Five-year longitudinal study of frailty prevalence and course assessed using the Kihon Checklist among community-dwelling older adults in Japan

Masayuki Ohashi (masayuki-ohashi@ksh.biglobe.ne.jp)
Niigata Daigaku Ishigaku Sogo Byoin https://orcid.org/0000-0002-9295-2580
Takuya Yoda
Niigata University Medical and Dental Hospital
Norio Imai
Niigata University Medical and Dental Hospital
Toshihide Fujii
Agano City Hospital
Kei Watanabe
Niigata University Medical and Dental Hospital
Hideki Tashi
Niigata University Medical and Dental Hospital
Yohei Shibuya
Niigata University Medical and Dental Hospital
Jin Watanabe
Niigata University Medical and Dental Hospital
Naoto Endo
Niigata University Medical and Dental Hospital

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Abstract

Background: The natural course of scores of the Kihon Checklist, one of the promising tools used for frailty screening, is unknown. We aimed to analyze the 5-year natural course of frailty as assessed using the Kihon Checklist in community-dwelling older adults.

Methods: We used the data from the postal Kihon Checklist survey conducted by the municipal government between 2011 and 2016. The sample of the current study consisted of 551 older adults (265 men and 286 women) aged 65-70 years in 2011, who responded to the postal Kihon Checklist both in 2011 and in 2016. A Kihon Checklist score of 0 to 3 was considered an indicator of robustness, 4 to 7 of prefrailty, and 8 or higher of frailty. Group comparisons were performed with significance set at $p<0.05$. To identify independent risk factors for a transition towards frailty, a logistic regression analysis was performed using factors of $p<0.20$ in the group comparisons.

Results: The median Kihon Checklist score significantly increased from 2 (interquartile range, 1-3) in 2011 to 3 (1-5) in 2016 ($p<0.001$). Hence, the prevalence of frailty significantly increased from 8.0% to 12.3% ($p<0.001$) during the same period. Regarding the 5-year transitions in frailty status, the majority (68.3%) of older adults remained unchanged, while 21.4% transitioned towards a worse frailty status, and 10.3% towards an improved status. Of the 507 respondents who were robust or prefrail at the baseline, 44 experienced a transition towards frailty, indicating that the 5-year incidence of frailty was 8.7%. These 44 individuals had higher body mass indexes and lower physical activity scores on the Kihon Checklist than the others ($p<0.05$). Multivariate analyses demonstrated that the physical activity score of the Kihon Checklist independently predicted a transition towards frailty in 5 years (odds ratio, 1.55; 95% confidence interval, 1.12–2.15; $p=0.009$).

Conclusions: This study was the first to evaluate the course of frailty status, assessed using the Kihon Checklist in community-dwelling elderly adults, and should provide reference data to evaluate the effects of frailty interventions. Additionally, our results suggest that maintaining optimal physical activity should be recommended to prevent transition towards frailty.

Background

The population of older adults in Japan is growing rapidly, with the proportion of those aged 65 years or more at 27.7% in 2017.[1] Moreover, the proportion is estimated to increase to 30% by 2025 and 37.7% by 2050.[1] This increasing number of older adults in Japan is expected to substantially contribute to healthcare costs. To prepare for the growing burden of an aging population, the Japanese government is attempting to facilitate healthy aging by promoting the maintenance of their physical function, thereby preventing disability and dependence[2] by targeting frailty.

Frailty is a common geriatric syndrome involving increased vulnerability to stressors or outcomes such as disability, requirement for long-term care, and death.[3] Frailty also includes vulnerability in psychological and social aspects of life.[3] Currently, several frailty criteria exist. One of the most widely used definitions of frailty is the frailty phenotype proposed by Fried et al. using data from the Cardiovascular Health Study.[4] On the

other hand, Rockwood et al. released their accumulated deficits model of frailty, which considered not only the physical components of frailty, but also its psychosocial aspects.[5]

In Japan, the Kihon Checklist (KCL) was developed to identify community-dwelling older adults at risk of dependency.[6,7] The KCL is a self-assessment tool comprising 25 yes/no items divided into seven dimensions including activities of daily living (ADL), physical activity, nutritional status, oral function, house-boundedness, cognitive status, and depressive mood (Table 1).[7] It demonstrated good validity in identifying frailty defined by Fried's criteria[8,9] and predicting the incidence of dependency and mortality within 3 years.[10] Moreover, it reportedly takes about 15 minutes for older adults to answer the KCL.[11] Therefore, annual health checkups using the KCL can be a cost- and time-effective method to maintain and improve the quality of life of older adults in a timely manner. However, to our knowledge, there is little longitudinal data of the KCL scores in community-dwelling older adults. This study analyzed the 5-year natural course of frailty status assessed with the KCL and the risk factors of transition towards frailty in community-dwelling older adults aged 65–70 years.

