

# Reliability and validity of the self-reported frailty screening questionnaire in older adults

Yanhong Zhang, Yaxin Zhang, Yun Li, Piu Chan and Lina Ma 

## Abstract

**Background:** Frailty is one of the most important risk factors for adverse outcomes in older adults. Despite a high prevalence, there is still a lack of frailty screening instruments specific to Chinese older adults. We developed a simple frailty screening questionnaire (FSQ) that could predict long-term mortality. We aimed to explore the reliability and construct validity of this new measurement tool.

**Methods:** A total of 205 individuals aged 65 years or older were recruited in this study. The FSQ and frailty phenotype were assessed. The FSQ included self-reported slowness, weakness, weight loss, inactivity, and exhaustion. A subgroup of 109 participants completed the FSQ a second time 2 weeks later for test–retest reliability. Frailty phenotype included slowness, exhaustion, weight loss, weakness, and inactivity.

**Results:** The intraclass correlation coefficient for the FSQ, slowness, weakness, weight loss, inactivity and exhaustion were 0.937, 0.938, 0.934, 0.921, 0.826, and 0.832, respectively. Using a cut-off of 3, the sensitivity, specificity, and area under the curve of the receiver operating characteristic were 52.6%, 93.5%, and 0.883 ( $p < 0.001$ ), respectively. The kappa coefficient between the FSQ and frailty phenotype was 0.431 ( $p < 0.001$ ). FSQ score was negatively correlated with walking speed and grip strength, and positively correlated with age. Frailty defined by the FSQ was associated with older age, chronic diseases, and worse physical function.

**Conclusions:** The FSQ is a potentially useful, reliable, and valid instrument in screening frailty in older adults, and can be recommended to identify frailty in clinical settings.

**Keywords:** frailty, measurement, older adults

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## Introduction

At present, the number of older people is increasing globally, and with this phenomenon comes decreased mortality rates and increased life expectancy.<sup>1</sup> Existing healthcare services cannot meet the demands of an increasingly aging population. Thus, frailty and its significant consequences for health have drawn much attention, as frailty is one of the most commonly recognized risk states for adverse outcomes in older adults.<sup>2</sup> Despite varying definitions of frailty, a high prevalence of frailty in older adults has been reported across different studies.<sup>3,4</sup> Frailty is a consequence of age-related decline in various physiological systems, which

can lead to negative health outcomes including disability and death after what might otherwise be a relatively minor stressor. However, frailty is not an inevitable part of ageing, and the progression of frailty is potentially reversible if it is diagnosed and treated early.<sup>5</sup> Consequently, frailty screening has gained momentum as a possible health policy to develop appropriate interventions to prevent the onset and progression of frailty.

Currently, there is no standardized measurement tool for frailty, as there is not an internationally recognized operational definition. However, a wide range of frailty assessment tools have been

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developed, and two conceptual models dominate the field: the frailty phenotype (FP) and frailty index (FI). The FI identifies frailty as a state defined by an accumulation of physical to psychosocial deficits.<sup>6</sup> The FP distinguishes frailty as a syndrome identified by a predefined set of five criteria: involuntary weight loss, self-reported exhaustion, slowness, weakness, and inactivity.<sup>7</sup> Frailty assessed by FP has been shown to be significantly associated with mortality after adjustment for the number of long-term conditions, sociodemographic characteristics, and lifestyle in both middle-aged and older individuals.<sup>8</sup> FP is often modified for different populations and settings, and a systematic review reported the FP assessment had 262 different kinds of modifications.<sup>9</sup> An easy-to-use, self-reported screening tool may offer a simple and quick way to identify targeted participants who would benefit from a more complex assessment.

