)	0.95 ± 1.96	1.00
	Prefrail (n = 194)	82 (42.3)	1.47 ± 2.69	1.35 (0.96, 1.91)
	Frail (n = 53)	20 (37.7)	1.26 ± 2.03	1.11 (0.58, 2.10)
	p-value	*0.060*[a]	*0.024*[b]	
Specialist outpatient clinics	**Robust (n = 454)**	126 (27.8)	1.22 ± 2.93	1.00
	Prefrail (n = 194)	79 (40.7)	2.40 ± 5.83	1.65 (1.04, 2.63)
	Frail (n = 53)	27 (50.9)	3.92 ± 5.39	2.82 (1.22, 6.50)
	p-value	*< 0.001*	*< 0.001*	
Emergency department	**Robust (n = 454)**	28 (6.2)	0.09 ± 0.41	1.00
	Prefrail (n = 194)	22 (11.3)	0.18 ± 0.63	1.10 (0.55, 2.21)
	Frail (n = 53)	16 (30.2)	0.57 ± 1.01	3.05 (1.14, 8.12)
	p-value	*< 0.001*	*< 0.001*	
Day surgery	**Robust (n = 454)**	18 (4.0)	0.06 ± 0.37	1.00
	Prefrail (n = 194)	10 (5.2)	0.09 ± 0.61	2.02 (0.77, 5.27)
	Frail (n = 53)	6 (11.3)	0.13 ± 0.39	6.41 (1.33, 30.92)
	p-value	*0.060*	*0.062*	
Hospitalisations	**Robust (n = 454)**	13 (2.9)	0.04 ± 0.27	1.00
	Prefrail (n = 194)	20 (10.3)	0.14 ± 0.47	2.06 (0.91, 4.67)
	Frail (n = 53)	15 (28.3)	0.51 ± 0.95	6.72 (2.14, 21.11)
	p-value	*< 0.001*	*< 0.001*	

[a] *p-values were obtained by chi-squared tests.*

[b] *p-values were obtained by Kruskal-Wallis H tests.*

[c] *IRR: Incidence rate ratio. Adjusted for age, female, Chinese, marital status, highest education level, living alone, self-reported money insufficiency, smoking status, multimorbidity, and assistance required in ADLs*

Healthcare utilisation in the 6-months after baseline

Similarly, in the 6-months after baseline, significantly higher proportion and mean number of SOC and ED visits, as well as hospitalisations were observed in pre-frail and frail older adults compared to their robust peers (Table 4). After adjusted for all covariates, compared to their robust counterpart, frail older adults had a rate 3.3 times, 6.4 times, 5.8 times and 13.1 times for SOC visits, ED visits, day surgery done and hospitalisations, respectively. No significant difference in rate was observed for polyclinic visits. Pre-frail individuals had 1.5 times, 2.6 times and 3.8 times higher rate of polyclinic visits, ED visits and hospitalisations respectively compared to their robust counterpart (Table 4).

Table 4
Associations between frailty and healthcare utilisation in different settings in 6-months after baseline

