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Effects of social activity participation and trust in the community on the transition of frailty classification in late-stage older adults: a 4-year prospective cohort study

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ABSTRACT

Objectives In Japan, frailty is a major risk factor for requiring long-term care, especially among older adults aged 75 years or older (ie, late-stage older adults). Both physical and social factors (eg, social activities, social support and community trust) are protective factors against frailty. However, few longitudinal studies have examined reversible change or stage improvement in frailty. This study investigated social activity participation and trust in the community that may affect the transition of late-stage older adults' frailty status.

Design A mail-based survey was used to analyse the improvement or deterioration of frailty status (categorised as frailty, pre-frailty and robust) over a 4-year period. Binomial and multinomial logistic regression analyses were conducted; the transition in frailty classification was the dependent variable, while a change in social activity participation and the degree of trust in the community were the independent variables.

Setting Ikoma City, Nara Prefecture, Japan.

Participants 4249 community-dwelling older adults, aged ≥75 years, not requiring long-term care who completed a follow-up questionnaire from April to May 2016.

Results Adjusting for confounding factors, no significant social factors were detected regarding improvement in frailty. However, an increase in exercise-based social participation was an improvement factor in the pre-frailty group (OR 2.43 (95% CI 1.08 to 5.45)). Conversely, a decrease in community-based social activity was a risk factor in the deterioration from pre-frailty to frailty (OR 0.46 (95% CI 0.22 to 0.93)). In the robust group, increased community-based social activity (OR 1.38 (95% CI 1.00 to 1.90)) was a protective factor against frailty, whereas decreased community trust was a risk factor (OR 1.87 (95% CI 1.38 to 2.52)).

Conclusions No social factors had a significant influence on the improvement of frailty in late-stage older adults. However, the promotion of exercise-based social participation was found to be important for improvement in the pre-frailty state.

Trial registration number UMIN000025621.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ This is a 4-year longitudinal study that followed changes in frailty status among late-stage older adults living in the community.
⇒ This study focuses on changes in social participation activities at baseline as well as at follow-up.
⇒ Social factors affecting stage transitions in frailty classification over a 4-year period are investigated in terms of improvement and deterioration.
⇒ Unlike diseases, frailty does not have a specific date of onset; hence, the exact time a frailty transition occurs is unclear.
⇒ This study's disease burden adjustment variable was self-reported and not based on physicians' diagnostic records.

BACKGROUND

According to a report published by the Japanese Cabinet Office,[1] 28.8% of Japan's population was aged ≥65 years (13.8% and 14.9% were aged 65–74 and ≥75 years, respectively) in 2021. It is estimated that by 2065, the age of approximately 1 in 2.6 and 1 in 3.9 individuals in Japan will be ≥65 years and ≥75 years, respectively. The number of older adults requiring nursing care is increasing because of the ageing population, with a particularly substantial proportion of those aged >75 years.[1] Additionally, frailty is the leading cause of needing nursing care among older adults aged ≥75 years.[2] Therefore, extending healthy life expectancy and shortening the period of nursing care are urgent challenges in Japan, which has the longest life expectancy worldwide.[3]

The occurrence of frailty adversely affects the future health of older adults.[4 5] However, the definition of frailty in Japan was not clearly defined until the Japanese Geriatrics Society published a report in 2014.[6] In this report, it was defined as 'a condition in which vulnerability to stress increases due to a decline in physiological reserve in old age, which can lead to functional disability,

nursing care needs, death and other outcomes'. This concept includes physical problems (eg, loss of agility due to muscle weakness and the tendency to fall), mental and psychological problems (eg, cognitive dysfunction and depression) and social problems (eg, living alone and economic deprivation).

There are two main approaches to the evaluation of frailty. First, the 'disability accumulation model'[5] evaluates frailty by assessing the accumulation of disabilities, impairments in life functions and diseases associated with ageing. Second, the 'phenotype model'[4] considers syndromes that appear owing to the decline in biological functions associated with ageing. In Japan, the latter is predominantly used to evaluate small samples as it requires measuring walking speed and grip strength, and the results are limited to physical frailty. For large-scale surveys, a comprehensive evaluation is often performed using the Ministry of Health, Labour and Welfare's Kihon checklist (KCL)[7] and includes items such as cognitive function and depression. Additionally, the term 'frailty' generally refers to older adults who are at increased risk of becoming eligible for public nursing care insurance services. Increased attention is paid to preventing the need for nursing care (through a seven-level evaluation) or the occurrence of frailty. Such prevention is largely attributed to the economic burden associated with the increasing costs of long-term care insurance services and medical care.

