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ORIGINAL RESEARCH

NOVEL FRAILTY SCREENING QUESTIONNAIRE (FSQ) PREDICTS 8-YEAR MORTALITY IN OLDER ADULTS IN CHINA

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Abstract: *Background:* Although frailty status greatly impacts health care in countries with rapidly aging populations, little is known about the frailty status in Chinese older adults. *Objectives:* Given the increased health care needs associated with frailty, we sought to develop an easily applied self-report screening tool based on four of the syndromic frailty components and sought to validate it in a population of older adults in China. *Design:* Prospective epidemiological cohort study. *Setting:* Community-dwelling residents living in Beijing, China. *Participants:* 1724 community-dwelling adults aged ≥60 years in 2004 with an 8-year follow up. *Measurements:* We developed a simple self-report frailty screening tool—the Frailty Screening Questionnaire (FSQ)—based on the modified Fried frailty components. The predictive ability for outcome was assessed by age and sex adjusted Cox proportional hazards model. *Results:* According to FSQ criteria, 7.1% of the participants were frail. Frailty was associated with poor physical function, fractures, falls, and mortality. Both frailty and pre-frailty were associated with a higher mortality rate: frailty—hazards ratio (HR), 3.94, 95% confidence interval (CI), 3.16–4.92, P<0.001; pre-frailty—HR, 1.89; 95% CI, 1.57–2.27, P <0.001; adjusted models for this variable did not affect the estimates of the association. Among the four frailty components, slowness was the strongest predictor of mortality. The combination of the four components provided the best risk prediction. *Conclusions:* FSQ is a self-report frailty measurement tool that can be rapidly performed to identify older adults with higher risk of adverse health outcomes.

Key words: Frailty, physical function, mortality.

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Introduction

One of the most commonly recognized risk states for adverse outcomes in older adults is frailty. Quality frailty measurement should be able to identify frailty and those frail older adults that might respond to treatment, predict adverse outcomes, and ideally be able to identify those with a common biological underpinning (1). Frailty is most often defined as a geriatric syndrome, resulting from a cumulative decrease in multiple physiological systems and consequent reduction in physical reserve and defense ability (2, 3). It is often accompanied by increased vulnerability to adverse outcomes including falls, disability, and mortality (2). The most common definition of frailty was proposed by Fried, who considered the clinical phenotype of frailty as a well-defined syndrome with biological underpinnings (3). The Fried frailty detection identifies frailty by evaluating symptoms and signs associated with biological aging, including shrinking, exhaustion, weakness, slowness, and low levels of activity (3). Other main frailty concepts are often measured by cumulative comorbidities or "deficits" (4). The deficit model assesses accumulated declines in multiple domains with regard to diseases, and physical, psychological, and social functions, and comprehensively captures comorbidity and disability.

Although the original Fried's physical frailty phenotype scale remains the most validated and utilized method, self-report information on Fried components also showed good predictive ability (5, 6). Hence, a self-report frailty detection tool may provide an alternative method for rapidly screening large populations of frail adults. Although dozens of other measurement tools for frailty have been reported, frailty detection methods are recommended to be matched to a particular need or environment to be most effective (7).

When attempting to identify frailty detection methods applicable to Chinese older adults, it is evident that available screening tools present two major limitations. First, most are time-consuming and are difficult to apply in busy medical practices with large populations. Second, no tool to date has been developed specific for Chinese elders. Given the large number of older outpatients in Chinese health care settings, the use of a standardized subjective evaluation of frailty would likely be readily accepted and adopted by busy clinicians. To address the current lack of an easy-to-use, valid, reliable screening measure of physical frailty consistent with original conceptual and biological model, we developed and validated a simple frailty pre-screening tool for outpatient settings—the

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Table 1
Demographic characteristics of the frailty status defined by FSQ

