Research Square

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Psychosocial determinants of frailty among older adults in Singapore: a community-based survey

Elliot Yeung Chong
National University Singapore Yong Loo Lin School of Medicine
Angela Hui-Shan Lim
National University Singapore Yong Loo Lin School of Medicine
Freda Cheng Yee Mah
National University Singapore Yong Loo Lin School of Medicine
Lyn Hui Wen Yeo
National University Singapore Yong Loo Lin School of Medicine
Su Aw
National University Singapore Saw Swee Hock School of Public Health
Shu Tian Ng
National University Singapore Saw Swee Hock School of Public Health
Huso Yi (husoyi@nus.edu.sg)
National University of Singapore https://orcid.org/0000-0003-4724-5235

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Abstract

Background

With increasing life expectancy, it is important to understand the role of non-physical aspects of health in frailty prevention. The study aimed to examine how multiple dimensions of mental and social health, in addition to physical health, were associated with frailty in the population of older adults.

Methods

A cross-sectional door-to-door survey was conducted with 497 older adults in Singapore. Frailty was assessed using the FRAIL scale. Physical health was assessed by multimorbidity and physical activity; social health by the Lubbens' Social Network Scale, Community Integration Measure and UCLA loneliness scale; and mental health by the three-factor of the General Health Questionnaire (GHQ): anxiety/depression, loss of confidence and social dysfunction. Hierarchical ordinal regression was conducted to identify independent predictors of frailty, adjusting for socio-demographic variables.

Results

Compared to robust (59.5%) and pre-frail (32.6%) older adults, frail adults (7.9%) reported higher morbidity, lower physical activity, higher scores on all three subscales of GHQ, and had lower scores on all three social health scales that were assessed. In multiple regression model, frailty was significantly associated with 81–90 years old (adj. OR = 3.04), having 2–3 (adj. OR = 1.63) or > 3 (adj. OR = 2.01) chronic diseases, social dysfunction in GHQ (adj. OR = 4.31), and loneliness (adj. OR = 1.26). Physical activity did not remain significantly associated with frailty when mental and social health-related factors were entered in the regression.

Conclusions

The study findings highlight the importance of community intervention in mental and social health among older adults to prevent frailty in later life. Healthy aging is only possible when older adults' psychosocial needs are addressed.

Background

Frailty is a common geriatric state which affects roughly 10% of older people aged 65 years old and above [1]. While there are several definitions of frailty, it is commonly known as a clinical syndrome involving multiple signs and symptoms [2]; one can be considered as frail with three out of these 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,

hospitalizations, disability, institutionalization, and mortality [4]. Due to such harmful effects, frailty is a key indicator of the well-being of older people. With the rapid increase in population aging, it has become an urgent public health concern to increase healthy life expectancy. It is important to note that frailty is preventable and modifiable, especially in early stages [5]. Thus, understanding the risk factors of frailty provides opportunities to optimize experiences of aging and reduce related healthcare burdens.

Research has found major risk factors for frailty. To date, 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]. Recently research pointed out that frailty develops over the lifespan influenced by multidimensional factors on various pathways; therefore, culminating in increased frailty [6]. Social-ecological intervention is important to improve primary care and community health as it elucidates the complexity of care required as part of the health and social care burdens [7].

A better understanding of the psychosocial aspects of frailty can help to delay its onset and slow down its progression. In the domain of mental health, depression is the most well studied. Studies have found that 16–35% of frail individuals have experienced co-existing depression [8]. Although similar biological mechanisms have been hypothesized 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 that there was 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].

However, mental health is more than the absence of psychiatric disorders. As defined by the World Health Organization, ‘mental health is a state of well-being in which an individual realizes his or her own abilities, can cope with the normal stresses of life, can work productively and is able to make a contribution to his or her community’ [12]. In line with this definition, mental health determinants of frailty need to include an individual’s intrinsic confidence in his own abilities (negatively formulated as loss of confidence) as well as self-management ability, which enables him to function in the social context (negatively formulated as social dysfunction). A recent review reported eight longitudinal studies which examined mental health effects on frailty and most evaluated psychiatric disorders such as depression, anxiety and neuroticism [13]. 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]. The role of intrinsic confidence, such as a sense of mastery and self-efficacy, in frailty, was the least studied [15].