The definition of frailty includes the ability to return to a healthy state,[8] and early detection and appropriate intervention are necessary to avoid frailty and maintain and improve life functions. Although numerous studies have investigated the risk and protective factors for frailty, only a few longitudinal studies have monitored the transition of frailty.[9–12] A systematic review of longitudinal studies that tracked changes in the stages of frailty demonstrated that risk factors for frailty include sex, cognitive function and brain pathology. These findings indicate that physical and socioeconomic factors (eg, education, poverty and social support) influence frailty.[12] Protective factors that slow the progression of frailty include physical and cultural activities. However, these studies are characterised by variability of the subjects' age and the follow-up period. Moreover, it has been stated that results concerning risk factors and prevalence of frailty depend on the population and setting.[13] In Japan, the risk of falls, fractures and the need for long-term care is higher among late-stage (≥75 years) older adults than among early-stage older adults (age 65–74 years).[14] Therefore, studies that consider all individuals aged ≥65 years as older adults may underestimate the risk of frailty among late-stage older adults.

In recent years, attention has focused on social frailty as a risk factor for depression, dementia[15] and all-cause mortality.[16] Although the definition of social frailty differs between studies, there is a consistent understanding that the determination of social frailty includes the lack of social relationships, interactions with others and social support.[17–19] The incidence of social frailty increases significantly in those aged ≥75 years[20] and leads to a higher risk of disability incidence, cognitive decline and physical decline, even after adjusting for physical activity, disease and medication use.[18 20] The results of these studies suggest that changes in social participation activities may be an independent influencing factor in the stage transition of frailty; however, these relationships have not been clarified. Social participation can be defined as a person's involvement in activities providing interactions with others in community life and in important shared spaces, evolving according to available time and resources.[21] Examples of social activity, also known as social participation or engagement, may include meeting friends, attending events or functions, and volunteering or participating in occupational duties or group recreational activities.[22]

Previously, we focused on the reversibility of frailty and investigated the social and psychological factors that influence the improvement of frailty in late-stage older adults through a 2-year longitudinal study. We found that increased exercise-based social participation and improved self-rated health were independent influencing factors.[23] The present study extended the follow-up period of the late-stage older adults' cohort to 4 years, to investigate stage transitions (both improvement and deterioration) of frailty.

First, we hypothesised that increased participation in social activities would improve frailty, whereas a decrease would worsen it. Second, we hypothesised that trust in the community, which is related to the risk of requiring long-term care and is a major component of social capital,[24] influences changes in frailty status. This is because trust in the community has been reported to be related to various diseases and health behaviours.[25] A cohort study in Japan also reported that a decrease in trust in the community increases the risk of requiring long-term care.[24]

This study clarifies the effects of changes in the participation of social activities and trust in the community on the transition of frailty in community-dwelling late-stage older adults.

METHODS

Study design and population

The study included community-dwelling older adults aged ≥75 years (ie, late-stage older adults) in Ikoma City, Nara Prefecture, Japan. At baseline, a postal survey was conducted by the community-based integrated care division of Ikoma City, using the KCL of the Ministry of Health, Labour and Welfare. This approach was used to assess frailty among 8685 late-stage older adults not requiring long-term care (ie, complete survey), from April to May 2016. A total of 6517 participants completed the survey (response rate: 75.0%), excluding those who did not follow-up and those with missing data. During the follow-up survey (performed from April to May 2020 (median: 48 months)), 567 individuals had been newly

identified as requiring long-term care. Given this study's focus on the prevention of the need for nursing care, the individuals newly requiring long-term care services and the 1701 participants who did not respond to the KCL, or were missing (relocation or death) were excluded. Finally, 4249 participants completed the KCL (follow-up rate: 70.4%) and were included in the analysis.

The study was conducted in accordance with the tenets of the Declaration of Helsinki and the Ethical Guidelines for Medical and Biological Research Involving Human Subjects by the Ministry of Health, Labour and Welfare in Japan (2021). The need for informed consent was waived by Kio University's Institutional Review Board owing to the use of anonymised information that does not identify specific individuals. Data anonymisation was performed by the community-integrated care section of Ikoma City, and the researchers were blinded to participants' personal data. Data were extracted from the KCL and the long-term care database, which is managed by the community-integrated care section of Ikoma City.

Patient and public involvement

None.