Table 1

Kihon Checklist[7]

1.	**Do you go out by bus or train by yourself?**	**0. Yes**	**1. No**
2.	Do you go shopping to buy your daily necessities by yourself?	0. Yes	1. No
3.	Do you manage your own deposits and savings at the bank?	0. Yes	1. No
4.	Do you sometimes visit your friends?	0. Yes	1. No
5.	Do you turn to your family or friends for advice?	0. Yes	1. No
6.	Do you normally climb stairs without using handrails or walls for support?	0. Yes	1. No
7.	Do you normally stand up from a chair without any aids?	0. Yes	1. No
8.	Do you normally walk continuously for 15 minutes?	0. Yes	1. No
9.	Have you experienced a fall in the past year?	1. Yes	0. No
10.	Do you have a fear of falling while walking?	1. Yes	0. No
11.	Have you lost 2 kg or more in the past 6 months?	1. Yes	0. No
12.	Height: cm, weight: kg, BMI†: kg/m^2 If BMI is less than 18.5, this item is scored	1. Yes	0. No
13.	Do you have any difficulties eating tough foods compared to 6 months ago?	1. Yes	0. No
14.	Have you choked on your tea or soup recently?	1. Yes	0. No
15.	Do you often experience having a dry mouth?	1. Yes	0. No
16.	Do you go out at least once a week?	0. Yes	1. No
17.	Do you go out less frequently compared to last year?	1. Yes	0. No
18.	Do your family or your friends point out your memory loss? E.g. "You always ask the same question over and over again."	1. Yes	0. No

†BMI, body mass index.

1.	**Do you go out by bus or train by yourself?**	**0. Yes**	**1. No**
19.	Do you make a call by looking up phone numbers?	0. Yes	1. No
20.	Do you find yourself not knowing today's date?	1. Yes	0. No
21.	In the last two weeks have you felt a lack of fulfilment in your daily life?	1. Yes	0. No
22.	In the last two weeks have you felt a lack of joy when doing the things you used to enjoy?	1. Yes	0. No
23.	In the last two weeks have you felt any difficulty in doing what you could do easily before?	1. Yes	0. No
24.	In the last two weeks have you felt helpless?	1. Yes	0. No
25.	In the last two weeks have you felt tired without a reason?	1. Yes	0. No

[†]BMI, body mass index.

Methods

This study was a retrospective analysis of the postal KCL surveys conducted by the municipal government of Agano City, located in the northeast region of Niigata Prefecture, Japan. The municipal government has conducted an annual postal KCL survey since 2011 for citizens aged 65 years and older as part of a long-term care prevention project. In 2011, Agano City had a population of 3,013 people aged 65–70 years, of which 1,053 older adults were randomly selected by the municipal government and surveyed. Out of the 1,053 selected individuals, 774 completed the KCL in 2011, and of the latter, 551 completed the survey in 2016. The current longitudinal study population consisted of the 551 older adults aged 65–70 years in 2011 who had responded to the KCL surveys both in 2011 and in 2016 (follow-up rate, 52.3%). This study was reviewed and approved by the Institutional Review Board of Niigata University (2019 – 0221).

The Kihon Checklist (KCL)

The KCL is a self-reporting questionnaire consisting of 25 “yes” or “no” items, with 5 items testing for ADL, 5 for physical activity, 2 for nutritional status, 3 for oral function, 2 for house-boundedness, 3 for cognitive status, and 5 for depressed mood (Table 1).[7] Each question was rated on a pass/fail basis, and the sum of all the indices’ questions ranged from 0 to 25, with a higher KCL score indicating a higher risk for requiring support or care. In this study, according to the frailty criteria reported by Satake et al.[9], a KCL score of 0 to 3 was considered an indicator of robustness, 4 to 7 of prefrailty, and 8 or higher of frailty. The transition in frailty status was classified into three categories based on changes between 2011 and 2016: improved, unchanged, and worsened transitions. In the improved transition category, the total or dimensional scores of the KCL had

decreased in 2016 compared to 2011, while the score increased in the worsened transition category. The 5-year incidence of frailty was calculated as a percentage of older adults who were frail in 2016 and those who were robust or prefrail in 2011. Older adults who were robust or prefrail in 2011 were divided into 2 groups according to their status in 2016: Group A included older adults who were also robust or prefrail in 2016, and Group B included those who were frail in 2016.