Social factors are the least well studied of the determinants of frailty. The literature is still inconclusive on the nature and conceptualization of social frailty, suggesting various approaches to it [16]. The lack of conceptual and methodological frameworks for social frailty in older adults makes it difficult to develop a framework for assessment and, as a consequence, establish the evidence of social effects on frailty [17]. While many studies used social health measures to examine their correlates of adverse health outcomes

such as cognitive decline and mortality [18], few studies tested the multiple constructs of social health in single study design to explore the interrelatedness of the factors. Thus, little is known about the relative predictive value of each social health factor and on pathways of how social factors mediate each other's impact.

One approach to a systematic assessment of social domains is the through evaluating the structural and functional aspects of social relationships [19]. The structural evaluation includes assessments of social networks and community integration, which are mostly objective, whereas functional evaluations comprise measurements of the individual's perception of and response to these social resources. The structural aspects can be assessed at the micro level – examining individual social networks, and at the macro level – such as an individual's integration within his community [20]. Different social networks provide various forms of social support – the functional aspects 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 [21]. Meanwhile, community integration, which includes involvement in social activities, also entails the functional aspect of a sense of belongingness within the community [22]. Research suggests that the functional aspects were more relevant to their health and quality of life compared to the objective measures of structural relations [17].

Another distinct aspect of social health is loneliness, which can be defined as a 'subjective state based on a person's emotional perception of the number and/or quality of social connections needed in comparison to what is being experienced at the time' [23]. It is different from the structural aspects 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 [23]. Thus, the assessment of the structural and functional aspects of networks and loneliness provides insights into older adults' social engagement and psychological responses to social contexts, and their association with frailty.

The current study explored how frailty was associated with multiple domains of physical, mental, and social health among older adults in Singapore. The proportion of residents aged 65 and above has increased from 8.8% in 2009 to 14.4% in 2019 [24], and the prevalence of frailty ranges from 5.7–11.3% in the population [4], depending on the operationalization of frailty. Studies in Singapore established physical health determinants of frailty such as multimorbidity [4, 25–28], physical exercise [4], and other lifestyle factors, including smoking [29] and drinking [25, 27]. Mental health determinants included cognitive impairment [4, 27, 28] and depressive symptoms [4, 25–27, 29, 30]. However, compared to physical and mental domains, the social health domain is the least well studied, with social networks [27, 28] and social activity [27], both of which evaluating the structural aspects of social health, found to be determinants of frailty. Importantly, little research in Singapore investigated physical, social, and mental determinants of frailty concurrently. The study utilized the FRAIL phenotypic scale to assess frailty for comparability with local studies [4, 26, 30] and due to its ease of administration [31]. The objectives were two-fold: (1) to describe the profiles of physical, mental, and social health across robust, pre-frail and frail

older adults; and (2) to assess the effects of psychosocial determinants of frailty on top of physical health in the 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. Ethics approval was obtained from the university institutional review board. Older residents with severe cognitive issues that rendered them incapable of fully understanding and/or responding to the survey were excluded. This was assessed by the survey interviewers at the time when they introduced the survey. The interviewers worked in a team to knock on every unit in the 25 public housing 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 so respondents could refuse any question deemed too personal. The survey was administered by the interviewers; responses were entered onto an electronic data collection platform. An umbrella, as a token of appreciation, was provided upon survey completion.

Measures

In addition to the key multidomain health measurements below, sociodemographic information such as gender, age, ethnicity, religion, education, employment status, housing type, duration of stay, and cohabitants, were collected.