Measures

Dependent variables: comprehensive frailty assessment

KCL is a postal self-administered questionnaire (online supplemental figure 1), comprising 25 questions with 'yes' or 'no' answers in seven fields (ie, daily life-related activities, motor functions, nutritional status, oral functions, homebound status, cognitive functions and depressed mood). It is included in the frailty management guidelines for the Asia-Pacific region[26] and has been validated according to the Cardiovascular Health Study frailty criteria.[7] Assessment using the KCL score is useful for determining the frailty status of older adults and for predicting the need for support/care through the long-term care insurance system.[7 27] A functional decline in each field is assessed with the following: at least three of five motor function items (online supplemental figure 1: Nos. 6–10), both nutritional status items (online supplemental figure 1: Nos. 11–12), at least two of three oral function items (online supplemental figure 1: Nos. 13–15), homebound status (online supplemental figure 1: Nos. 16–17), at least one of three cognitive function items (online supplemental figure 1: Nos. 18–20) and at least two of five depressed mood items (online supplemental figure 1: Nos. 21–25). For daily life-related activities, a decline in instrumental activities of daily living was defined as any of the five items (online supplemental figure 1: Nos. 1–5) that corresponded to any of three instrumental activities of daily living items (ie, using trains and buses, shopping and withdrawing/depositing money).

According to the previous research, the classification of frailty is based on the number of checked items from 25 questions: 0–3 for robust, 4–7 for pre-frailty and ≥8 for frailty.[28] The transition of frailty and change in the frailty status between the baseline and follow-up surveys were compared. Changes were categorised as 'maintenance', 'improvement' and 'deterioration'. As frailty classification is a categorical variable, an increase or decrease in the number of functional declines during the follow-up period was considered 'maintenance' if the change remained in the same stage. Additionally, as this study focuses on dynamic changes in frailty status, maintenance of each status (ie, remaining robust or remaining frail) was considered a reference category. In the robust and frailty groups, in some cases, the transition category changed in two steps (eg, from robust to frailty, or frailty to robust), but no weighting was used in the analysis in the present study.

Independent variables: assessment of social participation activity and trust in the community

Social participation activities were categorised into community-based activities, exercise-based activities, hobbies and volunteer/non-profit organisation activities, respectively. Community activities included participation in senior citizen clubs, residents' associations and older adult salons. Exercise-based activities referred to regular participation in gymnastics classes, ground golf (Japanese style golf suitable for older adults) and Japanese croquet, among others. Hobby activities included non-exercise activities (eg, handicrafts, gardening and board games), while volunteer/non-profit organisation activities included community-cleaning activities and counselling neighbouring residents.

In the questionnaire, respondents were asked to record all the above social activities in which they were currently participating regularly (regardless of the frequency of the activity) (online supplemental figure 2). For changes in their participation in social activities, we focused on changes in the participation status at baseline and follow-up. For example, those with no exercise-based social activity at baseline but were participating at follow-up were defined as increasing, and vice versa. Those who were inactive or remained active at both time points were considered maintenance. The degree of interaction with neighbours was rated using a 4-point scale,[29] where the following sentences were used: (4) 'I talk and cooperate in terms of life with other people', (3) 'I have a daily standing conversation with at least one other person', (2) 'I only socialise by greeting others' and (1) 'I have no interaction with neighbours'. A higher score indicated a closer interaction. The level of trust in the community (ie, 'people in your neighbourhood can be trusted') was assessed using a 5-point scale.[30] Answer options were: 5='agree', 4='partially agree', 3='neither agree nor disagree', 2='partially disagree' or 1='disagree'. A higher score indicated deeper trust.

Covariates

Sociodemographic characteristics (eg, age, sex, living alone and so on), the number of chronic diseases (eg, hypertension, sequelae of stroke, heart disease, diabetes