Statistical analysis

Statistical analyses were performed using SPSS software (version 19; IBM Corp., Armonk, NY). Continuous data are expressed as mean ± standard deviation or median [interquartile range (IQR)], as appropriate. Differences in the KCL scores between 2011 and 2016 were evaluated using the Wilcoxon rank-sum test. Differences between Groups A and B were analyzed using the unpaired t-test, the Mann-Whitney U test, and the chi-square test. A post hoc test for the chi-square test was performed using a residual analysis, when appropriate. Additionally, a stepwise logistic regression analysis was performed to identify independent risk factors for a transition towards frailty within 5 years. First, univariate analyses were performed to compare variables at the baseline between Groups A and B. Factors with $p < 0.20$ in the univariate analyses were included in the multivariate analysis. The value of $p < 0.05$ was considered statistically significant. In the residual analysis, when the absolute value of the adjusted residual was greater than 1.96, the observed frequency was considered to be significantly different from the expected frequency at the level of $p < 0.05$.

Results

Our cohort consisted of 551 older adults (265 men and 286 women) with an average age of 67.3 ± 1.5 years (range, 65–70 years) in 2011. The median KCL score significantly increased from 2 (IQR, 1–3) in 2011 to 3 (1–5) ($p < 0.001$). As a result, the prevalence of prefrailty and frailty significantly increase from 16.5% (n = 91) to 23.2% (n = 128) (adjusted residual, 2.793), and from 8.0% (n = 44) to 12.3% (n = 68) (adjusted residual, 2.393), while the prevalence of robustness significantly decreased from 75.5% (n = 416) to 64.4% (n = 355) (adjusted residual, -4.008) (chi-square test, $p < 0.001$) (Fig. 1). On the other hand, body mass index (BMI), which was calculated using the answer to Question 12 of the KCL (Table 1),[7] did not change between 2011 [23.0 ± 3.2 kg/m^2 (range, 14.5–34.7 kg/m^2)] and 2016 [23.0 ± 3.3 kg/m^2 (range, 12.3–37.5 kg/m^2)] ($p = 0.10$).

Table 2 shows transitions in seven dimensions assessed in the KCL from 2011 to 2016. The incidences of transition, which were improved, unchanged, and worsened transitions, differed significantly among the dimensions ($p < 0.001$). Residual analyses demonstrated significantly higher incidences of worsened transitions in physical activity (28.9%) and oral function (25.1%), and significantly lower incidences of worsened transitions in nutritional status (15.8%), house-boundedness (14.0%), and cognitive status (16.9%) compared to the other dimensions ($p < 0.05$).

Table 2

Transitions in seven dimensions in the Kihon Checklist, from the baseline to the 5-year follow-up

	ADL†	Physical activity	Nutritional status	Oral function	House-boundedness	Cognitive status	Depressive mood
Improved (cases, %)	64 (11.62%)	109 (19.78%)	49 (8.89%)	97 (17.60%)	59 (10.71%)	75 (13.61%)	83 (15.06%)
Unchanged (cases, %)	379 (68.78%)	283 (51.36%)	415 (75.32%)	316 (57.35%)	415 (75.32%)	383 (69.51%)	340 (61.71%)
Worsened (cases, %)	108 (19.60%)	159 (28.86%)	87 (15.79%)	138 (25.05%)	77 (13.97%)	93 (16.88%)	128 (23.23%)
Adjusted residuals for worsened transition	-0.554	5.261*	-2.948*	2.867*	-4.088*	-2.264*	1.727
†ADL, activities of daily living.							
*Statistically significant at the level of $p < 0.05$.							

Table 3 shows the prevalence of frailty status at the baseline (2011) and at the 5-year follow-up survey (2016). The majority (68.3%) of older adults remained unchanged, while 21.4% transitioned towards a worsened frailty status over the 5 years, and 10.3% towards an improved status. Among older adults who were robust at the baseline, 25.7% demonstrated a transition towards a worsened frailty status, of which 17.8% were prefrailty, and 7.9% were frailty (Fig. 2). On the other hand, 40.7% of older adults who were prefrail at the baseline transitioned towards robustness in the 5 years, while 12.1% experienced a transition towards frailty (Fig. 3). Interestingly, approximately half of older adults who were frail at the baseline improved their frailty status, transitioning towards prefrailty (25.0%) or robustness (20.5%) (Fig. 4).

Table 3

Transitions in frailty status from the baseline to the 5-year follow-up.

Baseline status (2011)	Status at 5-year follow-up (2016)		
	Robust	Prefrailty	Frailty
Robust	309 (56.1%)	74 (13.4%)	33 (6.0%)
Prefrailty	37 (6.7%)	43 (7.8%)	11 (2.0%)
Frailty	9 (1.6%)	11 (2.0%)	24 (4.4%)
Data are shown as the number of cases (prevalence, %).			