	Total	Robust, n (%)	Prefrail, n (%)	Weighted (%)	Frail, n (%)	Weighted (%)
All sample	1724	970(56.3)	560(32.5)	29.5	194(11.3)	7.1
Sex**						
Male	836	537(64.2)	238(28.5)	24.3	61(7.3)	4.6
Female	888	433(48.8)	322(36.3)	34.2	133(15.0)	9.4
Living area**						
Urban	804	574(71.4)	181(22.5)	17.8	49(6.1)	3.3
Rural	920	396(43.0)	379(41.2)	39.5	145(15.8)	10.2
Age (ys) **						
60-69	470	333(70.9)	120(25.5)	27.5	17(3.6)	3.7
70-79	857	496(57.9)	284(33.1)	30.5	77 (9.0)	8.5
≥80	397	141(35.5)	156(39.3)	38.5	100(25.2)	24.8
Occupation**						
White-collar	430	319(74.2)	92(21.4)	17.4	19(4.4)	2.6
Light physical labor	544	317(58.3)	161(29.6)	24.2	66(12.1)	7.7
Heavy physical labor	744	333(44.8)	305(41.0)	40.3	106(14.2)	9.2
Education**						
Illiterate	740	321(43.4)	282(38.1)	35.8	137(18.5)	13.4
Elementary school	452	242(53.5)	171(37.8)	36.8	39(8.6)	7.0
Middle school	202	145(71.8)	47(23.3)	26.3	10(5.0)	3.1
High school and above	330	262(79.4)	60(18.2)	14.0	8(2.4)	1.3
Monthly income ($)**						
<90	868	360(41.5)	361(41.6)	41.0	147(16.9)	11.3
90-180	409	263(64.3)	117(28.6)	23.7	29 (7.1)	4.7
>180	447	347(77.6)	82(18.3)	14.7	18(4.0)	2.1
Marital status**						
Married	1163	708(60.9)	364(31.3)	28.8	91 (7.8)	5.4
Not married	561	262(46.7)	196(34.9)	31.6	103(18.4)	12.5
Health satisfaction**						
Well	792	520(65.7)	229(28.9)	25.7	43(5.4)	2.6
Bad	932	450(48.3)	331(35.5)	33.4	151(16.2)	11.9
Life satisfaction**						
Well	1672	958(57.3)	538(32.2)	28.9	176(10.5)	6.6
Bad	37	5(13.5)	19(51.4)	62.5	13(35.1)	29.2
Smoke						
Yes	617	341(55.3)	208(33.7)	29.8	68(11.0)	6.8
No	1107	629(56.8)	352(31.8)	29.0	126(11.4)	7.4

**P<0.01.

Phenotypic Frailty Screening Questionnaire (FSQ).

Methods

Participants

Data were from the Beijing Longitudinal Study of Aging, a longitudinal study funded by the United Nations Population Fund (UNPFA CPR/90/P23) in 1992 (8). A cross-sectional survey comprising 1865 adults aged ≥60 years was conducted based on sample data from the fourth census of Beijing in 2004. Well-established statistical sampling techniques, which included clustering, stratification, and random selection were applied. Details of the sampling scheme were described elsewhere (9, 10). 1724 participants completed the frailty assessment. Data were collected on the following aspects: socioeconomic and demographic characteristics, physical health (self-report history of chronic disease and clinical syndromes), physical function, life behavior and social function, neuropsychological health, and medical condition. The definitions of cognitive impairment and depression appear in our previous publication (11). The mortality data for all subjects were collected every year until the end of December 2012. Mortality ascertainment was 100% complete. Instances of death were confirmed by family members or neighborhood or village committees. This study was approved by the ethics review board of Xuanwu Hospital, Capital Medical University and all the participants provided informed consent.

FSQ assessment

The FSQ scale was developed to represent four of five components of the Fried criteria: slowness, weakness, inactivity, and exhaustion (Table S1). Slowness received a score of 1 if participants had difficulty walking 250 meters. Weakness received a score of 1 if participants had difficulty in lifting or carrying something weighing 5 kilograms. Exhaustion received a score of 1 for participants who responded yes to either "Everything I did was an effort" or "I could not get going" in the past week. Inactivity was measured by asking participants how many hours they had spent on weekly exercise; subjects who responded <3 hours/week scored 1 point. The FSQ total score is 0–4. A score of 0 was considered robust; 1–2 was considered pre-frail; and a score of ≥3 indicated frailty.

Physical function

We assessed physical function by means of the balance test, chair-stand test, activities of daily living (ADL), and instrumental activities of daily living (IADL) as well as in terms of fractures and falls.

Statistical methods

Statistical analyses were performed by SPSS 11.5 (SPSS, Inc., Chicago, IL, USA). Chi-square tests were conducted for discrete variables, and analysis of variance and Student t tests were used to compare means of the groups for continuous variables with Tukey post hoc tests. We evaluated survival using Kaplan-Meier curves stratified for different sex and age-groups. A Cox proportional hazards model was used to evaluate the effect of covariates (age, sex, and frailty) on mortality after testing for the proportionality assumption. We considered $P < 0.05$ statistically significant.

