


BMJ Open Assessing the psychosocial dimensions of frailty among older adults in Singapore: a community-based cross-sectional study

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ABSTRACT

Objective To examine how multiple dimensions of mental and social health, in addition to physical health, were associated with frailty among older adults.

Design A door-to-door sampling household community-based survey.

Setting Thirty-two public housing blocks within a residential town in Singapore's central region.

Participants 497 residents aged 60 years or older from the public housing town.

Outcome measures Physical frailty was assessed using the FRAIL Scale, which stands for fatigue, resistance, ambulation, illnesses and loss of weight. Physical health was assessed by multimorbidity, physical activity and functional ability; mental illness was assessed by the General Health Questionnaire (GHQ); and social domains were assessed by the Lubben Social Network Scale, Community Integration Measure and UCLA (University of California, Los Angeles) Loneliness Scale.

Results Compared with robust (59.5%) and prefrail (32.6%) older adults, frail adults (7.9%) reported higher morbidity, lower functional ability and physical activity, higher scores on GHQ, and lower scores on all three social health scales. In multiple regression models, frailty was significantly associated with age 81–90 years (adjusted OR=2.22, 95% CI 1.23 to 3.99), having 2–3 (adjusted OR=1.56, 95% CI 1.02 to 2.38) or >3 (adjusted OR=1.83, 95% CI 1.05 to 3.18) chronic diseases, reduced ability to perform daily tasks without assistance (adjusted OR=0.41, 95% CI 0.23 to 0.73), having fallen in the past 6 months (adjusted OR=2.18, 95% CI 1.18 to 4.06), social dysfunction in GHQ (adjusted OR=1.24, 95% CI 1.08 to 1.43) and loneliness (adjusted OR=1.26, 95% CI 1.06 to 1.50). Physical activity did not remain significantly associated with frailty when mental and social health-related factors were entered in the regression.

Conclusion Community intervention for frailty prevention and management needs to include mental health promotion and social engagement to increase its impact on older adults.

INTRODUCTION

Frailty is a common geriatric state which affects roughly 10% of people aged 65 years and above.¹ While there are several definitions

Strengths and limitations of this study

- The community-based household survey enabled to produce an epidemiological profile of physical and social frailty among older adults in a public housing town in Singapore.
- The study used multidimensional assessments of physical, social and mental health to examine the psychosocial dimensions of physical frailty.
- The nature of cross-sectional survey limited inference on the directionality of associations.
- Cognitive function, a confounder of frailty, was not adjusted in the analysis as a formal assessment of cognition was not conducted in the study.

of frailty, it is commonly known as a clinical syndrome involving multiple signs and symptoms;² one can be considered frail with three out of the following five phenotypic criteria: low grip strength, low energy, slowed walking speed, low physical activity and/or unintentional weight loss.³ Frailty increases the risk of adverse health outcomes, including falls, hospitalisations, disability, institutionalisation and mortality.⁴ Due to such harmful effects, frailty is a key indicator of well-being of older people. In particular, with the ageing population, it has become a key challenge in the effort of increasing healthy life expectancy. Frailty is preventable and modifiable, especially in early stages.⁵ Thus, understanding the risk factors for frailty provides opportunities to optimise experiences of ageing and reduce related healthcare burden.

With regard to risk factors for frailty, most of the evidence concerns physical health factors associated with developing frailty, including older age, female, chronic disease, allostatic load, chronic systemic inflammation, low physical activity, being either underweight or overweight, smoking and heavy drinking.⁶ Recent studies suggested that frailty exists in

a life-course manner, developing through multiple pathways throughout an individual's lifespan, influenced by multidimensional factors, including mental and social health factors, beyond just physical health.⁶ Hence a multidimensional approach to frailty which encompasses the psychosocial dimensions of frailty, beyond physical, elucidates the complexity of care needs required in the prevention and management of frailty.⁷

In mental health, studies found that 16%–35% of frail individuals experienced coexisting depression.⁸ Although similar biological mechanisms were hypothesised to account for both frailty and depression, for example, subclinical cardiovascular disease and inflammation,⁹ it is unlikely that one mechanism is largely responsible for either or both syndromes. A meta-analysis found a reciprocal interaction between depression and frailty in older adults, where each condition is associated with an increased incidence of the development of the other.¹⁰ Anxiety also frequently co-occurs with depression, which in combination is associated with a higher risk of morbidity and mortality.¹¹