Thus, we have proposed a two-step pathway for frailty identification: (a) a quick frailty screening for initial identification, and (b) using complex instruments, such as the comprehensive geriatric assessment (CGA), for further frailty assessment and management.<sup>10</sup> Validated measurement tools to identify frailty were recommended by the Asia-Pacific Clinical Guidelines for the Management of Frailty;<sup>11</sup> however, most of those frailty tools are time-consuming, require objective measurements, or are difficult to implement in routine clinical work. Owing to the lack of a frailty screening tool specifically designed for Chinese older adults, we developed a simple frailty screening questionnaire (FSQ) comprising five self-reported components based on the original FP proposed by Fried and colleagues<sup>7,12</sup> Frailty, as defined by the FSQ, was shown to be associated with poor physical function and death in a large community-dwelling population, as well as predicted mortality.<sup>12</sup> These results indicated that the FSQ could be used to identify older adults with a high risk of adverse health outcomes;<sup>12</sup> however, the reliability and construct validity of the FSQ still needed to be explored.

## Material and methods

### Study design and participants

This study included 205 older adults aged 65 years or older who were seen at Xuanwu Hospital, Capital Medical University. Inclusion criteria consisted of relatively healthy participants (without acute or

severe illness) 65 years or older who were admitted to the Department of Geriatrics for a physical examination and completed the frailty assessment. Exclusion criteria included disability, acute infection, severe cardiac, liver or kidney dysfunction, acute cerebrovascular disease, Parkinson's disease, depression or anxiety, alcohol or drug abuse, and a Mini-Mental State Examination (MMSE) score less than 18. The average age of participants was  $75.18 \pm 6.29$  years, and the average hospital stay was  $8.29 \pm 2.31$  days. Comprehensive medical histories and frailty measurements of all patients were obtained by trained staff. A subgroup of 109 participants aged  $75.11 \pm 6.09$  years was revisited *via* a telephone interview 2 weeks after the initial assessment. The study protocol was approved by the institutional review board of Xuanwu Hospital, Capital Medical University (2018-076), and informed consent was obtained from all participants prior to participation.

### Data collection

All participants underwent the CGA, including frailty measurements. Chronic health conditions including hypertension, diabetes, cardiovascular disease, chronic obstructive pulmonary disease, asthma, kidney disease, stroke, hyperlipidemia, and digestive disease were diagnosed by a doctor. Blood pressure was measured with participants in a sitting position, following a 10-minute rest. Functional ability was assessed based on the capacity of individuals to perform activities of daily living and instrumental activities of daily living (IADL). Mental health was assessed using the Center for Epidemiological Studies Depression (CES-D) scale<sup>13</sup> and cognitive function was assessed by MMSE.

### Frailty assessment

FP was defined according to the Fried FP assessment, which includes slowness (by usual pace 4-meter walking speed), exhaustion (by self-report), weight loss (by self-reported unintentional weight loss of 4.5 kg or more in the last year or body mass index less than  $18.5 \text{ kg/m}^2$ ), weakness (by grip strength), and inactivity (by self-report). Participants were classified as either frail ( $\geq 3$  components) or non-frail ( $< 3$  components). Grip strength, walking speed measurement, and details of the criteria for each component were reported in previous publications.<sup>14,15</sup>

The FSQ includes five self-reported components based on modified Fried FP criteria: slowness, weakness, weight loss, inactivity, and exhaustion. Slowness was defined as being unable to walk for 250m independently or with assistive devices, except a wheelchair, regardless of speed.<sup>12</sup> Weakness was defined as experiencing difficulty in lifting or carrying 5kg.<sup>12</sup> Exhaustion was defined as a 'yes' response to either of two questionnaire items from the CES-D: 'Everything I did was an effort' or 'I could not get going'. Inactivity was identified as <3h per week spent on leisure activities.<sup>12</sup> Weight loss was defined as an unintentional loss of body weight of at least 4.5kg in the past year.