Frailty was assessed by the 5-item FRAIL scale, which stands for fatigue, resistance, ambulation, illnesses, and loss of weight [32]. Fatigue was measured by asking respondents how often during the past 4 weeks they felt tired with responses of "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, and Ambulation by asking if they had any difficulty walking 300 meters without aids; "yes" responses were each scored as 1 point. Illness was scored 1 for respondents who reported 5 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 FRAIL scale is recognized as a reliable screening tool with comparable predictive validity with the multi-dimensional deficit accumulation frailty index of Fried's phenotypic scale and other frailty measures [33]. Total score ranges from 0 to 5, where a score of 3 to 5 indicates frailty, 1 to 2 as having a pre-frail, and score of 0 as 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 then calculated by summing the number of chronic diseases of each respondent into ordinal categories ('0' for no chronic disease, '1' for one to two chronic disease, '3' for three or more). 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 [34]. Psychometric studies provide strong evidence of a three-factor structure of GHQ-12, namely - (1) anxiety/depression, (2) loss of confidence, and (3) social dysfunction [35]. Items on anxiety/depression include 'losing sleep over worry', 'feeling unhappy or depressed'. Items on loss of confidence items include 'thinking of self as worthless', while items on social dysfunction include 'feeling capable of making decisions', 'able to concentrate', 'been able to face up to your problems', 'feeling that one is playing a useful role in things' etc. Each item was scored from 1 to 4, and negative items were reverse scored. Total scores ranged from 1 to 48; higher scores indicated worse mental health. There was good reliability for all subscales in the study sample (α= .74 to .88).

Social health was assessed by social networks, community integration, and loneliness**.** Social networks were assessed using the 6-item Lubben's Social Network Scale [36]. 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 6, total scores ranged from 0 to 30; higher scores indicated larger social networks. This provides a quantification of the participants' social networks in the respective spheres of family/relatives and friends. There was good reliability of the family/relatives subscale (α=.87) and friend subscale (α=.85) in the sample. Community integration was assessed using the 8-item Community Integration Measure (CIM) [37]. It contains measures of the perceptions of community belongingness and participation in community activities [38]. Items from the CIM survey was initially designed and validated in a study to assess community integration among people with acquired brain injury. It was validated for the general population as well [37]. Each item was scored from 1 to 4, and total scores ranged from 1 to 32 where higher scores indicated higher community integration. There was good reliability for the CIM scale in the sample (α= 0.81). Loneliness was assessed by the 3-item UCLA Loneliness Scale [39], which asks the frequency of feeling that one '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 (α= 90).

Data analysis

The presentation of each FRAIL item (fatigue, resistance, ambulance, illness and loss of weight) and resulting frailty categories were described. Categorical variables such as demographic characteristics, multimorbidity status, and lifestyle factors were reported where chi-square tests were conducted to test the differences across frailty levels. One-way analysis of variance (ANOVA) 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 $p < .10$ were entered into the multiple regression models.

Multimorbidity was 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.

Results

Prevalence of frailty

Table 1 shows the results of frailty assessment. Of the symptoms reported, “difficulty walking 10 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.

[Table 1 Here]

Characteristics of participants

Table 2 shows the demographic characteristics of participants by the level of frailty. The majority of participants were in their age of 60 to 80 years old (86%), of Chinese ethnicity (91%), unemployed (84%), did not live alone (86%), and about half (57%) were male. Sociodemographic characteristics such as age, education, and employment differed by frailty level (χ^2=33.0, 20.2 and 5.9 respectively, all p<.05). In the age group of 81 to 90 years old, the proportion of robust and prefrail notably decreased; only 9% robust and 18% prefrail were reported. In regard to education, 14% of the robust group reported no education compared to 30% of prefrail and 20% of frail. For employment, 81% of the robust group reported being unemployed compared to 86% of prefrail and 95% of frail. Other sociodemographic characteristics did not differ by frailty level.

[Table 2 Here]

Physical, mental and social health

Table 3 shows the physical, social and mental health status by the level of frailty. Frailty was significantly associated with multimorbidity (χ^2=20.1, p<.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 the older adults, the prevalence rates were not different across the three-level of frailty. Instead, less prevalent conditions, like cardiovascular (6%) and musculoskeletal (5%) diseases differed by the level of frailty (χ^2=23.1 and 48.9, respectively, all p<.001). The level of frailty also differed by frequency of physical activity (χ^2=13.6, p<.001), where sedentary lifestyles with no physical activity in a week increased from 20% to 24% and 41% with increasing level of frailty.