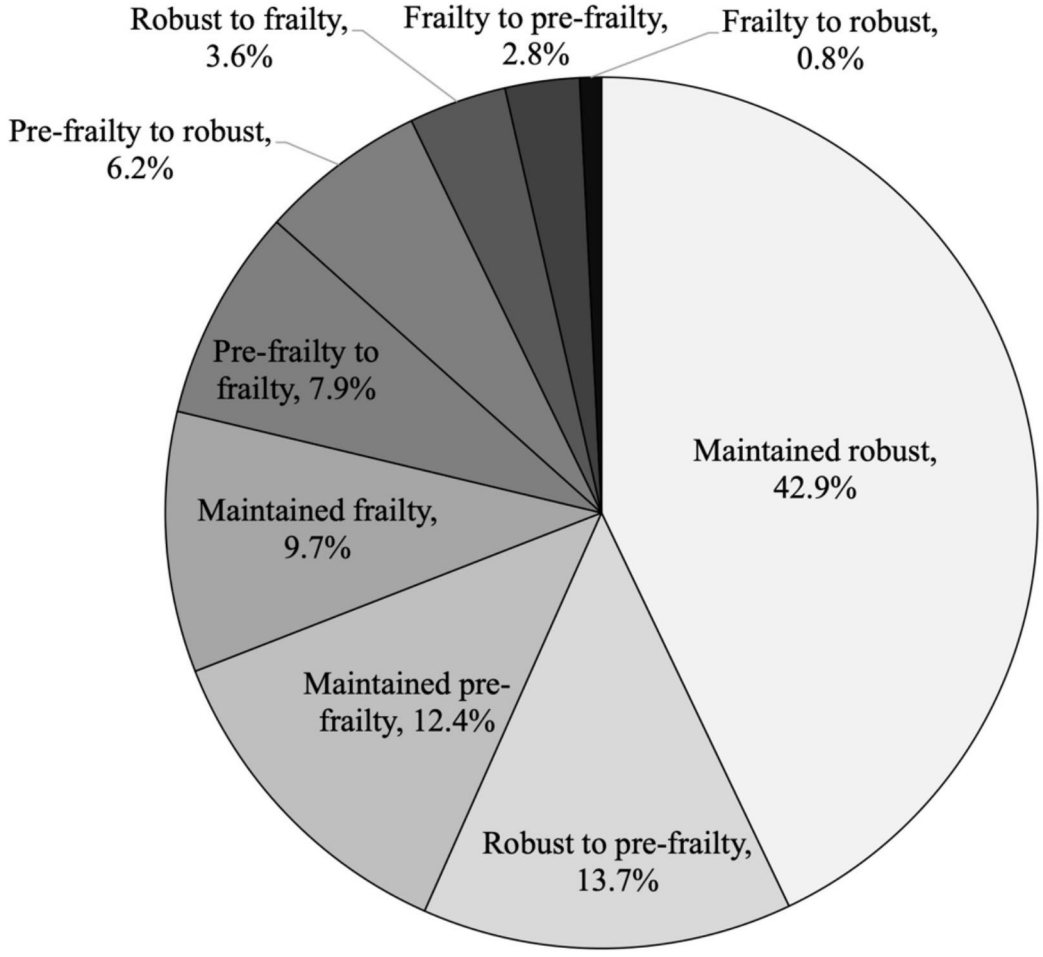

Figure 1 Four-year transition of frailty classification (n=4249).

mellitus, depression, respiratory disease, arthropathy with pain and dental disease and so on) and self-rated health were assessed as covariates. These evaluation items were included in the mailed questionnaire. The number of chronic diseases of each participant was defined as the disease burden. Self-rated health was assessed using a 5-point scale, as previously described.[31]

Statistical analysis

At baseline, between-group comparisons of participant characteristics were performed based on frailty classification. One-way analysis of variance was used for comparing continuous variables, and Fisher's least significant difference was used for multiple comparison tests. To compare nominal variables, the χ^2 test and residual analysis were used. Adjusted residual values >1.96 and <−1.96 denoted significantly more and fewer participants than expected, respectively.

Next, we analysed the change in frailty classification from baseline to follow-up, defining those without change as 'maintenance', those with improvement as 'improvement' and those with progressive frailty as 'deterioration'. Changes from baseline social activity participation and trust in the community were classified accordingly: maintenance (or no change), improvement and deterioration, respectively.

Subsequently, according to the frailty classification at baseline, the data set was divided into three data subsets: robust group (n=2121), pre-frailty group (n=1228) and frailty group (n=900). We identified the social activity participation or trust in the community that influenced the change in frailty status during the study period. Accordingly, we conducted a binomial logistic regression analysis. For individuals classified into the robust group at baseline, the change to pre-frailty or frailty (ie, deterioration) was the dependent variable. For individuals classified into the frailty group at baseline, an improvement from frailty was the objective variable. For individuals classified into the pre-frailty group at baseline, multinomial logistic regression analysis, with the maintenance of pre-frailty as the reference category, was conducted to identify factors that influenced both the improvement and deterioration in frailty status.

In all regression analyses, age, sex, disease burden, self-rated health and living alone were used as adjustment variables, and the forced imputation method was used to select the independent variables. SPSS software (V.26.0; IBM) was used to perform statistical analysis.