It is important to note that mental health is more than the absence of psychiatric disorders. As defined by the WHO, 'mental health is a state of well-being in which an individual realises his or her own abilities, can cope with the normal stresses of life, can work productively and make a contribution to his or her community'.¹² In line with this definition, mental health determinants of frailty need to include individuals' psychological well-being (negatively formulated as psychological distress) and self-management ability, which enables an individual to function within his social context (negatively formulated as social dysfunction). A review reported eight longitudinal studies which examined mental health effects on frailty and most examined the role of psychological distress on frailty through conditions such as depression, anxiety and neuroticism.¹³ However, few studies examined factors relating to lack of self-management ability or social dysfunction, which was measured by self-perceptions of positive and negative affect,¹⁴ and personal mastery and self-efficacy.¹⁵

Social factors are the least well studied in the determinants of frailty. Social domain is often explored through evaluating the structural and functional aspects of social relationships,¹⁶ with the interpersonal level assessment involving the individual's social networks and one at the community level involving one's integration within the belonged community.¹⁷ The structural aspects of social networks include the number of friends/family, the number of encounters with them within a specified period of time and other objective measurements. However, different social networks provide various forms of social support, which is the functional aspect of networks. For example, friend-based networks tend to be high on emotional support, as friends are generally age peers, but low on instrumental support, while the converse can be true for family networks.¹⁸ Community integration, which includes a structural evaluation of involvement in social

activities, also entails the functional aspect of a sense of belongingness within the community.¹⁹

Research suggests that the functional aspects were more relevant to their health and quality of life compared with the objective measures of structural relations.²⁰ In relation, another aspect of social health is loneliness, which can be defined as a subjective state based on a person's emotional or psychological response to the number and/or quality of social connections needed in comparison with what is being experienced at the time.²¹ It is different and not necessarily linked to the structural aspect of social isolation as an individual can have a large number of social connections and still experience the subjective feeling of loneliness, or alternatively be objectively isolated but not experience loneliness.²¹ Assessment of loneliness provides insight into the psychological responses to the structural and functional aspects of social relationships.

In Singapore, the proportion of residents aged 65 and above increased from 8.8% in 2009 to 14.4% in 2019,²² and the prevalence of frailty ranges from 5.7% to 11.3% in the population,⁴ depending on the operationalisation of frailty. Local studies established physical health determinants of frailty such as multimorbidity,^{4 23–26} physical exercise,⁴ and other lifestyle factors including smoking²⁷ and drinking.^{23 25} Mental health determinants included cognitive impairment^{4 25 26} and depressive symptoms.^{4 23–25 27 28} Compared with physical and mental domains, the social health domain is the least well studied, with social networks^{25 26} and social activity,²⁵ both of which evaluate the structural aspects of social health, found to be determinants of frailty. Little research in Singapore investigated the physical, social and mental determinants of frailty concurrently. The study used the FRAIL Phenotypic Scale to assess frailty for comparability with local studies^{4 24 28} and due to its ease of administration.²⁹ The objective was to examine the psychosocial factors associated with frailty in addition to physical health factors among community-dwelling older adults.

METHODS

Participants

A door-to-door survey was conducted in October 2019 among 497 older adults living in a public housing town in the central region of Singapore. If an older adult seemed incapable of communicating with us when we introduced the survey, we used the 'mini-cog', a screening tool for dementia detection, to check the participant's cognitive function.³⁰ Older residents with severe cognitive issues were excluded based on the screening result. This was assessed by the survey interviewers at the time when they introduced the study. The interviewers worked in a team to knock on every unit in the 32 blocks at different times of the day. Verbal informed consent was obtained in the respondent's preferred language, where the anonymity and voluntary nature of the survey was stressed. The survey was administered by the interviewers; responses were entered into an electronic data collection platform.

The survey took about 30 min to complete. The overall response rate was 58.5%. Common reasons for refusal to participate in the survey included unavailability, no interest in responding to the survey, communication difficulty and refusal without giving a specific reason. An umbrella, as a token of appreciation, was provided on survey completion.

Measures

In addition to the key measures below, sociodemographic information such as gender, age, ethnicity, religion, education, employment, housing type and cohabitants was collected.