Healthcare setting	Frailty	Yes, n (%)	Mean ± SD	Adjusted IRR[c] (95% CI)
Polyclinics	**Robust (n = 454)**	153 (33.7)	0.97 ± 2.3	1.00
	Prefrail (n = 194)	82 (42.3)	1.64 ± 4.18	1.54 (1.08, 2.19)
	Frail (n = 53)	20 (37.7)	1.11 ± 1.82	1.17 (0.60, 2.29)
	p-value	*0.113*[a]	*0.080*[b]	
Specialist outpatient clinics	**Robust (n = 454)**	139 (30.6)	1.21 ± 2.61	1.00
	Prefrail (n = 194)	70 (36.1)	2.03 ± 4.13	1.48 (0.96, 2.27)
	Frail (n = 53)	31 (58.5)	5.08 ± 7.32	3.31 (1.56, 7.06)
	p-value	*< 0.001*	*< 0.001*	
Emergency department	**Robust (n = 454)**	20 (4.4)	0.05 ± 0.25	1.00
	Prefrail (n = 194)	20 (10.3)	0.19 ± 0.73	2.55 (1.25, 5.20)
	Frail (n = 53)	16 (30.2)	0.47 ± 0.82	6.40 (2.38, 17.24)
	p-value	*< 0.001*	*< 0.001*	
Day surgery	**Robust (n = 454)**	24 (5.3)	0.06 ± 0.31	1.00
	Prefrail (n = 194)	11 (5.7)	0.09 ± 0.47	1.77 (0.77, 4.06)
	Frail (n = 53)	5 (9.4)	0.13 ± 0.44	5.75 (1.28, 25.78)
	p-value	*0.468*	*0.450*	
Hospitalisations	**Robust (n = 454)**	11 (2.4)	0.03 ± 0.17	1.00
	Prefrail (n = 194)	19 (9.8)	0.12 ± 0.41	3.76 (1.66, 8.53)
	Frail (n = 53)	16 (30.2)	0.53 ± 0.97	13.11 (4.9, 35.04)
	p-value	*< 0.001*	*< 0.001*	

[a] *p-values were obtained by chi-squared tests.*

[b] *p-values were obtained by Kruskal-Wallis H tests.*

[c] *IRR: Incidence rate ratio. Adjusted for age, female, Chinese, marital status, highest education level, living alone, self-reported money insufficiency, smoking status, multimorbidity, and assistance required in ADLs*

Discussion

We examined the associations between frailty and healthcare utilisation in different public healthcare settings in Singapore and the results showed that the association between frailty and healthcare utilisation varies in different settings. While the frail elderly in the community had significantly higher proportion and number of SOC visits, ED visits, day surgery and hospitalisations in the 6-months before and after the baseline, their utilisation of public primary care services was lower relative to their pre-frail robust peers.

Prior studies consistently reported that increasing frailty is associated with substantial increases in hospital admissions, measured either retrospectively or prospectively [8, 15, 38]. We also observed that the frail older adults in the study had more hospitalisations than their robust and prefrail peers, regardless whether the hospitalisations incurred before or after the baseline. Their association is persistent even after adjusting for the socio-demographics, multimorbidity and disability status. Among the healthcare service utilisation in the five different care settings, our study found that frailty had the most significant impact on hospitalisations in both 6-months before and after baseline, which is consistent with findings reported in prior studies [8, 11, 39]. The association between frailty and hospitalisations reflects that frail elderly in Singapore tend to present to the healthcare system, especially tertiary care, when they are in a more severe stage of frailty [40].

Although the association between frailty and healthcare utilisation of specialist outpatient care is less investigated compared with that of inpatient services, prior studies do suggest that frailty has positive association with the use of specialist outpatient services [8, 41]. Our study provides additional support for their association, regardless whether the SOC visits incurred 6 months before or after the baseline. This reflects that an increase in the severity of frailty among older adults corresponds with a greater need for comprehensive and specialised health care services [41, 42].

Unlike prior studies which reported that frailty had a positive association with probability of use of primary care services in general practitioner clinics [8, 14, 15, 39], our study found frail individuals did not have higher risk of utilising more polyclinic services than their robust counterparts. Instead, the older adults who were in the prefrail stage tended to use more polyclinic services. This suggests that when older adults deteriorate from robust health state to prefrail stage, their use of primary care services increase significantly; and when older adults are in a more severe stage of frailty, their needs may shift towards increased specialist care services. However, the results should be interpreted with caution as only about 20% of the total primary care services in Singapore are provided by polyclinics. The omission of private general practitioner utilisation data in the RHS database made it challenging to infer the association between frailty and total primary care utilisation. This might partially explain why frail individuals did not report higher primary care visits compared to their robust or prefrail counterparts, although polyclinics provide a larger percentage of care for patients with chronic and more complex conditions compared to private general practitioners.