[Table 3 Here]

In regard to mental health, while all three domains were significantly associated with frailty, the associations were higher with anxiety/depression and social dysfunction compared to loss of confidence (F=10.6 and 22.1, ps<.001 and F=4.1, p<.05 respectively). In social health, frailty was significantly associated with a lower level of community integration, smaller size of social networks with friends (F=3.4, 3.8 and 19.7 respectively, all p< .05). The association between loneliness and frailty was higher than other variables (F=19.7, p< .001). Social networks with family members was not associated with frailty.

Correlation

Table 4 shows the correlations between the variables that were entered in regression models: multimorbidity, lifestyle factors, mental health, social health, and frailty. Besides the significant associations with frailty, the following correlations were found. For physical health factors, multimorbidity was positively correlated with loneliness (r=.09), loss of confidence (r=.11), and social dysfunction (r=.09). Physical activity was positively correlated with community integration (r=.12), social networks with friends (r=.20), but negatively correlated with loneliness (r=-.10), anxiety/depression (r=-.09) and social dysfunction (r=-.19). For social health factors, social networks with friends was positively correlated with community integration (r=.42), while negatively correlated with loneliness (r=-.25). Loneliness was also negatively correlated with community integration (r=-.20). Amongst the social health factors, loneliness was most strongly correlated with mental health factors, with positive correlations with anxiety/depression (r=.31), loss of confidence (r=.22), and social dysfunction (r=.25). Three subscales of mental health were significantly correlated with each other with a range of r = .28 to .69.

[Table 4 Here]

Hierarchical ordinal regression

Table 5 presents the results of regression models of frailty, adjusted for age and education, which were found to be significant at the univariate level. In model 1, age, low (2-3 diseases) and high (> 3 diseases) multimorbidity was associated with increased odds of frailty (adj. OR=1.21, 95% CI: 0.82-1.80, adj. OR=1.77, 95% CI: 1.18-2.65 and adj. OR=2.15, 95% CI: 1.26-3.67 respectively). In model 2, physical activity was entered. Age and multimorbidity remained a significant predictor of frailty. Three or more days of physical activity per week was associated with decreased odds of frailty (adj. OR=0.59, 95% CI: 0.37-0.93). In model 3, the effects of mental health were tested. After entering the three mental health variables, multimorbidity remained significant in the model, but physical activity was no longer significant. Anxiety/depression and social dysfunction were associated with increased odds of frailty (adj. OR = 1.73, 95% CI:1.02-2.91 and adj. OR = 5.32, 95% CI: 2.32-12.19 respectively), but not loss of confidence. In the last model adding on social health factors, age, multimorbidity, and social dysfunction remained as significant predictors, while anxiety/depression was no longer significant. Amongst the social health factors, only loneliness but not social networks with friends and community integration was associated with increased odds of frailty (adj. OR = 1.26, 95% CI: 1.06-1.49).

[Table 5 Here]

Discussion

Frailty is a common geriatric state associated with multiple adverse health outcomes from morbidity, disability, falls, and hospitalization to lower quality of life for older people [4]. Although physical risk factors of frailty are well known, psychosocial determinants of frailty are less investigated. Our study documented the different profiles of social, physical, mental health across robust, pre-frail, and frail older adults. It examined the effects of mental and social health on frailty, in addition to commonly known physical factors. The prevalence of 7.9% frail and 32.6% pre-frail in the study is comparable to other studies in Singapore: 5.7% and 6.2% frailty and 37.0% and 40.1% pre-frailty in similar age groups [4, 28]. Consistent with other studies, frail older adults were more likely to be advanced in age (e.g., 81 years and older), have lower education levels, and be unemployed. Contrary to other international studies [40], gender was not associated with frailty in our study, and previous local studies also found no association between gender and frailty [28]. Different findings between local and international research require further investigation as gender roles and norms are highly contextual. Unlike previous local studies reporting the ethnic difference in frailty [28] and the evidence of health disparities in ethnicity [41], the study finding of no ethnic difference may be due to the over-representation of Chinese residents in the study community. Singapore reports 74% Chinese, 13% Malay, and 9% Indian in the total population [42].