### Statistical analysis

All statistical analyses were performed using SPSS version 11.0 (SPSS Inc., Chicago, IL, USA) or GraphPad Prism version 7.0 software (GraphPad Software Inc., CA, USA). Data were presented as mean  $\pm$  standard deviation or number and percentage. The differences in characteristics between the two groups were evaluated by chi-square tests for categorical variables or independent *t* tests for continuous variables. The test-retest reliability of the FSQ was assessed using intraclass correlation coefficients (ICC). The area under the curve of the receiver operating characteristic (AUC-ROC) was also calculated. The kappa coefficient was calculated to examine agreement between performed and self-reported frailty for each component. Spearman rank correlation coefficients were calculated for the relationship of FSQ score with age and physical function. All statistical tests were two-tailed, and a *p* value of <0.05 was considered statistically significant.

### Results

The data of a subgroup of 109 participants was used for test-retest reliability analysis. These patients completed the FSQ again, 2 weeks after the initial assessment. The characteristics of the total sample and subgroup are shown in Table 1. The ICCs for FSQ, slowness, weakness, weight loss, inactivity and exhaustion were 0.937, 0.938, 0.934, 0.921, 0.826, and 0.832, respectively (Table 2).

Using a cutoff of 3, a total of 22 participants were classified as frail according to the FSQ

(10.7%). The sensitivity and specificity of the FSQ in identifying frailty were 52.6% and 93.5%, respectively, and the AUC-ROC for the FSQ *versus* FP in 205 older adults was 0.883 ( $p < 0.001$ , Figure 1). In the subgroup, the sensitivity, specificity, and AUC-ROC for the FSQ were 45.5%, 92.9%, and 0.871 ( $p < 0.001$ ), respectively. The kappa coefficient reflecting agreement between FSQ and FP was 0.431 ( $p < 0.001$ ). The kappa coefficients between self-reported and performed slowness, and self-reported and performed weakness were 0.405 ( $p < 0.001$ ) and 0.140 ( $p = 0.045$ ), respectively. FSQ score was positively correlated with age ( $r = 0.191$ ,  $p = 0.006$ ), and negatively correlated with walking speed ( $r = -0.374$ ,  $p < 0.001$ ) and grip strength ( $r = -0.154$ ,  $p = 0.028$ , Figure 2).

Frailty, as defined by the FSQ, was associated with older age, hypertension, more IADL dependency, and worse physical function (e.g. walking speed and grip strength). For each self-reported component, slowness was associated with IADL dependency and slower walking speed; weakness was associated with age, IADL dependency, slower walking speed, and worse grip strength; inactivity was associated with age and slow walking speed; and exhaustion was associated with age, IADL dependency, and slower walking speed (Table 3).

### Discussion

The present study showed high levels of test-retest reliability for the FSQ and its components. Furthermore, FSQ score was negatively correlated with walking speed and grip strength, which indicated that the FSQ is a reliable frailty screening tool. An effective frailty instrument should be able to identify frailty, predict outcomes and responses to potential treatments, and be grounded in biological theory.<sup>16</sup> The available screening tools present two major limitations. First, FP and FI measurement are complex and time-consuming, thus difficult to apply in daily clinical practice or when targeting large populations. Furthermore, simplified frailty assessment techniques, such as the Study of Osteoporotic Fractures, have limited application in clinical assessment.<sup>17</sup> Thus, self-reported questionnaires may be the most appropriate solution for busy clinicians. Second, no frailty assessment tool has yet been developed or validated specifically for