At the baseline, 507 older adults had non-frailty status (robust or prefrailty). Of these, 44 experienced a transition towards frailty (Group B), indicating that the 5-year incidence of frailty was 8.7%. In the comparison of the baseline data between Groups A and B (Table 4), BMI (mean; 22.9 kg/m^2 in group A, 24.5 kg/m^2 in

group B, p = 0.035), and physical activity score of the KCL (median; 0 in group A, 1 in group B, p = 0.002) were significantly higher in Group B than in Group A. On the other hand, there were no significant differences in age, sex, and the other dimensional scores of the KCL between Groups A and B. In the multivariate analysis, in which BMI and scores of ADL, physical activity, oral function, and house-boundedness were included, only the physical activity score of the KCL independently predicted a transition towards frailty in 5 years (odds ratio, 1.55; 95% confidence interval, 1.12–2.15; p = 0.009).

Table 4

Comparisons of the baseline data between older adults who experienced a transition from non-frailty to frailty, and those who did not.

Baseline data (2011)	**Group A (n = 463)**	**Group B (n = 44)**	**p-value**
Age (years, mean ± SD)	67.3 ± 1.5	67.4 ± 1.5	0.63
Sex (cases)			
Male	227	20	
Female	236	24	0.65
BMI[†] (kg/m^2, mean ± SD[§])	22.9 ± 3.0	24.5 ± 4.6	0.035*
KCL[‡] score [median (IQR[¶])]			
Activities of daily living	0 (0)	0 (0–1)	0.19
Physical activity	0 (0–1)	1 (0–1)	0.002*
Nutritional state	0 (0)	0 (0)	0.53
Oral function	0 (0–1)	0 (0–1)	0.13
Houseboundness	0 (0)	0 (0)	0.12
Cognitive function	0 (0)	0 (0)	0.97
Depressive mood	0 (0)	0 (0)	0.49

Group A included older adults who were non-frail in both 2011 and 2016, and Group B included those who had transitioned from non-frailty to frailty.
[†]BMI, body mass index; [§]SD indicates standard deviation; [‡]KCL, Kihon Checklist; [¶]IQR, interquartile range.
*p < 0.05

Discussion

We evaluated the frailty status assessed using the KCL and found that in community-dwelling older adults aged 65–70 years, the status of 75.5% could be categorized as robustness, 16.5% as prefrailty, and 8.0% as frailty. The age of 65–70 years has recently been regarded as the start of old age. In this age range, people usually begin to experience major life events, such as retirement, which generally has a strong effect on physical activity and behavior.[12,13] Therefore, people aged 65–70 years could be an important age group for

preventing transitions towards frailty, and focusing on older adults within this 5-year age range should reveal predictors for early interventions.

Regarding the previously reported prevalence of frailty among community-dwelling older adults, Choi et al. reviewed 6 national population-based surveys and reported that the prevalence of frailty defined by Fried's criteria demonstrated significant differences among countries, ranging from 5.8–27.3%.[14] In the previous systematic review, age-stratified prevalence of frailty was approximately 4% among people aged 65–69 years.[15] Among the older adults in Japan, the prevalence of frailty defined by Fried's criteria reportedly ranged from 1.5–11.6%,[9,16–19] while that defined using the KCL ranged from 4–17.2%.[10,16,20] On the other hand, the age-stratified prevalence of frailty defined by Fried's criteria was reported to be 1.9%-5.4% for Japanese people aged 65–69 years,[18,19] and 4.0% for those aged 65–74 years.[17] Considering that the prevalence of frailty evaluated with the KCL was reported to be slightly higher than that using Fried's criteria,[16] we believe that the baseline frailty status of the current study was similar to that of previously reported cohorts. Therefore, our longitudinal data can represent the natural course of frailty status defined with the KCL in 65-70-year old adults living in Japan.

Recently, the KCL has been reported to be a predictor of long-term care risk,[9] healthy life expectancy,[21] and cognitive function.[22] Therefore, in Japan, with its rapidly aging population, the KCL could be a useful tool to monitor and evaluate frailty status at a low cost because the survey using the KCL is performed with a self-reporting questionnaire through the mail. On the other hand, to design appropriate frailty interventions and identify optimal target populations to prevent or delay progression, it is imperative to understand the progressive course of frailty and to predict how the frailty status of older people evolves over time. However, little is known about the natural course of frailty status defined using the KCL.