Physical determinants of frailty

The finding of the strong 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 physiologic changes of aging that are not disease-based (e.g., aging-related sarcopenia or anorexia) [3]. Musculoskeletal disease and cardiovascular disease are key clinical conditions that are 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 [43]. Cardiovascular disease, which includes heart diseases and stroke, is a common end manifestation of the metabolic syndrome pathway [44]. Not only is there a link between metabolic syndrome and frailty, but a bilateral association is suggested [45]. Both chronic diseases are preventable at earlier stages through appropriate interventions. Regular physical activity contributes to the reversal of detrimental effects of chronic diseases, as well as the maintenance of functional autonomy in older adults, slowing down the onset of frailty [46]. 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 (from adj. OR=0.59, 95% CI:0.37-0.93 to adj. OR=0.82, 95% CI:0.51-1.32; see Table 5), suggesting a strong 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 interventions,

which are meant for the pre-frail, could possibly still reap the social and mental health benefits for frailty through a well-designed group intervention that is less physically taxing.

Psychosocial determinants of frailty

Social dysfunction was found to increase the highest odds of frailty above age, multimorbidity, physical activity, and loneliness. The finding can be explained by the decreased intrinsic ability of older adults to actively self-manage their aging process and to cope with and be in control of their health needs, as its measure 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 to not only chronic diseases but also psychosocial problems such as depression and loneliness [47]. 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 maintain his overall well-being rather than short term extrinsic interventions, which focus on just one problematic aspect of physical or psychosocial health [47].

The association between depression and frailty is well evidenced, with common biological mechanisms such as subclinical cardiovascular disease and inflammation hypothesized to account for the comorbidity of both syndromes [48]. Beyond the shared biological mechanisms, a longitudinal study found a relationship between depressive symptoms and incident frailty [49]. In our study, anxiety/depression was only significant until the addition of social health factors, suggesting a possible pathway from depression to frailty mediated by loneliness. Depressive symptoms may cause people to reduce their social activities or impair the quality of these activities, thereby elevating the person's feelings of loneliness [50]. Loneliness increases frailty through its effects on physical health [51], cognitive decline [52], and psychological issues [53].

The multidimensional assessments of social domains for frailty yields several important insights. Deficits in each component of social relations – social networks, community integration, and loneliness - were found to be individually associated with frailty at the bivariate level, while only moderately correlated with each other, suggesting that these are distinct but interrelated factors, each of which can be administered as a holistic assessment. At the multivariate level, only loneliness was found as an independent predictor of frailty. Loneliness can be regarded as a psychological manifestation outcome of a lack of social networks or a feeling of dissatisfaction regarding the frequency and closeness of one's social contacts [51]. Thus, loneliness may mediate the relationship between the structural components of social networks and community integration and frailty, especially through pathways that involve mental health factors. For example, the Irish Longitudinal Study on Ageing found that loneliness was a significant mediator on the association between social networks and depression [54]. Hence community interventions to promote mental and social health will be needed to reduce loneliness among the older adults who are at risk of frailty. Given the complex, potentially multiplicative, effects of depression, social

isolation, and loneliness on frailty, there is an urgent need to enhance our understanding of the intersectionality of these domains and their impact on frailty.

Limitations

There are several limitations to our study. Its cross-sectional nature limits inference on the directionality of associations. We went door-to-door in the public housing estates to recruit participants. There may be non-response bias where more depressed older adults may be 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 to 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.

Conclusions

Community interventions need to address the psychosocial determinants of frailty [55]. Globally, multidomain interventions have shown promise. Singapore also implemented a healthy aging promotion program for you (HAPPY) program, which adapted dual-tasking exercises from the Cognicise (a combination of cognition and physical exercise) Program at the National Centre for Geriatrics and Gerontology in Japan [7]. In these efforts, loneliness needs to be addressed in social interventions, which include providing direct social support, creating opportunities for social interactions and social skills training [56] – all of which facilitate the social engagement and creation of support networks, hence addressing social isolation but not necessarily loneliness. An intervention which more directly addresses the psychological component of loneliness is cognitive-behavioral training – a technique to effectively deal with negative thoughts [56]. Some of these social and mental health interventions can be easily embedded within the existing physical activity and nutritional interventions, and special care should be taken to identify elderly who are lonely, as this may not always coincide with those who are socially isolated.