Results

Using the FSQ in the Beijing Longitudinal Study of Aging population, 194 participants were identified as frail and the prevalence was 11.3% (weighted, 7.1%). The prevalence of pre-frailty was 32.5% (weighted, 29.5%). Frailty was associated with female gender, rural residency, older age, and lower socioeconomic status. Higher prevalence of frailty was observed among participants who were not married, those with a history of heavy physical labor occupation, and those with poor health or life satisfaction (Table 1). For both men and women, the prevalence of frailty increased with age and was higher among rural residents (Table S2). Frailty was more common in subjects with chronic diseases (Table S3).

The prevalence of frailty components according to the FSQ included slowness, 15.3%; weakness, 19.0%; inactivity, 23.0%; and exhaustion, 21.9%. The prevalence of 0, one, two, three, and four components was 56.3%, 22.9%, 9.6%, 7.9%, and 3.4%, respectively. The prevalence of the four components was higher among women than among men (Table S4).

Compared with robust subjects, frail and pre-frail status was associated with poor balance and chair-stand performance, ADL dependency, IADL dependency, fracture and falls, even after adjustment for sex (but not fractures in male) (Table 2). Among both men and women, being frail or pre-frail was associated with 8-year mortality. The four components showed a higher mortality rate in the overall, female, and male samples (Table S5). Frailty and each of the four components were associated with mortality in every age-group (except inactivity in 60-69 years group and exhaustion in ≥ 80 years group) (Table S6). Figures S1, S2 and S3 present Kaplan-Meier curves for the proportional survival of participants with different frail statuses in the different age- and sex groups. The unadjusted associations were significant for the predictive association of frailty and pre-frailty with mortality; after adjusting for age and sex, the 8-year mortality hazard ratio was 2.131–3.444 and 1.318–1.972, respectively, for frailty and pre-frailty. Each component could predict mortality—even after adjusting for age and sex. Slowness was the strongest predictor and exhaustion the weakest predictor. Combined, the four components offered best risk prediction for mortality than the single component (Table 3; Figure S4).

Discussion

The FSQ is an easy to use self-report tool developed in a Chinese population. It was loosely derived from the phenotypic

Table 2
Characteristics of physical functions in different sex according to the FSQ

	Robust, n (%)	Prefrail, n (%)	Frail, n (%)	X2	P
Balance test failure					
Total	78(8.8)	73(18.6)	14(32.6)	40.394	<0.001
Male	36(7.2)	22(13.3)	6(42.9)	24.256	<0.001
Female	42(10.9)	51(22.4)	8(27.6)	17.642	<0.001
Chair stand test failure					
Total	96(10.0)	156(28.5)	140(76.9)	398.919	<0.001
Male	45(8.4)	61(26.2)	45(78.9)	184.169	<0.001
Female	51(11.8)	95(30.2)	95(76.0)	200.878	<0.001
ADL dependency					
Total	14(1.4)	43(7.7)	103(53.1)	514.765	<0.001
Male	8(1.5)	24(10.1)	40(65.6)	286.733	<0.001
Female	6(1.4)	19(5.9)	63(47.4)	250.068	<0.001
IADL dependency					
Total	160(16.5)	315(56.6)	193(100.0)	580.738	<0.001
Male	77(14.3)	126(53.4)	60(100.0)	255.857	<0.001
Female	83(19.2)	189(58.9)	133(100.0)	302.616	<0.001
Fracture [a]					
Total	41(4.2)	26(4.6)	17(8.8)	7.271	0.026
Male	13(2.4)	11(4.6)	2(3.3)	2.496	0.287
Female	28(6.5)	15(4.7)	15(11.3)	6.762	0.034
Fall [b]					
Total	68(7.0)	83(15.0)	53(27.5)	71.401	<0.001
Male	27(5.0)	28(11.9)	12(20.0)	22.858	<0.001
Female	41(9.5)	55(17.2	41(30.8)	36.351	<0.001

a: have a fracture in last two years. b: fall twice in the last year; Abbreviations: ADL, activities of daily living; IADL, instrumental activities of daily living.