Table 1 Participant characteristics and frailty classification at baseline survey

Items	All (n=4249)	Robust (n=2121)	Pre-frailty (n=1228)	Frailty (n=900)	P value	Between-group difference
Age, years (SD)	78.5 (2.8)	78.2 (2.7)	78.9 (2.9)	79.3 (2.9)	<0.001	Frail>Pre-frail>Robust
Sex: female, n (%)	2074 (48.8)	1157 (45.2)	599 (53.2)	318 (56.6)	<0.001	Frail>Pre-frail>Robust
Disease burden (SD)	1.5 (0.7)	1.4 (0.7)	1.6 (0.8)	1.8 (0.9)	<0.001	Frail>Pre-frail>Robust
Living alone, n (%)	632 (14.9)	374 (14.6)	166 (14.7)	92 (16.4)	0.561	n.s.
IADL decline, n (%)*	138 (3.2)	104 (4.1)	149 (13.4)	141 (28.1)	<0.001	Frail>Pre-frail>Robust
Motor dysfunction, n (%)*	585 (13.8)	44 (1.7)	234 (20.8)	307 (54.6)	<0.001	Frail>Pre-frail>Robust
Malnutrition, n (%)*	77 (1.8)	15 (0.6)	28 (2.5)	34 (6.0)	<0.001	Frail>Pre-frail>Robust
Oral dysfunction, n (%)*	705 (16.6)	106 (4.1)	297 (26.4)	302 (53.7)	<0.001	Frail>Pre-frail>Robust
Homebound, n (%)*	194 (4.6)	32 (1.2)	49 (4.4)	113 (20.1)	<0.001	Frail>Robust
Cognitive decline, n (%)*	1222 (28.8)	374 (14.6)	465 (41.3)	383 (61.8)	<0.001	Frail>Pre-frail>Robust
Depressive mood, n (%)*	882 (20.8)	73 (2.9)	360 (32.0)	449 (79.9)	<0.001	Frail>Pre-frail>Robust
History of falls, n (%)*	669 (15.7)	201 (7.9)	261 (23.3)	207 (37.0)	<0.001	Frail>Pre-frail>Robust
Fear of falling, n (%)*	1677 (39.5)	565 (22.4)	663 (59.5)	449 (80.9)	<0.001	Frail>Pre-frail>Robust
Self-rated health (SD)	3.6 (1.0)	3.8 (0.9)	3.3 (0.8)	2.8 (0.8)	<0.001	Robust>Pre-frail>Frail
Number of social activity (SD)	0.9 (1.0)	1.0 (1.0)	0.8 (0.9)	0.5 (0.7)	<0.001	Robust>Pre-frail>Frail
Interaction with neighbours (SD)	1.9 (0.8)	2.0 (0.7)	1.8 (0.8)	1.6 (0.8)	<0.001	Robust>Pre-frail>Frail
Trust in the community (SD)	3.1 (0.7)	3.2 (0.6)	3.0 (0.7)	2.9 (0.7)	<0.001	Robust>Pre-frail>Frail

Categorical variables were analysed by χ^2 test (with residual test), and continuous variables were analysed by one-way ANOVA (with post-hoc LSD test).
*Based on Kihon Checklist (KCL) subscore of each area.
†Frailty identification: out of KCL 25 items, 0–3 for robust, 4–7 for pre-frailty and >8 for frailty.
ANOVA, analysis of variance; IADL, instrumental activities of daily living; LSD, least significant difference; n.s., not significant.

RESULTS

Frailty classification transition

Figure 1 shows the transition in frailty classification over a 4-year period. At follow-up, 583 (13.7%) and 154 (3.6%) participants exhibited a progression of frailty by one and two levels from robust at baseline, respectively. Of those classified into the pre-frailty group at baseline, 335 participants (7.9%) exhibited a progression of frailty by one level and 263 participants (6.2%) improved to robust. Among those classified into the frailty group at baseline, 117 (2.8%) and 34 (0.8%) participants showed one and two levels of improvement, respectively. In summary, a total of 414 participants (9.7%) improved during the 4-year observation period, whereas 1072 participants (25.2%) showed a progression of frailty (more than twofold higher rate).

Table 1 shows the characteristics of participants at baseline and the results of the participants according to the degree of frailty. A comparison of basic characteristics between the groups showed that participants included in the frailty group were older, had a higher proportion of women and had more comorbidities. Additionally, the frailty group showed poorer results than the other groups, regarding all psychological and social assessment items, except for the number of individuals living alone (see table 1).

Influencing factors from frailty or pre-frailty status at baseline

In the frailty group at baseline, binomial logistic regression analysis after adjustment for age, gender, disease burden, self-rated health and living alone showed a trend toward increased exercise-based social participation contributing to an improvement in frailty, but there were no statistically significant factors contributing to this result (see table 2). The results of the multinomial logistic regression analysis for the pre-frailty group at baseline showed that increased exercise-based social participation (OR=2.43, 95% CI: 1.08 to 5.45) influenced stage improvement. In contrast, decreased community-based social participation (OR=0.46, 95% CI: 0.22 to 0.93) was identified as a risk factor (see table 3). For stage deterioration, no significant factors were determined in the pre-frailty group.