Social dysfunction and older adults' inability to self-manage their needs adversely affects multiple health domains and frailty. Practical aid and referral to social services through a social worker may be needed to increase older adults' ability to cope, on top of counseling to increase the sense of mastery and address worries about existing stressors. While many physical activity and nutritional interventions have targeted bonding and community integration, the use of social strategies such as peer learning and encouragement to boost's one mood, motivate behavior change and increase self-management ability in these interventions could be considered.

There remains a gap in evidence regarding the effective translation of proposed multidomain intervention programs in the real-world setting. Program evaluation and implementation research will need to

incorporate appropriate frameworks and outcome measures for complex interventions to understand the mechanisms and interrelated components of these frailty prevention programs [7]. Thus, our study plays an important role in highlighting key factors, especially from the social and mental health domains, that can potentially exert an impact on an individual's progression to frailty and should also be considered in the evaluation of these complex interventions.

Abbreviations

CIM
Community Integration Measure
FRAIL
Fatigue, Resistance, Ambulation, Illness, Loss of weight
GHQ
General Health Questionnaire
HAPPY
Healthy Ageing Promotion Program

Declarations

Ethics approval and consent to participate

The research ethics approval was obtained from the Social, Behavioural and Educational Research Ethics Committee of the National University of Singapore (NUS-IRB Reference Code: S-19-231). Verbal informed consent was approved by the committee and was obtained from all the study participants.

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

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Authors' contribution

HY, EC, AL, LY, and FM conceived the design for the current research study. All authors agreed on the analytic plan and data collection. EC, AL, LY, and FM managed data collection. HY, STN and SA conducted the data analysis. EC and AL wrote the first draft of the manuscript under the supervision 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.

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Tables

Table 1. Prevalence of Frailty and Categorisation

	N (%)
FRAIL Scale Items	
Feeling tired	98 (19.7)
Difficulty walking up 10 steps without aids and rest	125 (25.2)
Difficulty walking 300m without aids	107 (21.5)
Diagnosed with 5 or more illnesses/diseases	10 (2.0)
Significant weight loss in the past year (>5% change)	22 (4.4)
Frailty Categories	
Robust (0 conditions)	296 (59.5)
Prefrail (1-2 conditions)	162 (32.6)
Frail (3-5 conditions)	39 (7.9)

Table 2. Demographic Characteristics by Level of Frailty

	Total	Robust	Prefrail	Frail	χ2
	N (%)	N (%)	N (%)	N (%)	
Age					33.0 ***
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					3.3
Male	214 (43.1)	137 (46.3)	61 (36.7)	16 (41.0)	
Female	283 (56.9)	169 (53.7)	101 (62.3)	23 (59.0)	
Ethnicity					1.9
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					20.2**
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	177 (33.4)	103 (34.8)	53 (32.7)	10 (25.6)	
Pre-Tertiary/Tertiary	61 (12.3)	42 (14.2)	15 (9.3)	4 (10.3)	
Employment					5.9*
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					2.2
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)	