In the current study, we found that the total score of the KCL significantly increased from the baseline to the 5-year follow-up and the prevalence of frailty defined using the KCL significantly increased from 8.0–12.3%. These results are comparable with previous studies, which reported that advanced age is a strong risk factor for frailty status.[19,20] Regarding transitions in frailty status defined by Fried's criteria, Kojima et al. reviewed 16 studies and reported that 13.7% of older adults improved, 29.1% worsened, and 56.5% remained unchanged over a mean of 3.9 years.[24] Our study evaluated frailty status as assessed with the KCL and demonstrated that 11.6% of older adults improved, 19.6% worsened, and 68.8% maintained the same frailty status in 5 years, in which the rate of worsened transition was slightly lower than that reported in the previous meta-analysis.[24] It might be due to the difference in criteria for defining frailty status, which could affect the prevalence of frailty.[16] Moreover, it might also be due to the younger age of our participants (mean age 67.3 years, range 65–70 years) than that in the previous meta-analysis, in which most studies had participants with a mean age older than 70 years.[24] Indeed, previous studies showed that older people's frailty status is likely to worsen.[25–27] On the other hand, it should be noted that frailty is not an irreversible status, but a reversible and dynamic status involving improvement as well as progression. Actually, in our study, 45.5% of frail elderly individuals improved their status to prefrailty or robustness. This reversibility of frailty status indicates that it is worth the effort to attempt to establish appropriate interventions for frailty. To this end, it is necessary to clarify the risk factors of a transition towards frailty, and thus, we performed comparisons of the baseline data between the older adults who experienced a transition towards frailty (Group B) and those who did not (Group

A). BMI was significantly higher in Group B (mean, 24.5 kg/m^2) than in Group A (mean, 22.9 kg/m^2). This is in line with the results of the review article in which obesity and high waist circumference demonstrated highly convincing results for an association with frailty.[28] Additionally, the physical activity score of the KCL was significantly higher in Group B (median, 1) than in Group A (median, 0), indicating that those in Group B had a significantly worsened status in the physical activity category than those in Group A. In the multivariate analysis, we demonstrated that the physical activity score of the KCL independently predicted a transition towards frailty in 5 years. A systematic review demonstrated that exercise can potentially prevent, delay or reverse frailty. [29] Moreover, Macdonald et al. performed a meta-analysis and reported that frailty can be improved, mainly through resistance-based exercise.[30] Therefore, we believe that to prevent frailty, maintaining or improving physical activity should be recommended to older adults with a physical activity score of 1 or higher.

Limitations exist in the current study. First, this is a retrospective analysis of the questionnaire surveys conducted by the government; therefore, we could analyze 5-year follow-up data only in older adults aged 65–70 years due to the method of selecting participants of the postal KCL survey conducted by the government. However, we believe that it reduced heterogeneity with age, which is one of the strongest factors for frailty. Second, we had no data on medical history, physical and social activity, and lifestyle. Finally, the “optimal” exercise regimen and BMI to prevent frailty are still unclear. To address these limitations, further prospective, comprehensive studies that include older adults aged over 70 years is necessary for future research.

In conclusion, to our knowledge, this study is the first to evaluate frailty status and its longitudinal transitions using the KCL, which is a promising tool to easily and cost-effectively evaluate frailty status. We demonstrated that 8.0% of community-dwelling older adults aged 65–70 years were frail. Regarding transitions in frailty status, 11.6% of older adults improved, 19.6% worsened, and 68.8% maintained their status over the course of 5 years. The 5-year incidence of frailty status was 8.7%. To prevent a transition towards frailty, maintaining optimal levels of physical activity and normal body weight should be recommended.

Abbreviations

KCL
Kihon Checklist; ADL:activities of daily living; IQR:interquartile range; BMI:body mass index

Declarations

Ethics approval and consent to participate

This study was reviewed and approved by the Institutional Review Board of Niigata University (2019-0221). The authors received administrative permission to access and use the data from the municipal government of Agano City.

Consent for publication

Not applicable.

Availability of data and materials

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

Competing interests

The authors declare no competing interests.

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Authors' contributions

This work was performed in the Division of Orthopedic Surgery, Niigata University School of Medical and Dental Sciences.

Masayuki Ohashi (MO) and Takuya Yoda (TY) undertook the collection and analysis of the data. MO, YT, Norio Imai (NI), Toshihide Fujii (TF), Kei Watanabe (KW), Hideki Tashi (HT), Yohei Shibuya (YS), Jin Watanabe (JW), and Naoto Endo (NE) conceived and designed the project. MO wrote the manuscript. TY, NI, TF, KW, HT, YS, JW, and NE revised the manuscript critically for important intellectual content. All the authors read and approved the final version of the manuscript for publication. All authors agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work would be appropriately investigated and resolved.