Strengths and limitations

To the best of our knowledge, this is the first study investigating the association between frailty and patterns of healthcare utilisation in different care settings in Singapore. We examined the association using both retrospective and prospective utilisation data and found consistent relationship between frailty and healthcare utilisation in respective settings.

The analyses presented in the study used number of hospitalisations to capture the inpatient utilisation. Although number of hospitalisations is a partial indicator of inpatient utilisation, length of stay, which also reflects another important aspect of inpatient utilisation [43], was not measured.

The healthcare utilisation data were derived from regional healthcare system, as such, healthcare utilisation in other RHS, private general practitioners, private specialist clinics and hospitals, as well as home care services provided by Voluntary Welfare Organisations were not included. This may cause under-estimation of the association between frailty and healthcare utilisation. However, as the participants were the residents in the region with their health entrusted to the NHG RHS, the majority of their utilisation in public healthcare services should have been captured and serve the purpose of understanding the patterns of service delivery for older people with different frailty status in these five healthcare settings within the defined geographical region served by the NHG RHS.

Conclusions

Frailty was positively associated with SOC visits, ED visits, and hospitalisations measured 6-months before or after among community-dwelling older adults. Frail individuals tended to have higher risk of SOC and ED visits, and hospitalisations but lower risk of DS utilisation compared to their robust counterpart. As frailty is a potentially reversible health state with early screening and intervention, identifying the pre-frail and frail elderly in the community, and providing effective interventions at early stage could be an effective strategy of reducing or delaying utilisation of secondary and tertiary care services.

Declarations

Ethics approval and consent to participate

The PHI study was approved by the ethics review committee of the National Healthcare Group (Domain Specific Review Board, Reference Number: 2015/00269). Written informed consent was obtained from all individual participants after they were being informed about the study objectives and the safeguards put in place so that confidentiality of the collected data is maintained.

Consent for publication

Not applicable.

Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

Funding

This work was supported by National Healthcare Group Pte Ltd in the form of salaries for all authors. The funder had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript.

Authors' contributions

CWY conceptualised the revised FRAIL scale and linked PHI data with RHS utilisation data. LG conceptualised the manuscript, analysed and interpreted the data, and was a major contributor in writing the manuscript. WST conceptualised, reviewed and edited the manuscript. BHH obtained the funding and supervised the PHI study. All authors read and approved the final manuscript.

Acknowledgements

Not applicable.

References

1. Howlett SE, Rockwood K. New horizons in frailty: ageing and the deficit-scaling problem. Age Ageing. 2013;42:416–23.
2. Collard RM, Boter H, Schoevers RA, Oude Voshaar RC. Prevalence of frailty in community-dwelling older persons: a systematic review. J Am Geriatr Soc. 2012;60:1487–92.
3. WHO WHO. Facts about ageing. WHO. 2014. http://www.who.int/ageing/about/facts/en/. Accessed 18 Feb 2019.
4. Buckinx F, Rolland Y, Reginster J-Y, Ricour C, Petermans J, Bruyère O. Burden of frailty in the elderly population: perspectives for a public health challenge. Arch Public Health. 2015;73:19.