Frailty was assessed by the five-item FRAIL Scale, which stands for fatigue, resistance, ambulation, illnesses and loss of weight.³¹ Fatigue was measured by asking respondents how often during the past 4 weeks they felt tired, with the following responses: 'all of the time' or 'most of the time', scored as '1'. Resistance was assessed by asking if they had any difficulty walking up 10 steps alone without resting and without aids. Ambulation was assessed by asking if they had any difficulty walking 300 m without aids; 'yes' responses were each scored as 1 point. Illness was scored 1 for respondents who reported five or more illnesses. Loss of weight was scored 1 for self-report of weight decline of 5% or greater within the past 12 months. The total score ranges from 0 to 5, where a score of 3–5 indicates frailty, 1–2 as having a prefrail and score of 0 as a robust state.

Physical health was assessed through the self-reported presence of chronic diseases such as hypertension, diabetes mellitus, high cholesterol, cardiovascular disease, musculoskeletal disease, thyroid disease and malignancies. The extent of multimorbidity was calculated by summing the number of chronic diseases of each respondent into ordinal categories ('0' for no, '1' for one to two, '3' for three or more chronic diseases). Functional ability was assessed through (1) ability to perform tasks of daily living without assistance ('0' for no, '1' for yes) and (2) fall history in the past 6 months ('0' for no, '1' for yes). In addition, we assessed lifestyle factors such as (1) amount of physical activity done in a week ('0' for none, '1' for 0–6 days a week, '2' for every day), (2) smoking history ('0' for no, '1' for yes) and (3) high alcohol intake in the past week ('0' for no, '1' for yes).

Mental health was assessed using the 12-Item General Health Questionnaire (GHQ-12), which has been shown to screen reliably and accurately for psychiatric disorders such as depression in primary care and outpatient settings.³² It includes questions relating to the psychological state of respondents and whether they have been feeling different recently, allowing to detect any recent changes in the respondent's psychological status and coping ability. The factors of GHQ-12 have been widely reported across regions. The two subscales used in this study were named psychological distress and social dysfunction,³³ and they have high internal consistency (Cronbach's $\alpha=0.87$ and $\alpha=0.88$, respectively).

Social health was assessed by social networks, community integration and loneliness. Social networks were assessed using the six-item Lubben Social Network Scale.³⁴ It measures the quantity of social networks among family/relatives and friends that the older person 'sees or hears from at least once a month', 'feels at ease to talk about private matters' and 'can call on them for help'. Each item was scored from 0 to 5. Total scores ranged from 0 to 30, with higher scores indicating larger social networks. There was good reliability of the family/relatives subscale ($\alpha=0.87$) and friend subscale ($\alpha=0.85$) in the sample. Community integration was assessed using the Community Integration Measure (CIM).³⁵ It contains measures of perceptions of community belongingness and participation in community activities.³⁶ Items from the CIM survey were initially designed and validated in a study to assess community integration among people with acquired brain injury, but has since been validated for the general population as well.³⁵ In the study, we used 9 out of the 10 original questions from the measure, omitting 'I know the rules in this community, and I can fit in with them', as this was not applicable to the context of our local population. Each item was scored from 1 to 4, and total scores ranged from 9 to 36, where higher scores indicate higher community integration. There was good reliability for the CIM scale in the sample ($\alpha=0.79$). Loneliness was assessed by the three-item UCLA (University of California, Los Angeles) Loneliness Scale,³⁷ which asks the frequency of experiencing 'lack companionship', 'feel left out' and 'isolated from others'. Each item was scored from 1 to 3; total scores ranged from 3 to 9. There was good reliability for the UCLA Loneliness Scale in the sample ($\alpha=0.90$).

Data analysis

The presentation of each FRAIL item (fatigue, resistance, ambulation, illness and loss of weight) and the resulting frailty categories were described. Categorical variables such as demographic characteristics, multimorbidity status and lifestyle factors were reported, where χ^2 tests were conducted to test the differences across frailty levels. One-way analysis of variance was conducted for continuous variables. Spearman correlations between the variables were conducted. Hierarchical ordinal regression analyses were performed to identify the independent predictors of frailty. Variables that were significant at the bivariate level with $p<0.10$ were entered into the multiple regression models. Age and physical health factors were entered in the first step, followed by physical activity (step 2), mental health (step 3) and social health (step 4). The regression model was adjusted for demographic variables that were significantly associated with frailty.