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Figures

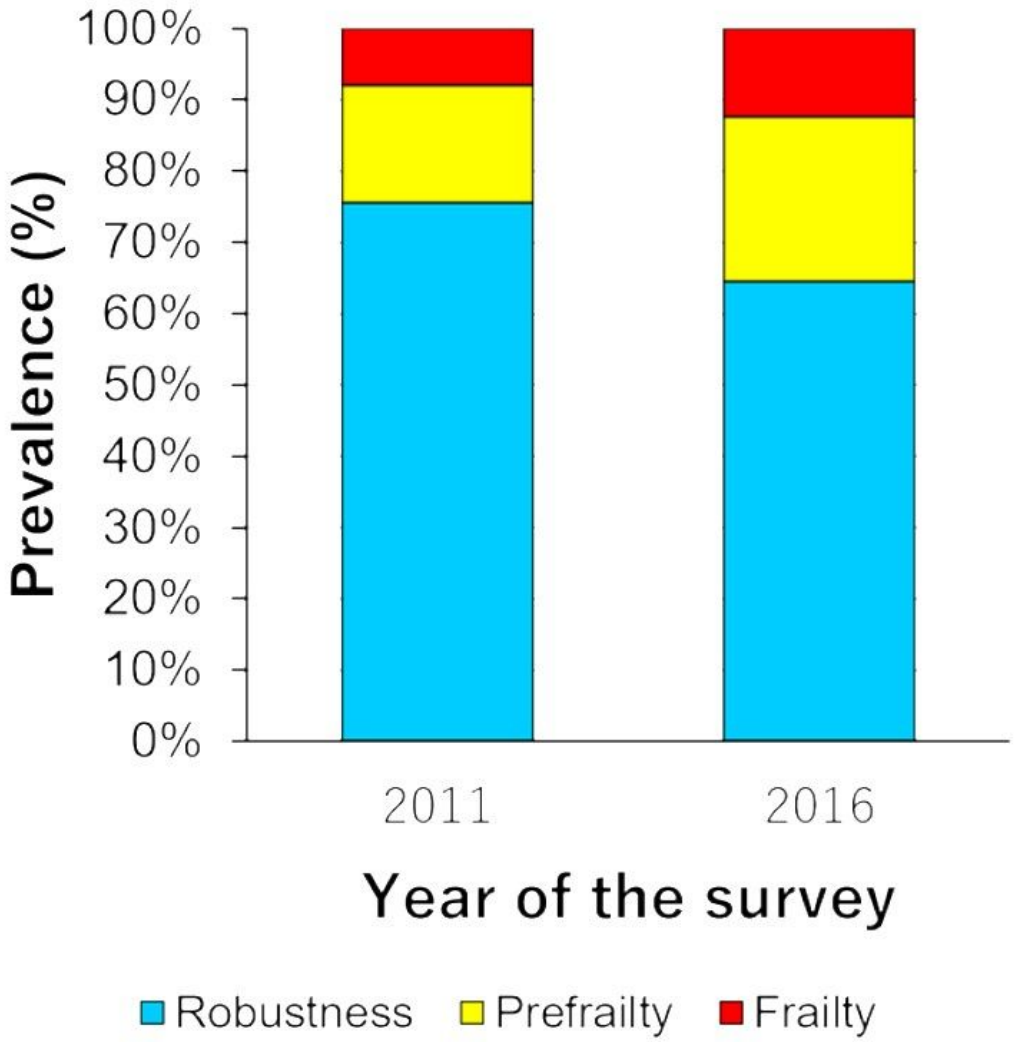

Figure 1

Figure 1

Each frailty status in 2011 and 2016.