5. Department of Statistics. Singapore residents by age group, ethnic group and sex. Population and population structure. 2020. http://www.tablebuilder.singstat.gov.sg/publicfacing/createDataTable.action?refId=14911.
6. United Nations, Department of Economic and Social Affairs, Population Division. World population ageing 2017 - highlights (ST/ESA/SER.A/397). the United Nations; 2017.
7. Hajek A, Bock J-O, Saum K-U, Matschinger H, Brenner H, Holleczek B, et al. Frailty and healthcare costs-longitudinal results of a prospective cohort study. Age Ageing. 2018;47:233–41.
8. Roe L, Normand C, Wren M-A, Browne J, O'Halloran AM. The impact of frailty on healthcare utilisation in Ireland: evidence from the Irish longitudinal study on ageing. BMC Geriatr. 2017;17. doi:10.1186/s12877-017-0579-0.
9. Ministry of Health. Reorganisation of healthcare system into three integrated clusters to better meet future healthcare needs. Ministry of Health Singapore, News Highlights. 2017. https://www.moh.gov.sg/news-highlights/details/reorganisation-of-healthcare-system-into-three-integrated-clusters-to-better-meet-future-healthcare-needs. Accessed 25 Mar 2020.
10. Dent E, Hoon E, Karnon J, Newbury J, Kitson A, Beilby J. Frailty and health service use in rural South Australia. Archives of Gerontology and Geriatrics. 2016;62:53–8.
11. Hoeck S, François G, Geerts J, Van der Heyden J, Vandewoude M, Van Hal G. Health-care and home-care utilization among frail elderly persons in Belgium. Eur J Public Health. 2012;22:671–7.
12. Rochat S, Cumming RG, Blyth F, Creasey H, Handelsman D, Le Couteur DG, et al. Frailty and use of health and community services by community-dwelling older men: the Concord Health and Ageing in Men Project. Age and Ageing. 2010;39:228–33.
13. Ensrud KE, Kats AM, Schousboe JT, Taylor BC, Cawthon PM, Hillier TA, et al. Frailty phenotype and healthcare costs and utilization in older women. Journal of the American Geriatrics Society. 2018;66:1276–83.
14. Simpson KN, Seamon BA, Hand BN, Roldan CO, Taber DJ, Moran WP, et al. Effect of frailty on resource use and cost for Medicare patients. Journal of Comparative Effectiveness Research. 2018;7:817–25.
15. Gobbens RJJ, van Assen MALM, Luijkx KG, Schols JMGA. Predictive validity of the Tilburg Frailty Indicator: Disability, health care utilization, and quality of life in a population at risk. The Gerontologist. 2012;52:619–31.
16. Ilinca S, Calciolari S. The patterns of health care utilization by elderly Europeans: frailty and its implications for health systems. Health Serv Res. 2015;50:305–20.
17. Lim WS, Wong SF, Leong I, Choo P, Pang WS. Forging a frailty-ready healthcare system to meet population ageing. Int J Environ Res Public Health. 2017;14:e1448.
18. Hogan DB, Maxwell CJ, Afilalo J, Arora RC, Bagshaw SM, Basran J, et al. A scoping review of frailty and acute care in middle-aged and older individuals with recommendations for future research. Can Geriatr J. 2017;20:22–37.

