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Comparison of the effectiveness of Fried's frailty phenotype and the FRAIL scale in assessing pre-frailty among community-dwelling older adults undergoing health examinations ☆

Pang Shu[a], Sun Ying[b], Jiang Chunyan[a,*]

[a] Department of General Practice, Beijing Friendship Hospital, Capital Medical University, Beijing 100050, China
[b] Health Care Center, Beijing Friendship Hospital, Capital Medical University, Beijing 100050, China

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ABSTRACT

Background: Pre-frailty represents a transitional risk status between health and frailty. Early identification and intervention during this stage can delay or even reverse the frailty development. However, there is a lack of standardized pre-frailty assessment tool tailored for community-dwelling older adults.

Objective: To compare the effectiveness of Fried's Frailty Phenotype (FP) and the FRAIL scale in assessing pre-frailty among community-dwelling older adults undergoing health examinations, thereby providing evidence for the selection of appropriate assessment tools.

Methods: A cross-sectional study was conducted using convenience sampling to recruit older adults aged 60 years and above undergoing health examinations at five community health centres in Beijing from December 1, 2024, to March 20, 2025. Demographic data were collected, and frailty status was assessed using the FP and the FRAIL scale. Activities of daily living (ADL) were evaluated using the Modified Barthel Index (MBI), and quality of life was assessed using the 36-Item Short Form Survey (SF-36). Spearman rank correlation and Kappa statistics were used to analyze the consistency and correlation between the two scales. Using MBI and SF-36 scores as validity criteria, the validity of both tools was evaluated via Spearman rank correlation, Receiver Operating Characteristic (ROC) curve analysis, and Bayes discriminant analysis.

Results: The prevalence of pre-frailty detected by the FP was higher than that by the FRAIL scale (36.3 % vs. 25.3 %). The two scales showed a moderate positive correlation ($r = 0.713$, $P < 0.001$) and moderate agreement ($Kappa = 0.606$, $P < 0.001$), with consistent classification in 81.2 % of participants. Frailty severity assessed by both scales was positively correlated with ADL decline and negatively correlated with SF-36 total, Physical Component Summary(PCS), and Mental Component Summary (MCS) scores. Both scales demonstrated associations with ADL decline, with ROC curve areas under the curve (AUC) of 0.736 and 0.735, respectively ($P < 0.001$). Bayes discriminant analysis indicated that the cross-validation accuracy for ADL decline was higher for the FP (86.3 %) than the FRAIL scale (85.1 %). ROC analysis revealed that the FP had higher sensitivity (74.0 % vs. 64.4 %), while the FRAIL scale had superior specificity (80.1 % vs. 65.8 %) for predicting ADL decline. The optimal cutoff value for both scales in predicting ADL decline was 0.5.

Conclusion: The FP and FRAIL scale demonstrate moderate correlation and consistency, and both are negatively associated with quality of life. Both tools possess moderate validity in verifying ADL decline and are suitable for assessing pre-frailty in community-dwelling older adults. The FP, with its higher sensitivity and inclusion of objective indicators, is more suitable for pre-frailty screening in health examination settings aiming for "early detection and intervention." Conversely, the FRAIL scale, due to its simplicity and high specificity, serves as a viable alternative for rapidly identifying high-risk individuals in resource-limited settings. These findings suggest practical value in integrating frailty screening into routine community health examinations and initiating interventions based on a 0.5 cutoff value.

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* Corresponding author.
E-mail address: jchy12368@sina.com (J. Chunyan).

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Frailty, a common geriatric syndrome, is characterized by a diminished capacity to maintain homeostasis in response to stressors, leading to increased risk of adverse outcomes such as falls, cognitive impairment, and disability.[1] Pre-frailty, also known as intermediate frailty, represents a transitional risk state between health and frailty, encompassing physical, social, cognitive, and nutritional dimensions.[2] The prevalence of pre-frailty among community-dwelling older adults ranges from 26.8 % to 62.8 % in China.[3] Pre-frail significantly increases healthcare resource cost among older adults[4]; medical costs for pre-frail individuals increased by 79 - 13,423.83 dollars compared with the robust group.[5] Early screening and identification of pre-frailty, followed by timely intervention, can delay or even reverse the progression to frailty. This approach can also reduce healthcare expenditures and enhance healthy aging.[2,6] Furthermore, a 7-year follow-up by the Chinese Longitudinal Healthy Longevity Survey (CLHLS) identified pre-frailty as a critical window for intervention for mitigating mortality risk.[7] In recent years, geriatric experts advocated for routine frailty screening among community-dwelling older adults. Currently, health examinations in primary care facilities in China primarily focus on chronic disease management and routine physiological monitoring. However, systematic screening for pre-frailty has not yet been integrated into standard protocols, causing the miss of early intervention in older adults on the verge of frailty. Therefore, integrating pre-frailty screening into the primary health examination system is a crucial strategy for advancing "Healthy Aging" initiatives and optimizing the allocation of healthcare resources.