Patient and public involvement

The study was designed in collaboration with a non-government organisation which provided various community activities to promote healthy ageing and social engagement among older adults in the study community. A series of research collaboration meetings were held to

Table 1 Prevalence of frailty and categorisation (N=497)

Measures of frailty	n/N (%)
FRAIL Scale items	
Feeling tired	98/497 (19.7)
Difficulty walking up 10 steps without aid and rest	125/497 (25.2)
Difficulty walking 300 m without aids	107/497 (21.5)
Diagnosed with five or more illnesses/diseases	10/497 (2.0)
Significant weight loss in the past year (>5% change)	22/497 (4.4)
Frailty categories	
Robust (0 characteristic)	296/497 (59.5)
Prefrail (1–2 characteristics)	162/497 (32.6)
Frail (3–5 characteristics)	39/497 (7.9)

FRAIL, fatigue, resistance, ambulation, illnesses and loss of weight.

discuss research questions, survey measures, a probability-based sampling framework and recruitment strategies for a door-to-door survey. The final study protocol was reviewed. The survey questionnaire was pilot-tested by

senior volunteers from the organisation. We organised a community forum where we presented the preliminary findings of the survey and received feedback from the organisation staff as well as older adults in the community. Their feedback was incorporated in the interpretation and discussion of the findings in the paper.

RESULTS

Prevalence of frailty

Table 1 shows the frailty assessment. Of the symptoms reported, ‘difficulty walking ten steps without aid’ was the most common (25%), followed by ‘difficulty walking 300 meters without aid’ (22%), fatigue (20%), significant weight loss in the past year (4%) and diagnosis of five or more illnesses (2%). Adding these up, the prevalence of frailty and prefrailty in the study sample was 8% and 33%, respectively.

Characteristics of participants

Table 2 shows the demographic characteristics of participants by level of frailty. The majority of participants were 60–80 years old (86%), of Chinese ethnicity (91%), unemployed (84%) and did not live alone (86%), and about half (57%) were female. Sociodemographic

Table 2 Demographic characteristics by level of frailty

	Total (N=497)	Robust (n=296)	Prefrail (n=162)	Frail (n=39)	χ^2	P value
	n (%)	n (%)	n (%)	n (%)		
Age					33.29	<0.0001
60–70	229 (46.1)	150 (50.7)	69 (42.6)	10 (25.7)		
71–80	197 (39.6)	120 (40.5)	64 (39.5)	13 (33.3)		
81–90	71 (14.3)	26 (8.8)	29 (17.9)	16 (41.0)		
Gender					3.26	0.213
Male	214 (43.1)	137 (46.3)	61 (36.7)	16 (41.0)		
Female	283 (56.9)	159 (53.7)	101 (62.3)	23 (59.0)		
Ethnicity					2.56	0.860
Chinese	451 (90.7)	272 (91.9)	144 (88.9)	35 (89.7)		
Malay	17 (3.4)	9 (3.1)	7 (4.3)	1 (2.6)		
Indian	27 (5.5)	14 (4.7)	10 (6.2)	3 (7.7)		
Others	2 (0.4)	1 (0.3)	1 (0.6)	0 (0.0)		
Education					20.01	0.005
None	99 (19.9)	42 (14.2)	49 (30.2)	8 (20.5)		
Primary	171 (34.4)	109 (36.8)	45 (27.8)	17 (43.6)		
Secondary	166 (33.4)	103 (34.8)	53 (32.7)	10 (25.6)		
Pretertiary/tertiary	61 (12.3)	42 (14.2)	15 (9.3)	4 (10.3)		
Employment					5.98	0.037
Employed	80 (16.1)	56 (18.9)	22 (13.6)	2 (5.1)		
Unemployed	417 (83.9)	240 (81.1)	140 (86.4)	37 (94.9)		
Lived alone					2.29	0.301
No	429 (86.3)	250 (84.5)	144 (88.9)	35 (89.7)		
Yes	68 (13.7)	46 (15.5)	18 (11.1)	4 (10.3)		