Influencing factors from robust status at baseline

For those classified into the robust group at baseline, trust in the community was recognised as a significant factor for both the increase and decrease in categories. Notably, the decrease in trust was more influential (increase in trust, OR=1.38, 95% CI: 1.00 to 1.90; decrease in trust, OR=1.87, 95% CI: 1.38 to 2.52; table 4).

Table 2 Transition factors for participants categorised frailty at baseline (n=900)

Items	Unadjusted OR (95% CI)	P value	Multivariate* OR (95% CI)	P value
Exercise-based social activity (no change)	Ref		Ref	
Increased	1.67 (0.73 to 3.81)	0.224	2.26 (0.66 to 7.79)	0.196
Decreased	0.78 (0.25 to 2.45)	0.675	0.68 (0.16 to 2.86)	0.601
Hobby-based social activity (no change)	Ref		Ref	
Increased	1.26 (0.54 to 2.93)	0.588	1.25 (0.35 to 4.44)	0.734
Decreased	0.48 (0.19 to 1.20)	0.117	0.70 (0.19 to 2.48)	0.578
Community-based social activity (no change)	Ref		Ref	0.439
Increased	1.08 (0.49 to 2.37)	0.851	0.62 (0.23 to 1.69)	0.350
Decreased	0.70 (0.32 to 1.53)	0.376	0.58 (0.18 to 1.92)	0.375
Interaction with neighbours (no change)	Ref		Ref	
Increased	0.93 (0.55 to 1.58)	0.934	0.96 (0.44 to 2.07)	0.916
Decreased	0.73 (0.41 to 1.28)	0.269	0.62 (0.26 to 1.45)	0.252
Trust in the community (no change)	Ref		Ref	
Increased	1.21 (0.72 to 2.02)	0.475	0.78 (0.36 to 1.69)	0.532
Decreased	1.45 (0.84 to 2.50)	0.177	1.73 (0.72 to 4.17)	0.218

Note: Binomial logistic regression analysis (dependent variable=improvement from frailty). Reference category indicates no change (or maintained).
Nagelkerke R^2=0.201.
*Adjusted for sex, age, disease burden, self-rated health and living alone.
Ref, reference.

DISCUSSION

Frailty transition

In this study, we investigated transitions in frailty classification and factors affecting the improvement or deterioration at each stage, in a 4-year cohort study of late-stage older adults not requiring nursing care. The largest proportion of stage changes in frailty classification was recorded among those who were healthy at baseline and maintained a healthy status for 4 years. The second most common transition was a one-stage deterioration from robust to pre-frailty status, which was greater than the number of individuals who maintained the pre-frailty status at follow-up. This may reflect changes in physical functions caused by natural ageing over the 4-year study period. Nevertheless, very few of those classified into the frailty group at baseline improved to the pre-frailty or robust status at follow-up (2.8% and 0.8%, respectively). Gill *et al*[32] studied 754 community-dwelling older adults aged ≥70 years, over a period of 3 years. They reported that the progression of frailty was more common (≤43.3%) than the transition to milder frailty (≤23.0%), and the rate of transition from a frail status to a non-frail status was very low (0%–0.9%). Although our study included a larger scale and longer follow-up period than the previous study, the results of the two investigations are consistent.

In another study of 551 community-dwelling older adults in Japan,[33] changes in frailty status were investigated over a 5-year period. According to the data, 21.4% of participants reported that their frailty status deteriorated, whereas 10.3% reported an improvement. In this study, the transition rate was 25.2% for the progression of frailty and 9.7% for the improvement by at least one stage. These rates were slightly lower than those reported in the aforementioned study. This difference may be because the previous study included early-stage older adults (ie, aged ≥65 years). Other studies that focused on the transition of frailty also differed in terms of age group, follow-up period and the method for diagnosing frailty. This variability in research methodology complicates the direct comparison of the present transition rates with those reported in the literature.[10 34–39]

Factors for frailty transition

In this study, we hypothesised that changes in social activity participation and trust in the community significantly influence frailty classification. Consequently, stage improvement over the 4-year study period was rare among those classified into the frailty group at baseline. Moreover, no significant social factors contributing to the improvement of frailty were detected in the frailty group at baseline. An increase in exercise-based social activity participation was an expected factor for improvement. Nevertheless, this study did not identify any social activities as significant independent factors. Except for interventional studies,[40] few studies have investigated factors that improve frailty. Abe *et al*[34] reported that agriculture, intellectual activity and social participation were factors associated with an improvement in frailty status; however,