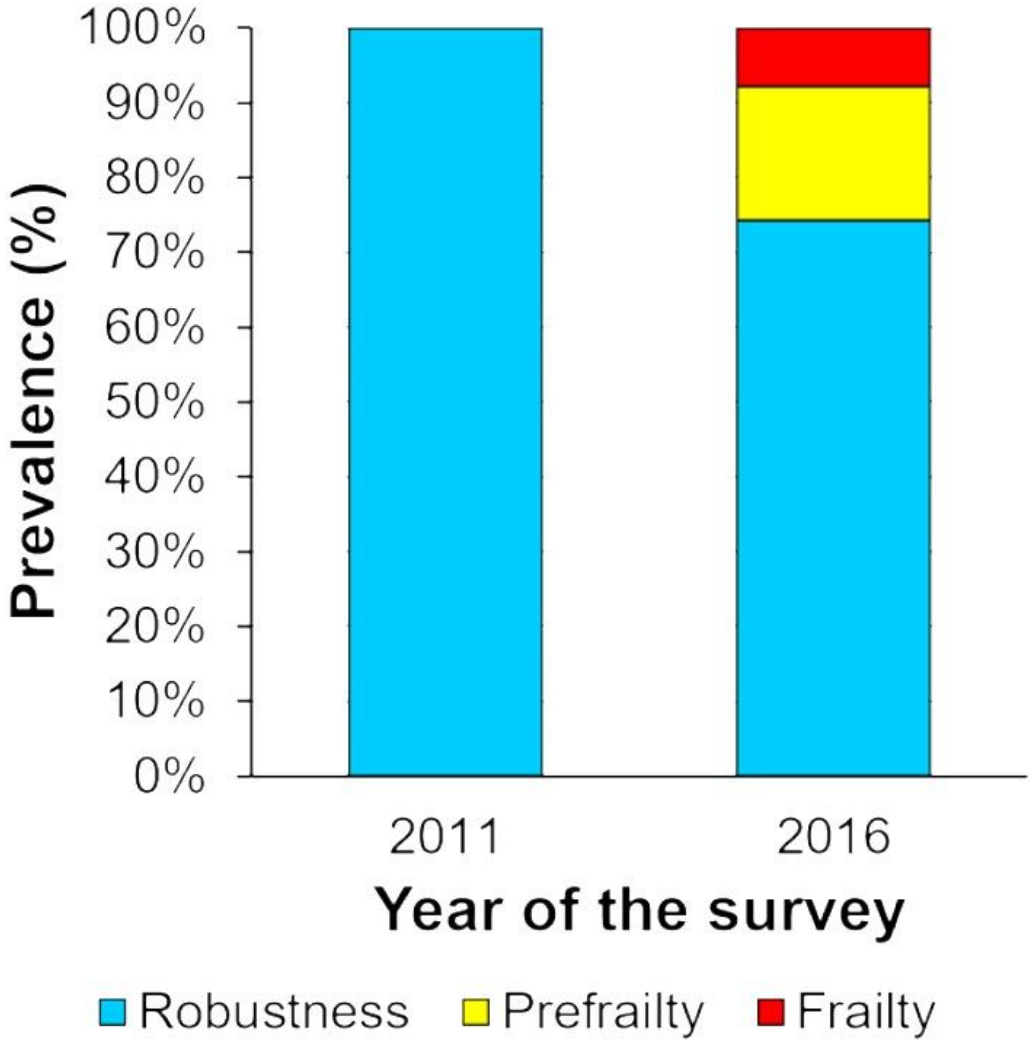

Figure 2

Figure 2

Transitions in older adults who were robust in 2011.