Table 3 Physical and psychosocial health status by level of frailty

	Total (N=497)	Robust (n=296)	Prefrail (n=162)	Frail (n=39)	χ^2 or F	P value
	n (%) or M (SD)*	n (%) or M (SD)*	n (%) or M (SD)*	n (%) or M (SD)*		
Multimorbidity						
None (0–1 disease)	190 (38.2)	131 (44.3)	54 (33.3)	5 (12.8)	21.78	<0.0001
Low (2–3 diseases)	231 (46.5)	129 (43.6)	75 (46.3)	27 (69.3)		
High (≥ 4 diseases)	76 (15.3)	36 (12.1)	33 (20.4)	7 (17.9)		
Chronic diseases						
Hypertension	211 (42.5)	116 (39.2)	78 (48.1)	17 (43.6)	3.89	0.136
Diabetes mellitus	102 (20.5)	57 (19.3)	40 (24.7)	5 (12.8)	3.41	0.254
High blood cholesterol	148 (29.8)	88 (29.7)	51 (31.5)	9 (23.1)	1.11	0.760
Cardiovascular disease	33 (6.6)	10 (3.4)	14 (8.6)	9 (23.1)	23.19	<0.0001
Musculoskeletal disease	26 (5.2)	2 (0.7)	14 (8.6)	10 (25.6)	48.94	<0.0001
Thyroid	9 (1.8)	6 (2.0)	2 (1.2)	1 (2.6)	2.30	0.306
Functional ability						
Daily living without assistance	440 (88.5)	279 (94.3)	135 (83.3)	26 (66.7)	32.21	<0.0001
Fallen in the past 6 months	48 (9.7)	16 (5.4)	25 (15.4)	7 (17.9)	18.72	<0.0001
Physical activity					15.14	0.004
0 day/week	113 (22.7)	58 (19.6)	39 (24.1)	16 (41.0)		
1–2 days/week	99 (19.9)	63 (21.3)	26 (16.0)	10 (25.6)		
≥ 3 days/week	285 (57.3)	175 (59.1)	97 (59.9)	13 (33.3)		
Smoking	50 (10.1)	37 (12.5)	12 (7.4)	1 (2.6)	5.23	0.073
Drinking	42 (8.5)	28 (2.5)	12 (7.4)	2 (5.1)	1.20	0.584
Mental health						
Psychological distress	10.06 (3.08)	9.70 (2.82)	10.27 (3.03)	11.85 (4.28)	9.64	<0.0001
Social dysfunction	12.03 (1.92)	11.67 (1.78)	12.30 (1.54)	13.64 (3.12)	21.14	<0.0001
Social health						
Community integration	26.34 (3.78)	26.68 (3.90)	25.96 (3.21)	25.33 (4.74)	3.54	0.030
Social network with family	7.29 (3.44)	7.28 (3.51)	7.21 (3.28)	7.72 (3.63)	0.28	0.758
Social network with friends	6.22 (4.38)	6.63 (4.32)	5.77 (4.24)	4.97 (5.06)	3.91	0.021
Loneliness	3.46 (1.17)	3.28 (0.89)	3.54 (1.27)	4.47 (1.89)	22.50	<0.0001

Psychological distress: range 6–24, social dysfunction: range 6–24, community integration: range 9–36, social network with family and friends: range 0–15, and loneliness: range 3–9.

*Mean/SD.

characteristics such as age, education and employment differed by frailty level ($\chi^2=33.0$, $\chi^2=20.2$ and $\chi^2=5.9$, respectively; all $p<0.05$). In the age group 81–90 years old, the proportion of robust and prefrail notably decreased; only 9% robust and 18% prefrail were reported. With regard to education, 14% of the robust group reported no education compared with 30% of prefrail and 21% of frail. For employment, 81% of the robust group reported being unemployed compared with 86% of prefrail and 95% of frail. Other sociodemographic characteristics did not differ by frailty level.