**Table 1.** Characteristics of the participants.

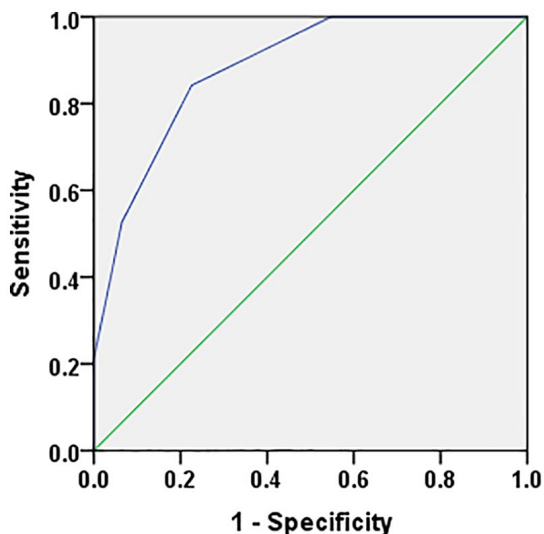
	Total sample ( <i>n</i> = 205)	Subgroup ( <i>n</i> = 109)
Age (years old)	75.18 ± 6.29	75.11 ± 6.09
Sex (male)	108 (52.7)	57 (52.3)
Hypertension	68 (33.3)	37 (33.9)
SBP (mmHg)	142.07 ± 31.58	141.71 ± 22.60
DBP (mmHg)	73.47 ± 11.09	74.11 ± 10.95
Diabetes	9 (4.4)	6 (5.5)
CVD	27 (13.2)	12 (11)
COPD	28 (13.7)	18 (16.5)
Asthma	8 (3.9)	6 (5.5)
Kidney disease	11 (5.4)	6 (5.5)
Stroke	8 (3.9)	6 (5.5)
Hyperlipidemia	17 (8.3)	9 (8.3)
Digestive disease	41 (20.0)	24 (22.0)
Polypharmacy	87 (42.4)	45 (41.3)
MMSE score	26.51 ± 5.17	26.69 ± 6.26
Fall	33 (16.1)	11 (10.1)
IADL dependency	34 (16.7)	19 (17.8)
Walking speed (m/s)	0.60 ± 0.22	0.61 ± 0.22
Grip strength (kg)	27.54 ± 8.12	27.10 ± 7.53
Smoking	80 (39.0)	42 (38.5)
Slowness	50 (24.4)	26 (23.9)
Weakness	54 (26.3)	29 (26.6)
Inactivity	42 (20.5)	22 (20.2)
Exhaustion	49 (23.9)	27 (24.8)
Weight loss	33 (16.1)	21 (19.3)
FP frailty	19 (9.3)	11 (10.1)
FSQ frailty	22 (10.7)	12 (11.0)

Data are expressed as mean (standard deviation) or *n* (%).  
COPD, chronic obstructive pulmonary disease; CVD, cardiovascular disease; DBP, diastolic blood pressure; FP, frailty phenotype; FSQ, Frailty Screening Questionnaire; IADL, instrumental activities of daily living; MMSE, Mini-Mental State Examination; SBP, systolic blood pressure.

**Table 2.** Test-retest reliability of FSQ and its components.

	Intraclass correlation coefficient	95% CI
FSQ total score	0.937	0.908–0.957
<b>FSQ component</b>		
Slowness	0.938	0.910–0.958
Weakness	0.934	0.903–0.955
Weight loss	0.921	0.885–0.946
Inactivity	0.826	0.746–0.881
Exhaustion	0.832	0.755–0.885

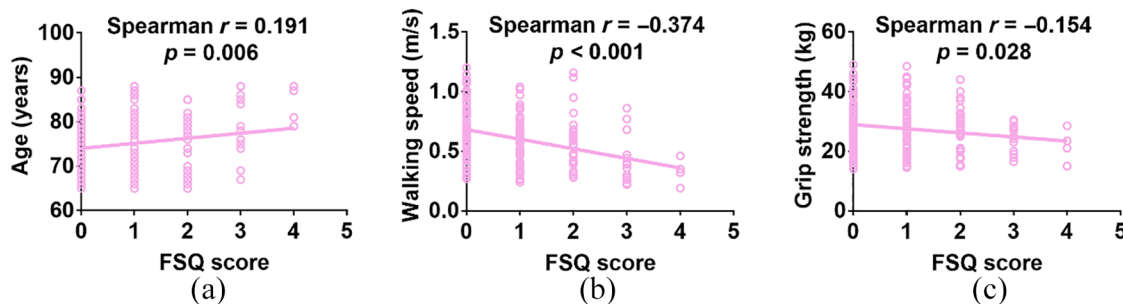
CI, confidence interval; FSQ, Frailty Screening Questionnaire.