Table 3
Predictive models of mortality at 8-year follow-up

	Model 1			Model 2		
	HR	95% CI	P	HR	95% CI	P
Frailty						
Prefrail	1.889	1.570-2.273	<0.001	1.631	1.348-1.972	<0.001
Frail	3.943	3.161-4.917	<0.001	2.709	2.131-3.444	<0.001
Components						
Slowness	3.214	2.683-3.849	<0.001	2.262	1.863-2.747	<0.001
Weakness	2.727	2.290-3.247	<0.001	1.893	1.561-2.296	<0.001
Inactivity	1.973	1.659-2.345	<0.001	1.623	1.358-1.939	<0.001
Exhaustion	1.655	1.383-1.980	<0.001	1.435	1.197-1.721	<0.001

Reference: Robust. Model 1: Unadjusted Cox proportional hazard analysis. Model 2: Adjusted Cox proportional hazard analysis. Adjusted for age and sex. Abbreviations: HR, hazard ratio; CI, confidence interval.

frailty detection method. This was developed in part because of the need for quick pre-screening tool for frailty in busy Chinese outpatient practices where up to 10 patients an hour may be seen. This study found the weighted prevalence of frailty based on the FSQ to be 7.1%. This is similar to the prevalence of frailty as measured using the Fried phenotype criteria in China (7.0%) (12). Most data on the prevalence of frailty in the Chinese population have been based on frailty index conceptual model. We previously reported the prevalence of frailty based on frailty index to be 8.8% in the China Comprehensive Geriatric Assessment Study and 9.1% in the Beijing Longitudinal Study of Aging II (13, 14). In this study, the prevalence of frailty based on the FSQ was found to be higher in women and increased with advancing age, consistence with previous studies (3, 13, 15–17). One meta-analysis confirmed the pattern of sex differences in frailty and mortality to be a "male-female health-survival paradox" (18).

We found that slowness was the highest predictor among the four components. This result constitutes a response to the question as to which component of the phenotype model is more informative with regard to frailty assessment. Another investigation found gait speed to be the best indicator of frailty and that the combination of gait speed and physical activity was the most informative among the Fried components (19). Several studies have determined gait speed to be the preeminent frailty screening tool (20–22). Gait speed is a simple, acceptable measurement that can be easily performed in a routine clinic. The present investigation provides evidence that among the four components, self-report slowness is also the most important indicator for mortality in older subjects.

We compared the new tool with other instruments reported in the literature in terms of the following five aspects: population; frailty components; ease of application; primary use; and validity (Table S7). Among the eleven self-report instruments in the comparison, the FSQ was one of only two tools which were based on physical frailty and showed validity in outcome prediction in a large population.

The present study's strengths include the large sample and completeness of the long-term follow-up. The Beijing Longitudinal Study of Aging is based on a large population-based cohort using clustering, stratification, and random-selection sampling techniques; thus, it can be taken to be representative of older Chinese people (8). Moreover, in the 8-year follow-up, mortality ascertainment was 100% complete. The present study also addressed the question as to which component of the phenotype model was more important. As shown in Table S7, the FSQ is quick to use by non-specific staff, and it is available from routinely comprehensive geriatric assessment data. Last and the most important, this study shows that the FSQ is feasible for a Chinese population. To the best of our knowledge, the FSQ tool is the only assessment tool based on the frailty phenotype designed for screening frailty in a Chinese population.

Our study also has several limitations. One of the main limitations is the lack of objective measurements. Hence, we were unable to evaluate the five-item Fried Phenotype in comparative analyses. Future studies on validation of FSQ with measured Fried phenotype should be conducted. Second, we did not take into account potential changes in frailty status between visits. A scoring system is needed to capture the dynamic nature of frailty so that it can be used as an outcome and intervention measurement (23). Third, we demonstrated that the four self-report Fried frailty components do not play the same role in predicting mortality, and the total level of frailty is not equivalent to the sum of those components. Future studies should weigh those components, characterize the trajectories of frailty, and examine cross-cultural validation.

Conclusions

FSQ is a useful quick and feasible self-report frailty tool that has been demonstrated to predict mortality in Chinese old adults. To our knowledge, this study is the first to report the prevalence of frailty and long-term prognosis using a self-report version of the Fried phenotype in a large longitudinal Chinese population. The FSQ was gathered using information provide by participants; it is associated with physical function, chronic disease, fracture, falls, and mortality, and it shows a good agreement with prior studies in China using Fried phenotype. The results of this study may ease frailty screening in older Chinese population by offering a very simple way to identify frailty and related risk of mortality in older adults. This in turn may facilitate targeted comprehensive geriatric assessment for the frail subset of patients as has previously been recommended in the United Kingdom (24). In addition, it may facilitate the development of novel interventions to better manage frailty and slow declines in health status.

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