Physical, mental and social health

Table 3 shows the physical, social and mental health status by level of frailty. Frailty was significantly associated with multimorbidity ($\chi^2=20.1$, $p<0.001$). The proportion of

older adults reporting two to three diseases increased from 44% to 46% to 69%, with an increasing level of frailty. While hypertension (43%), high blood cholesterol (30%) and diabetes mellitus (21%) were prevalent among older adults, the prevalence rates were not different across the three levels of frailty. Instead, less prevalent conditions like cardiovascular (7%) and musculoskeletal (5%) diseases differed by level of frailty ($\chi^2=23.1$ and $\chi^2=48.9$, respectively; both $p<0.001$). Poor functional ability was associated with frailty, with the proportion of older adults reporting ability to perform daily tasks of living without assistance decreasing from 94% to 83% to 67%, with an increasing level of frailty, and the proportion of older adults reporting falls in the last 6 months increasing from 5% to 15% to 18% across the levels of frailty ($\chi^2=32.2$ and

$\chi^2=15.4$, respectively; both $p<0.001$). The level of frailty also differed by frequency of physical activity ($\chi^2=13.6$, $p<0.01$), where no physical activity in a week increased from 20% to 24% to 41%, with increasing level of frailty. With regard to mental health, both psychological distress and social dysfunction were significantly associated with frailty ($F=6.2$ and $F=22.1$, respectively; both $p<0.001$). For social health, frailty was significantly associated with lower level of community integration and smaller size of social networks with friends ($F=3.4$ and $F=3.8$, respectively; both $p<0.05$). The association between loneliness and frailty was higher than other social factors ($F=19.7$, $p<0.001$). Social network with family members was not associated with frailty.

Correlations

Multimorbidity was positively correlated with having fallen in the past 6 months ($r=0.10$), loneliness ($r=0.09$) and social dysfunction ($r=0.09$). Functional ability—being able to perform tasks of living without assistance—was positively correlated with physical activity ($r=0.11$), community integration ($r=0.10$) and social networks with friends ($r=0.15$), but negatively correlated with social dysfunction ($r=-0.17$) and loneliness ($r=-0.10$). Physical activity was positively correlated with community integration ($r=0.13$) and social networks with friends ($r=0.20$), but negatively correlated with social dysfunction ($r=-0.19$) and loneliness ($r=-0.11$). Social network with friends was positively correlated with community integration ($r=0.43$), while negatively correlated with loneliness ($r=-0.25$). Loneliness was negatively correlated with community integration ($r=-0.20$). Loneliness was most strongly correlated with mental health factors, with positive correlations with psychological distress ($r=0.30$) and social dysfunction ($r=0.25$). Frailty was positively correlated with multimorbidity ($r=0.17$), fall in the past 6 months ($r=0.18$), psychological distress ($r=0.14$), social dysfunction ($r=0.24$) and loneliness ($r=0.21$); it was negatively correlated with functional ability ($r=-0.24$), physical activity ($r=-0.09$), community integration ($r=-0.12$) and social network with friends ($r=-0.12$). The table of correlations is included as online supplemental material.

Hierarchical regression

Table 4 presents the results of regression models of frailty, adjusted for education and employment, which were found to be significant at the univariate level. In step 1, increased age (81–90 years old), low (2–3 diseases) and high (>3 diseases) multimorbidity, and having fallen in the past 6 months were associated with increased odds of frailty (adjusted OR=2.20, 95% CI 1.23 to 3.93; adjusted OR=1.70, 95% CI 1.13 to 2.75; adjusted OR=2.03, 95% CI 1.18 to 3.49; adjusted OR=2.04, 95% CI 1.12 to 3.73, respectively), whereas the ability to perform daily tasks of living was associated with reduced odds of frailty (adjusted OR=0.31, 95% CI 0.18 to 0.53). In step 2, physical activity was entered, and increased age, multimorbidity, functional ability and having fallen in the past 6

months remained significantly associated with frailty. Additionally, three or more days of physical activity per week was found to be associated with decreased odds of frailty (adjusted OR=0.61, 95% CI 0.39 to 0.97). In step 3, after entering the two mental health variables, physical activity was no longer significantly associated with frailty. Between the two mental health factors, only social dysfunction was associated with increased odds of frailty (adjusted OR=1.28, 95% CI 1.11 to 1.47), but not psychological distress. In the last step, the effects of social health were tested. Only loneliness but not social networks with friends and community integration was associated with increased odds of frailty (adjusted OR=1.26, 95% CI 1.06 to 1.50).