* p < .05 ** p < .01 *** p < .001

Table 3. Physical and Psychosocial Health Status by Level of Frailty

	Total	Robust	Prefrail	Frail	χ2 or F^
	N (%)	N (%)	N (%)	N (%)	
Multimorbidity					20.1***
None (0-1 diseases)	190 (38.2)	131 (44.3)	54 (33.3)	5 (12.8)	
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)	3.5
Diabetes mellitus	102 (20.5)	57 (19.3)	40 (24.7)	5 (12.8)	3.4
High blood cholesterol	148 (29.8)	88 (29.7)	51 (31.5)	9 (23.1)	1.1
Cardiovascular disease	33 (6.6)	10 (3.4)	14 (8.6)	9 (23.1)	23.1***
Musculoskeletal disease	26 (5.2)	2 (0.7)	14 (8.6)	10 (25.6)	48.9***
Thyroid	9 (1.8)	6 (2.0)	2 (1.2)	1 (2.6)	0.5
Other diseases	37 (7.4)	15 (5.1)	15 (9.3)	7 (17.9)	9.4**
Physical Activity					13.6**
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)	
Smoke	50 (10.1)	37 (12.5)	12 (7.4)	1 (2.6)	5.6
Drink	42 (8.5)	28 (2.5)	12 (7.4)	2 (5.1)	1.2
Mental Health					
Anxiety & depression^	1.72 (0.54)	1.65 (0.49)	1.76 (0.52)	2.06 (0.73)	10.6***
Loss of confidence^	1.59 (0.57)	1.54 (0.53)	1.62 (0.58)	1.81 (0.77)	4.1*
Social dysfunction^	2.00 (0.32)	1.95 (0.29)	2.05 (0.26)	2.27 (0.52)	22.1***
Social Health					
Network with family^	7.29 (3.44)	7.28 (3.51)	7.21 (3.28)	7.72 (3.63)	0.3
Network with friends^	6.22 (4.38)	6.63 (4.32)	5.77 (4.24)	4.97 (5.06)	3.8*
Community integration^	26.34 (3.78)	26.68 (3.89)	25.96 (3.21)	25.33 (4.74)	3.4*
Loneliness^	3.46 (1.17)	3.28 (0.89)	3.54 (1.27)	4.47 (1.89)	19.7***

Note. For mental health, scores reported were divided by number of items in each subscale for comparison. * p < .05 ** p < .01 *** p < .001.

Table 4. Correlations between Variables

	1	2	3	4	5	6	7	8
1. Multimorbidity	-							
2. Physical activity	-.01	-						
3. Social network with friends	.02	.20***	-					
4. Community integration	-.02	.12**	.42***	-				
5. Loneliness	.09*	-.10*	-.25***	-.20***	-			
6. Anxiety & depression	.05	-.09*	-.08	-.14***	.31***	-		
7. Loss of confidence	.11**	0	-.03	-.14***	.22***	.69***	-	
8. Social dysfunction	.09*	-.19***	-.21*	-.26***	.25***	.34***	.28***	-
9. Frailty level	.17***	-.09*	-.12**	-.12**	.21***	.14**	.09*	.24***

* p < .05 ** p < .01 *** p < .001

Table 5. Hierarchical Ordinal Regression for Frailty

	Model 1	Model 2	Model 3	Model 4
	Adj. OR (95% CI)	Adj. OR (95% CI)	Adj. OR (95% CI)	Adj. OR (95% CI)
1. Age				
60 – 70	-	-	-	-
71 – 80	1.21 (0.82-1.80)	1.30 (0.87-1.94)	1.28 (0.85-1.93)	1.27 (0.84-1.93)
81 – 90	3.02 (1.72-5.28)***	3.13 (1.79-5.49)***	3.19 (1.79-5.67)***	3.04 (1.71-5.43)***
2. Multimorbidity				
None (0-1 disease)	-	-	-	-
Low (2-3 diseases)	1.77 (1.18-2.65)**	1.78 (1.19-2.68)**	1.67 (1.09-2.53)*	1.63 (1.07-2.49)*
High (≥ 4 diseases)	2.15 (1.26-3.67)**	2.20 (1.29-3.76)**	2.08 (1.19-3.60)**	2.01 (1.15-3.49)*
3. Lifestyle				
Physical Activity				
W0 days/week		-	-	-
1-2 days/week		0.60 (0.34-1.06)	0.68 (0.38-1.21)	0.69 (0.38-1.26)
≥ 3 days/week		0.59 (0.37-0.93)*	0.78 (0.49-1.24)	0.82 (0.51-1.32)
4. Mental Health				
Anxiety & Depression			1.73 (1.02-2.91)*	1.50 (0.88-2.57)
Loss of Confidence			0.69 (0.43-1.10)	0.69 (0.43-1.11)
Social Dysfunction			5.32 (2.32-12.19)***	4.31(1.86-9.99)**
5. Social Health				
Community Integration				1.00 (0.94-1.07)
Network with Friends				0.99 (0.94-1.04)
Loneliness				1.26 (1.06-1.49)**

Note. Multiple regressions adjusted for education which was not a significant predictor in all models. * p < .05 ** p < .01 *** p < .001