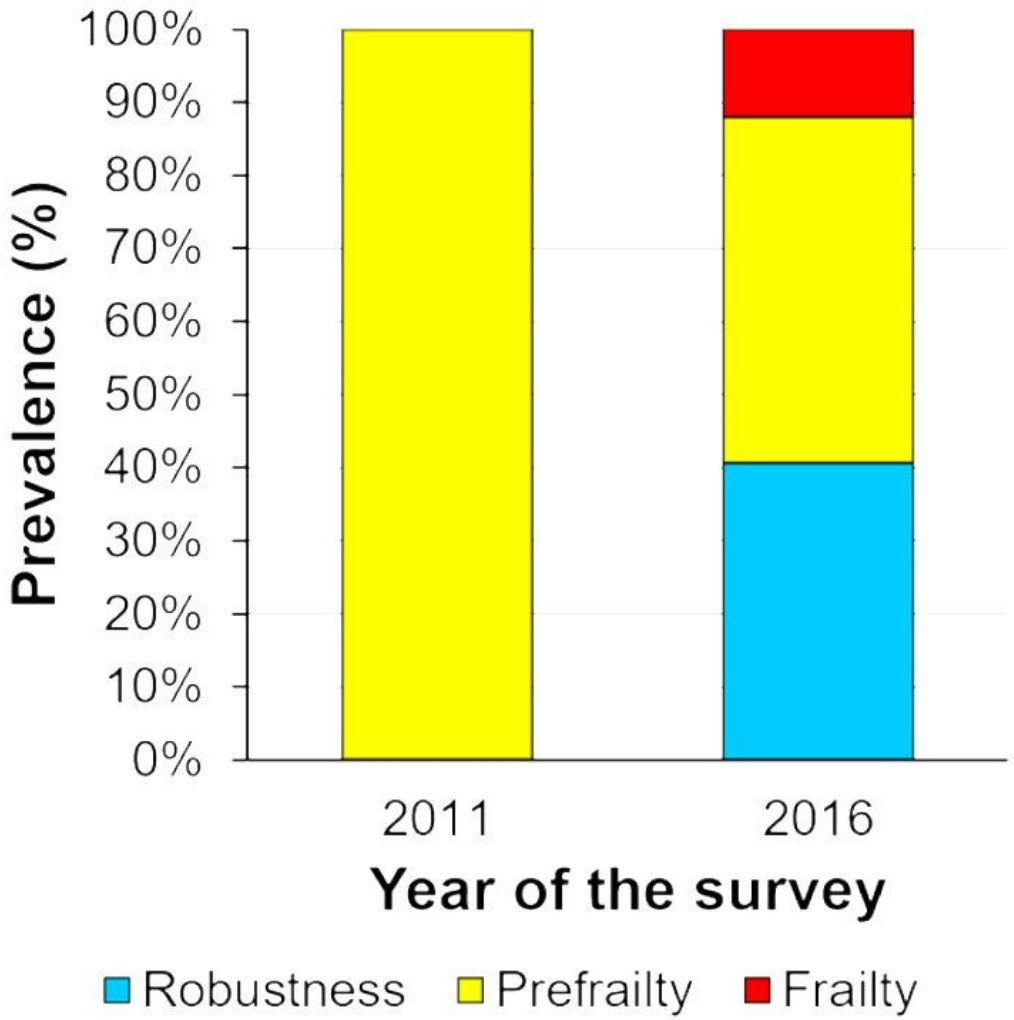

Figure 3

Figure 3

Transitions in older adults who were prefrail in 2011.

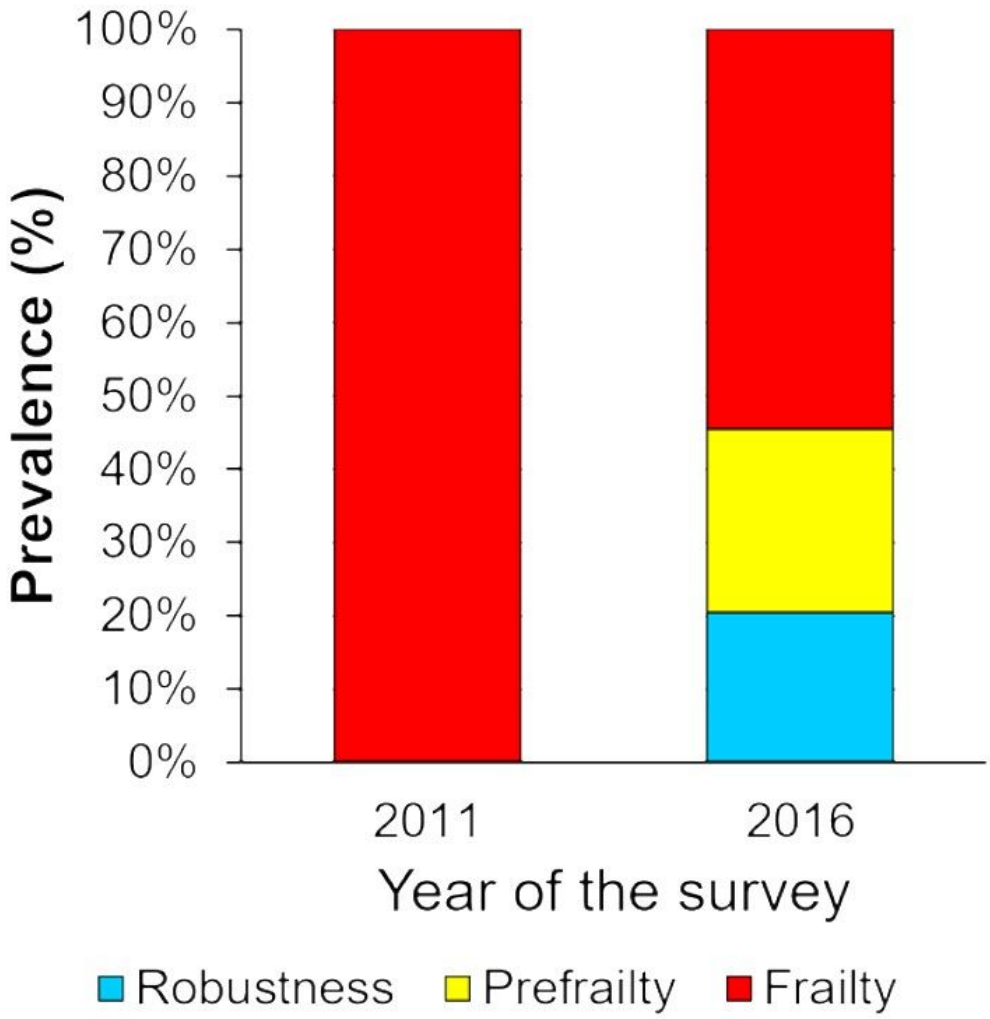

Figure 4

Figure 4

Transitions in older adults who were frail in 2011.