DISCUSSION

Frailty is a common geriatric state associated with multiple adverse health outcomes in older people. Although physical aspects of frailty are well known, psychosocial factors of frailty are less investigated. The study highlighted the associations of physical, social and mental health factors across robust, prefrail and frail older adults with a focus on the association of psychosocial factors with frailty. The prevalence of 8% frail and 33% prefrail in the study is comparable with other studies in Singapore: 5.7% and 6.2% frailty and 37.0% and 40.1% prefrailty in similar age groups.^{4,26} Consistent with other studies, frail older adults were more likely to be advanced in age (eg, 81 years and older), have lower education levels and be unemployed. Contrary to other international studies,³⁸ gender was not associated with frailty in our study, and previous local studies also found no association between gender and frailty.²⁶ This might be explained by gender roles and community engagement.³³

The finding of the association between multimorbidity and frailty is consistent with previous studies.⁴ The proportion of those with one or more chronic diseases increased from robust to frail older adults. There remained a small proportion of frail older adults without chronic disease, suggesting frailty from physiological changes of ageing that are not disease-based (eg, ageing-related sarcopaenia or anorexia).³ However, given that our study used the FRAIL definition of frailty, which revolves around the physical health of an individual, judged based on the fulfilment of physically measured phenotypic criteria, there is bound to be an overlap between frailty and somatic disease, which directly and indirectly led to the fulfilment of the FRAIL frailty criteria. The study identified musculoskeletal and cardiovascular diseases as key clinical conditions most strongly associated with frailty. Many of the common musculoskeletal problems of old age, including osteoporosis, osteoarthritis and fragility fractures, are associated with mobility problems and can spiral into functional decline and disability.³⁹ Cardiovascular diseases are a common end manifestation of the metabolic syndrome pathway.⁴⁰ Not only is there a link between metabolic syndrome and frailty, but a

Table 4 Hierarchical ordinal regression for frailty

	Model 1	Model 2	Model 3	Model 4
	Adjusted OR (95% CI)	Adjusted OR (95% CI)	Adjusted OR (95% CI)	Adjusted OR (95% CI)
Age and physical health				
Age				
60–70	–	–	–	–
71–80	1.01 (0.67 to 1.52)	1.05 (0.69 to 1.61)	1.05 (0.69 to 1.62)	1.05 (0.68 to 1.61)
81–90	2.20 (1.23 to 3.93)**	2.25 (1.26 to 4.04)**	2.30 (1.28 to 4.14)**	2.22 (1.23 to 3.99)**
Multimorbidity				
None (0–1 disease)	–	–	–	–
Low (2–3 diseases)	1.70 (1.13 to 2.57)*	1.71 (1.31 to 2.59)*	1.60 (1.05 to 2.44)*	1.56 (1.02 to 2.38)*
High (≥4 diseases)	2.03 (1.18 to 3.49)*	2.06 (1.19 to 3.55)**	1.87 (1.08 to 3.26)*	1.83 (1.05 to 3.18)*
Functional ability				
Daily living without assistance	0.31 (0.18 to 0.53)***	0.32 (0.19 to 0.57)***	0.38 (0.21 to 0.66)***	0.41 (0.23 to 0.73)**
Fallen in the past 6 months	2.04 (1.12 to 3.73)*	2.13 (1.16 to 3.91)*	2.12 (1.15 to 3.94)*	2.18 (1.18 to 4.06)*
Lifestyle				
Physical activity				
0 days/week	–	–	–	–
1–2 days/week		0.58 (0.33 to 1.03)	0.67 (0.37 to 1.20)	0.67 (0.37 to 1.22)
≥3 days/week		0.61 (0.39 to 0.97)*	0.78 (0.48 to 1.25)	0.81 (0.50 to 1.31)
Mental health				
Psychological distress			1.03 (0.96 to 1.11)	1.01 (0.94 to 1.06)
Social dysfunction			1.28 (1.11 to 1.47)***	1.24 (1.08 to 1.43)**
Social health				
Community integration				1.00 (0.94 to 1.06)
Network with friends				0.99 (0.95 to 1.04)
Loneliness				1.26 (1.06 to 1.50)**

Regressions were adjusted for the demographic confounders of education and employment, which were found to be significantly associated with the outcome at the bivariate level. However, the confounders did not remain significant in all models; therefore, they were not reported in the table.

*P<0.05, **P<0.01, ***P<0.001.

bilateral association is suggested.⁴¹ Both chronic diseases are preventable at earlier stages through appropriate interventions.