**Figure 1.** ROC curve for FSQ in identifying frailty. FSQ, Frailty Screening Questionnaire; ROC, receiver operating characteristic.

Chinese older adults. Therefore, an easy-to-use tool based on a standardized subjective evaluation of frailty would be more readily accepted and adopted.<sup>18</sup> We have previously reported the FSQ to be a useful tool to predict long-term prognosis,<sup>12</sup> and the present study indicated a good reliability for the FSQ as well.

The FSQ is a simplified Fried FP tool based on self-reported information. The cut off value for frailty we proposed for the FSQ was based on the combination of both sensitivity and specificity. When using a cut off value of three, the sensitivity was not good (52.6%); however, the specificity and AUC-ROC were 93.5% and 0.883, respectively, which indicated that the self-reported FSQ with a high specificity can be used to screen for frailty in older adults. There is no consensus on a standardized definition of frailty, and the reliability of many frailty tools has yet to be verified, which weakens the standardization of frailty models and comparability of results.<sup>9</sup> Furthermore, assessing frailty with the gait speed test, handgrip strength test, and Minnesota Leisure Time Activity instrument for estimating energy consumption is too time-consuming to be routine in busy Chinese clinics. The FSQ does not require assessor training and is simple to apply within a few minutes; therefore, it can be routinely incorporated into clinical work.

Although there is emerging evidence to support self-reported frailty screening as promising, significant gaps between preformed and self-reported components to assess frailty remain. Our data revealed that the kappa coefficient reflecting agreement between self-reported and performed slowness, and self-reported and performed weakness were 0.405 and 0.140, respectively. A few studies have focused on this issue. A study in

**Figure 2.** Correlation between FSQ score with age and physical function. (a) Age, (b) Walking speed, (c) Grip strength. FSQ, Frailty screening questionnaire.