Table 3 Transition factors for participants categorised pre-frailty at baseline (n=1228)

	Model 1: improvement				Model 2: deterioration			
	Unadjusted		Multivariate*		Unadjusted		Multivariate*	
Items	OR (95% CI)	P value	OR (95% CI)	P value	OR (95% CI)	P value	OR (95% CI)	P value
Exercise-based social activity (no change)	Ref		Ref		Ref		Ref	
Increased	1.38 (0.73 to 2.59)	0.311	2.43 (1.08 to 5.45)	0.030	0.99 (0.50 to 1.98)	0.990	1.06 (0.40 to 2.83)	0.905
Decreased	0.88 (0.48 to 1.62)	0.695	1.05 (0.47 to 2.35)	0.895	1.02 (0.58 to 1.76)	0.948	1.61 (0.79 to 3.28)	0.195
Hobby-based social activity (no change)	Ref		Ref		Ref		Ref	
Increased	1.80 (0.97 to 3.32)	0.061	1.38 (0.63 to 3.03)	0.410	0.86 (0.43 to 1.72)	0.678	0.53 (0.19 to 1.45)	0.213
Decreased	0.83 (0.49 to 1.39)	0.478	0.85 (0.43 to 1.69)	0.661	0.71 (0.44 to 1.17)	0.185	0.80 (0.40 to 1.60)	0.521
Community-based social activity (no change)	Ref		Ref		Ref		Ref	
Increased	1.40 (0.80 to 2.43)	0.234	1.19 (0.59 to 2.40)	0.623	0.61 (0.31 to 1.18)	0.143	0.66 (0.28 to 1.55)	0.338
Decreased	0.99 (0.60 to 1.65)	0.998	0.46 (0.22 to 0.93)	0.032	1.02 (0.63 to 1.52)	0.94	0.75 (0.39 to 1.44)	0.385
Volunteer/NPO activity (no change)	Ref		Ref		Ref		Ref	
Increased	2.30 (0.96 to 5.48)	0.060	1.93 (0.64 to 5.84)	0.240	1.57 (0.62 to 3.97)	0.337	0.95 (0.23 to 3.93)	0.948
Decreased	1.47 (0.70 to 1.12)	0.305	1.44 (0.55 to 3.77)	0.454	1.73 (0.83 to 3.59)	0.143	1.63 (0.63 to 4.23)	0.314
Interaction with neighbours (no change)	Ref		Ref		Ref		Ref	
Increased	0.96 (0.65 to 1.43)	0.856	0.68 (0.40 to 1.16)	0.161	0.83 (0.56 to 1.25)	0.385	0.64 (0.37 to 1.13)	0.126
Decreased	0.67 (0.42 to 1.05)	0.081	0.57 (0.32 to 1.01)	0.054	1.53 (1.06 to 2.19)	0.022	0.97 (0.59 to 1.62)	0.916
Trust in the community (no change)	Ref		Ref		Ref		Ref	
Increased	1.1 (0.70 to 1.65)	0.709	1.34 (0.76 to 2.36)	0.305	1.43 (0.97 to 2.11)	0.066	1.37 (0.79 to 2.40)	0.266
Decreased	1.1 (0.73 to 1.63)	0.659	1.03 (0.60 to 1.78)	0.892	0.92 (0.63 to 1.36)	0.700	0.94 (0.55 to 1.62)	0.835

Note: multinomial logistic regression analysis (dependent variable=transition from pre-frailty). Reference category indicates no change (or maintain).
Nagelkerke R^2=0.148.
*Adjusted for sex, age, disease burden, self-rated health and living alone.
NPO, non-profit organisation; Ref, reference.

Table 4 Transition factors for participants categorised robust at baseline (n=2121)

Items	Unadjusted OR (95% CI)	P value	Multivariate* OR (95% CI)	P value
Exercise-based social activity (no change)	Ref		Ref	0.672
Increased	0.92 (0.64 to 1.33)	0.680	1.20 (0.77 to 1.84)	0.410
Decreased	1.11 (0.79 to 1.54)	0.531	0.94 (0.59 to 1.48)	0.778
Hobby-based social activity (no change)	Ref		Ref	0.881
Increased	0.81 (0.56 to 1.15)	0.246	1.10 (0.75 to 1.59)	0.616
Decreased	0.98 (0.74 to 1.31)	0.926	1.00 (0.65 to 1.53)	0.989
Community-based social activity (no change)	Ref		Ref	0.020
Increased	0.55 (0.37 to 0.81)	0.003	0.49 (0.28 to 0.81)	0.006
Decreased	0.97 (0.73 to 1.28)	0.926	1.07 (0.75 to 1.51)	0.714
Volunteer/NPO activity (no change)	Ref		Ref	0.132
Increased	0.48 (0.28 to 0.84)	0.011	0.87 (0.52 to 1.43)	0.574
Decreased	0.91 (0.61 to 1.35)	0.664	0.49 (0.24 to 1.00)	0.050
Interaction with neighbours (no change)	Ref		Ref	0.760
Increased	1.05 (0.81 to 1.35)	0.697	1.10 (0.81 to 1.47)	0.553
Decreased	1.39 (1.11 to 1.74)	0.004	1.10 (0.78 to 1.53)	0.582
Trust in the community (no change)	Ref		Ref	0.000
Increased	1.44 (1.12 to 1.83)	0.003	1.38 (1.00 to 1.90)	0.049
Decreased	1.61 (1.27 to 2.02)	0.000	1.87 (1.38 to 5.52)	0.000