19. Ge L, Ong R, Yap CW, Heng BH. Effects of chronic diseases on health-related quality of life and self-rated health among three adult age groups. Nurs Health Sci. 2018.
20. Ge L, Yap CW, Heng BH. Sex differences in associations between multimorbidity and physical function domains among community-dwelling adults in Singapore. PLOS ONE. 2018;13:e0197443.
21. Ge L, Yap CW, Ong R, Heng BH. Social isolation, loneliness and their relationships with depressive symptoms: A population-based study. PLOS ONE. 2017;12:e0182145.
22. Abellan van Kan G, Rolland YM, Morley JE, Vellas B. Frailty: toward a clinical definition. J Am Med Dir Assoc. 2008;9:71–2.
23. Morley JE, Malmstrom TK, Miller DK. A simple frailty questionnaire (FRAIL) predicts outcomes in middle aged African Americans. The journal of nutrition, health & aging. 2012;16:601.
24. Gunapal PPG, Kannapiran P, Teow KL, Zhu Z, Xiaobin You A, Saxena N, et al. Setting up a regional health system database for seamless population health management in Singapore. Proceedings of Singapore Healthcare. 2016;25:27–34.
25. Peters LL, Burgerhof JGM, Boter H, Wild B, Buskens E, Slaets JPJ. Predictive validity of a frailty measure (GFI) and a case complexity measure (IM-E-SA) on healthcare costs in an elderly population. Journal of Psychosomatic Research. 2015;79:404–11.
26. Kuuire VZ, Bisung E, Rishworth A, Dixon J, Luginaah I. Health-seeking behaviour during times of illness: a study among adults in a resource poor setting in Ghana. J Public Health. 2015;:fdv176.
27. Low L, Tay W, Ng M, Tan S, Liu N, Lee K. Frequent hospital admissions in Singapore: clinical risk factors and impact of socioeconomic status. smedj. 2018;59:39–43.
28. Fried LP, Tangen CM, Walston J, Newman AB, Hirsch C, Gottdiener J, et al. Frailty in older adults: evidence for a phenotype. J Gerontol Med Sci. 2001;56A. doi:10.1093/gerona/56.3.M146.
29. Fried LP, Ferrucci L, Darer J, Williamson JD, Anderson G. Untangling the concepts of disability, frailty, and comorbidity: implications for improved targeting and care. J Gerontol A Biol Sci Med Sci. 2004;59:255–63.
30. Shah S, Vanclay F, Cooper B. Improving the sensitivity of the Barthel Index for stroke rehabilitation. J Clin Epidemiol. 1989;42:703–9.
31. Nemes S, Jonasson JM, Genell A, Steineck G. Bias in odds ratios by logistic regression modelling and sample size. BMC Med Res Methodol. 2009;9:56.
32. Peduzzi P, Concato J, Kemper E, Holford TR, Feinstein AR. A simulation study of the number of events per variable in logistic regression analysis. Journal of Clinical Epidemiology. 1996;49:1373–9.
33. van Smeden M, de Groot JAH, Moons KGM, Collins GS, Altman DG, Eijkemans MJC, et al. No rationale for 1 variable per 10 events criterion for binary logistic regression analysis. BMC Medical Research Methodology. 2016;16:163.
34. Wang X. Firth logistic regression for rare variant association tests. Front Genet. 2014;5. doi:10.3389/fgene.2014.00187.

35. Diehr P, Yanez D, Ash A, Hornbrook M, Lin DY. Methods for analyzing health care utilization and costs. Annual Review of Public Health. 1999;20:125–44.
36. Sarma S, Simpson W. A microeconometric analysis of Canadian health care utilization. Health Econ. 2006;15:219–39.
37. Payne EH, Gebregziabher M, Hardin JW, Ramakrishnan V, Egede LE. An empirical approach to determine a threshold for assessing overdispersion in Poisson and negative binomial models for count data. Commun Stat Simul Comput. 2018;47:1722–38.
38. Ng TP, Feng L, Nyunt MSZ, Larbi A, Yap KB. Frailty in older persons: Multisystem risk factors and the Frailty Risk Index (FRI). Journal of the American Medical Directors Association. 2014;15:635–42.
39. Han L, Clegg A, Doran T, Fraser L. The impact of frailty on healthcare resource use: a longitudinal analysis using the Clinical Practice Research Datalink in England. Age and Ageing. 2019;48:665–71.
40. Chen CY, Gan P, How CH. Approach to frailty in the elderly in primary care and the community. Singapore Med J. 2018;59:240–5.
41. Tan LF, Lim ZY, Choe R, Seetharaman S, Merchant R. Screening for frailty and sarcopenia among older persons in medical outpatient clinics and its associations with healthcare burden. J Am Med Dir Assoc. 2017;18:583–7.
42. Clegg A, Young J, Iliffe S, Rikkert MO, Rockwood K. Frailty in elderly people. Lancet. 2013;381:752–62.
43. Hubbard RE, Peel NM, Samanta M, Gray LC, Mitnitski A, Rockwood K. Frailty status at admission to hospital predicts multiple adverse outcomes. Age Ageing. 2017;46:801–6.