**Table 3.** Comparison between nonfrail and frail participants.

Item	Frailty		Slowness		Weakness		Inactivity		Exhaustion		Weight loss	
	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
<i>n</i>	183	22	145	60	157	48	163	42	156	49	199	6
Age (years old)	74.64 ± 6.05	79.59 ± 6.70**	74.70 ± 5.88	76.33 ± 7.13	74.25 ± 6.03	78.19 ± 6.26**	74.72 ± 5.96	76.95 ± 7.25*	75.47 ± 6.21	74.22 ± 6.52	75.09 ± 6.29	78.00 ± 6.33
Sex (Male)	101 [54.6]	7 [35.0]	78 [53.8]	30 [50.0]	89 [56.7]	19 [39.6]	87 [53.4]	21 [50.0]	78 [50.0]	30 [61.2]	106 [53.3]	2 [33.3]
<b>Chronic disease</b>												
Hypertension (yes)	57 [31.0]	11 [55.0]*	47 [32.6]	21 [35.0]	47 [30.1]	21 [43.8]	50 [30.9]	18 [42.9]	51 [32.9]	17 [34.7]	65 [32.8]	3 [50.0]
Stroke (yes)	6 [3.2]	2 [10.0]	6 [4.1]	2 [3.3]	5 [3.2]	3 [6.3]	6 [3.4]	2 [4.8]	6 [3.8]	2 [4.1]	8 [4.0]	0 [0.0]
COPD (yes)	25 [13.5]	3 [15.0]	18 [12.4]	10 [16.7]	21 [13.4]	7 [14.6]	22 [13.5]	6 [14.3]	19 [12.2]	9 [18.4]	28 [14.1]	0 [0.0]
SBP (mmHg)	141.02 ± 32.12	151.13 ± 25.33	139.85 ± 22.17	147.44 ± 46.93	140.63 ± 33.45	146.95 ± 23.91	140.42 ± 32.75	148.72 ± 25.65	140.88 ± 21.57	145.89 ± 52.14	142.14 ± 31.92	139.83 ± 18.56
DBP (mmHg)	73.70 ± 11.20	71.46 ± 10.14	73.06 ± 11.58	74.45 ± 9.82	73.77 ± 11.25	72.44 ± 10.60	73.58 ± 11.70	72.99 ± 8.31	73.82 ± 10.85	72.31 ± 11.88	73.58 ± 11.09	69.78 ± 11.37
<b>Physical function</b>												
IADL dependency	21 [11.5]	13 [65.0]**	12 [8.4]	22 [36.7]**	12 [7.7]	22 [45.8]**	25 [15.4]	9 [22.0]	19 [12.3]	15 [30.6]**	34 [17.3]	0 [0.0]
Fall	28 [15.1]	5 [25.0]	20 [13.8]	13 [21.7]	21 [13.4]	12 [25.0]	30 [18.4]	3 [7.1]	23 [14.7]	10 [20.4]	32 [16.1]	1 [16.7]
Walking speed (m/s)	0.62 ± 0.22	0.37 ± 0.14**	0.65 ± 0.21	0.47 ± 0.20**	0.63 ± 0.22	0.51 ± 0.21**	0.62 ± 0.22	0.51 ± 0.21**	0.62 ± 0.22	0.53 ± 0.20*	0.60 ± 0.22	0.73 ± 0.28
Grip strength (kg)	28.00 ± 8.33	23.73 ± 4.69**	27.90 ± 8.54	26.68 ± 6.98	28.82 ± 8.28	23.36 ± 5.92**	27.69 ± 8.26	26.97 ± 7.60	27.68 ± 8.10	27.09 ± 8.23	27.62 ± 8.18	24.92 ± 5.63
Data are expressed as mean (standard deviation) or <i>n</i> (%). Compared with 'no' group. * <i>p</i> < 0.05, ** <i>p</i> < 0.01. COPD, chronic obstructive pulmonary disease; DBP, diastolic blood pressure; HT, hypertension; IADL, instrumental activities of daily living; SBP, systolic blood pressure.												

England demonstrated single self-reported items were significant predictors of adverse outcomes; furthermore, the combination of five self-reported items was shown to provide a better risk stratification for adverse outcomes than performed FP.<sup>19</sup> Another study in the Netherlands showed a kappa value of 0.55 between performed FP and self-reported questionnaires,<sup>20</sup> which was similar to our findings (kappa value = 0.431). However, the self-reported questionnaires in the above two studies differed from what was used in the present study.

This study showed that the FSQ is feasible for use with Chinese older adults. To our knowledge, the FSQ is the only assessment tool designed for screening frailty in a Chinese population. The FRAIL questionnaire has been validated in multiple populations to predict mortality;<sup>21,22</sup> however, a problem in applying the FRAIL scale in a Chinese population, such as in the Beijing Longitudinal Study of Aging, is that the proportion of people who report five or more chronic diseases is often less than 4%. For example, we reported that the prevalence of hypertension in Beijing in 2004 was 59.8%, but the awareness rate was only 55.8%.<sup>23</sup> The situation is similar with other chronic diseases, which indicates FRAIL may underestimate the prevalence of frailty in China. Further studies on the comparison of the FSQ and FRAIL on the prevalence of frailty in Chinese populations are warranted.

### Conclusions and implications

In summary, the FSQ is a potentially useful, reliable and valid instrument for screening frailty in older adults and can be recommended to identify frailty in clinical settings. As we have stressed in our two-step method for frailty assessment and management,<sup>10</sup> further research on translation of the FSQ into subspecialized clinical work, as well as on the inconsistency between self-reported and performed frailty components, should be considered.

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### Conflict of interest statement

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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