Note: binomial logistic regression analysis (dependent variable=deterioration from robust). Reference category indicates no change (or maintained).
Nagelkerke R^2=0.10.
*Adjusted for sex, age, disease burden, self-rated health and living alone.
NPO, non-profit organisation; Ref, reference.

only frailty and non-frailty categories were used in their study, and the ages of participants differed. The fact that no significant improvement factors were detected in our study may be owing to the small number of participants who improved from frailty.

For those classified into the pre-frailty group at baseline, there was a transition to an improvement or deterioration, with increased exercise-based social participation identified as a factor causing the improvement. This supports the findings of numerous studies demonstrating that physical activity is a protective/improvement factor against frailty.[11 33 39 41] In addition, the Asia-Pacific Clinical Practice Guidelines for the Management of Frailty strongly recommend physical activity, including elements of resistance training, for the prevention of sarcopenia-related muscle wastage and mobility loss in the oldest old and older adults with frailty.[26] Moreover, many of the exercise-based activity classes in the target areas of this study were followed by a social time such as a tea party, suggesting that it is important for exercise-related social participation to include elements of social interaction. In contrast, a decrease in community-based social activity was identified as a risk factor. Changes in participation in social activities may, therefore, play an important role in stage improvement for individuals with a pre-frailty status.

For those classified into the robust group at baseline, a decreased trust in the community was identified as an independent factor for deterioration to the pre-frail or frail status. An increase in trust in neighbours was also adopted as an influencing factor, and this indicator may be associated with both positive and negative effects. A decreased trust in neighbours may result from relocation or bereavement of friends, among others, and is linked to a risk of social isolation. Conversely, the fact that an increase in trust was also recognised as a negative factor in this study may be related to increased dependence on neighbours in daily activities. However, it is difficult to draw conclusions based on the data of this study.

Limitations

This study has a few limitations. First, it focused on changes in endpoints and frailty during the observation period; therefore, we did not examine factors related to the maintenance of physical function. For late-stage older adults, maintaining a healthy state for 4 years or preventing deterioration in a frail state cannot be underestimated, and future analyses should include an analysis of maintenance at each state. Second, the assessment of all social participation activities used in this study has not been tested for reliability and validity since the questions

were originally designed. Third, unlike diseases, frailty does not have a specific date of onset; hence, the exact time when the actual transition occurs is unclear. Therefore, the transition may have recurred multiple times during the 4-year period. Fourth, the disease burden adjustment variable in this study was self-reported; thus, the type and number of comorbidities were not based on the physicians' diagnostic records. Finally, the results of the mail survey used in this study, in which many relatively health-conscious individuals responded, may have been influenced by selection bias.

As the sample size decreases with the extension of the follow-up period, we plan to continue the study as a long-term longitudinal study, supplementing the number of participants through a dynamic cohort approach involving multiple periods of observation.

CONCLUSION

This study followed late-stage older adults for 4 years, to identify social activity influencing the transition in frailty classification. Consequently, no increase or decrease in any social activity was adopted as a significant influencing factor in those who were determined to be in the frail category at baseline. For those classified in the pre-frailty group, increasing exercise-based social participation may improve their condition. In the robust group, increasing social community-based social activity and trust in the community were identified as protective factors against frailty. These findings suggest that social participation activities among late-stage older adults are protective against the development of frailty and that it is especially important to encourage exercise-related social participation during the pre-frailty stage.

Although social participation activities are particularly important to prevent social isolation among the elderly, the results of this study suggest that social exchange and hobby-related social participation alone may not be sufficient for preventing frailty. In addition, since the issue of transportation support for the elderly is also important for social participation activities, local governments need to support the creation of 'places for social interaction that include an element of exercise' that are accessible to the elderly on foot.

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