Regular physical activity contributes to the reversal of the detrimental effects of chronic diseases as well as the maintenance of functional status in older adults, slowing down the onset of frailty.⁴² However, beyond its direct physical benefits, the indirect effects of non-physical factors should be noted. In the regression model, adding on mental and social health factors respectively reduced the effects of daily exercise on frailty to non-significant level, suggesting a mediation effect of psychosocial factors in the relationship. This has implications for frailty interventions. Frail older adults, who are unable to participate in physical exercise that is meant for the prefrail, could still reap the mental and social health benefits for frailty through interventions that are less physically taxing.

Social dysfunction was found to be a strong predictor of frailty above increased age, multimorbidity, functional ability, physical activity and loneliness. The finding can be explained by the decreased intrinsic ability of older adults to actively self-manage their ageing process and to cope with and be in control of their health needs, as the assessment of self-management ability (negatively formulated as social dysfunction) included items on decision-making, facing up to problems, concentration ability and feeling that one is playing a useful role in things. The concept of self-management is applied not only to chronic diseases but also to psychosocial problems such as depression and loneliness.⁴³ Older adults experience multiple and interacting challenges across the physical, mental and social domains that need to be managed simultaneously to delay the progression of frailty. They benefit more from broad self-management interventions, which equip them with

the intrinsic skills to address overall well-being, rather than short-term extrinsic interventions, which focus on just one problematic aspect of physical or psychosocial health.⁴³

The multifactorial assessment of social frailty yielded important insights. Deficits in each component of social health—social networks, community integration and loneliness—were individually associated with frailty at the bivariate level, while only moderately correlated with each other, suggesting that these are distinct but inter-related factors. At the multivariate level, only loneliness was found to be an independent predictor of frailty. Loneliness is regarded as a psychological manifestation outcome of a lack of social networks or a feeling of dissatisfaction regarding the frequency and closeness of social contacts.⁴⁴ Thus, loneliness may mediate the relationship between the structural components of social networks and community integration and frailty. For example, the Irish Longitudinal Study on Ageing found that loneliness was a significant mediator on the association between social networks and depression.⁴⁵ Hence community interventions to promote mental and social health will be needed to reduce loneliness among older adults who are at risk of frailty.

Limitations

There are several limitations to the study. Its cross-sectional nature limits inference on the directionality of associations. While the door-to-door survey will reduce selection bias, as opposed to convenience sampling at community centres, there were yet non-response bias as older adults with depression were unwilling or unable to participate in the survey. As the majority of the surveys were administered during working hours, we captured a larger pool of unemployed or retired participants as compared with working older adults, who may have a more robust profile. Due to the self-reporting nature of our interviews, older residents with severe cognitive issues that rendered them incapable of fully understanding and/or responding to the survey were excluded. While respondents with mild to moderate cognitive impairments were still able to participate in the survey, the true impact of cognitive decline on frailty could not be evaluated as the most severe cases were excluded. Given the complex, potentially multiplicative effects of cognitive functions, depression, social isolation and loneliness on frailty, further research is needed to examine the intersectionality of these domains and their impact on frailty.⁴⁶

CONCLUSION

The study demonstrated the importance of the psychosocial dimensions of frailty in older adults. Public health interventions for healthy ageing should address how mental and social health affects an individual's progression to frailty. Programme evaluation and implementation research need to incorporate appropriate

frameworks and measures to understand the underlying psychosocial mechanisms and the interrelated components of frailty prevention programmes. In policy, health life expectancy based on physical frailty should incorporate psychological frailty for well-being in a lifetime course. Effective translation of scientific knowledge of social frailty in practice is crucial to meet the unmet needs of older adults in the local context.

Correction notice This article has been corrected since it was published. Joint authorship and equal contribution details have been updated.

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Contributors HY, EYC, AH-SL, LHMY and FCYM conceived the design of the study. EYC, AH-SL, LHMY and FCYM conducted and managed the survey data collection. HY and STN conducted the data analysis. EYC and AH-SL wrote the first draft of the manuscript under the supervision of HY, who later revised and made the final draft. The final draft was meaningfully commented on by all authors. All authors approved the version of the manuscript to be published. As a guarantor, HY accepts full responsibility for the work and/or the conduct of the study, had access to the data, and controlled the decision to publish.

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