However, there is currently no standardized pre-frailty assessment tool tailored for older adults undergoing routine community health examinations. Tools that have been validated in Chinese for pre-frailty assessment primarily include Fried's Frailty Phenotype (FP), the Fatigue, Resistance, Ambulation, Illness, and Loss of Weight Index(FRAIL) scale,[8] Frailty Index(FI), the Study of Osteoporotic Fractures index (SOF), and the Survey of Health, Ageing and Retirement in Europe Frailty Instrument (SHARE-FI).[2] Among these, the FI is calculated as the ratio of present health deficits to the total number of deficits assessed[9]; however, it requires the evaluation of 30 to 70 items, making it time-consuming to administer.[10] The SOF index, which correlates with the frailty phenotype, comprises only three physical components: weight loss, inability to rise from a chair five times without using arms, and reduced energy levels.[11]

The SHARE-FI is a web-based screening tool consisting of five items: fatigue, appetite, handgrip strength, walking difficulty, and physical activity,[12] while its Chinese version has not yet been widely adopted in China. The FP and the FRAIL scale are currently the most widely used and simple tools and are recommended by the Expert Consensus on Frailty Assessment and Intervention for Elderly Patients (2017) in China, but there is a lack of consensus regarding their effectiveness and applicability for assessing pre-frailty among older adults. Previous studies demonstrated a strong correlation between frailty status, activities of daily living (ADL), and quality of life.[13] It's crucial to promote healthy aging by selecting an appropriate assessment tool to timely identify pre-frailty, predict ADL and quality of life, thereby implementing targeted interventions.[14] This study utilizes the FP and the FRAIL scale to assess community-dwelling older adults undergoing health examinations. We aim to investigate pre-frailty states in this population and compare the two tools in terms of their assessment effectiveness and the strength of their associations with ADL and quality of life, guiding the selection of optimal pre-frailty assessment tool in community health examination contexts.

Methods

Data source and participants

Using convenience sampling, this study recruited older adults aged 60 years and older who underwent routine health examinations at five community health centres in Beijing between December 1, 2024, and March 20, 2025. The study sites included Lucheng (Tongzhou District), Xuxinzhuang in Songzhuang Town (Tongzhou District), Taoranting (Xicheng District), Chunshu (Xicheng District), and Zuojiazhuang (Chaoyang District).

The inclusion criteria were as follows: (1) aged 60 years or older; (2) possessing sufficient consciousness, comprehension, and language capabilities to communicate effectively. The exclusion criteria were: (1) functional disability, defined as long-term dependence on caregivers for activities of daily living due to physical or cognitive impairment, or an inability to independently complete gait speed and handgrip strength tests; (2) unstable severe comorbidities, including cardiovascular, cerebrovascular, hepatic, renal, or hematological diseases, or malignant tumors; (3) severe psychiatric disorders requiring pharmacological control or severe cognitive impairment. This study was approved by the Bioethics Committee of Beijing Friendship Hospital, Capital Medical University (Approval No 2024-P2–458).

Data collection and procedures

Data were collected by trained clinicians through face-to-face interviews and standardized measurements. Prior to the interviews, all participating clinicians underwent rigorous training on the study protocol to ensure the standardization of technical procedures and measurements. The total assessment duration per participant ranged from 15 to 30 min. Specifically, the FP assessment required approximately 3–4 min (due to the inclusion of objective measures such as handgrip strength and gait speed, which necessitated instructional guidance and standardized operation), whereas the FRAIL scale required approximately 1–2 min. Upon completion of the survey, data were verified and entered by two independent researchers to ensure accuracy and completeness. The data collection included the following components.

Demographic characteristics

Data collected included gender, age, education level, marital status, Body Mass Index (BMI), smoking and alcohol consumption, number of chronic diseases (diagnosed by secondary or higher-level hospitals), and number of medications.

FP

The FP assesses frailty based on the following five physiological components:

(1) Weight Loss: Weight loss of >4.5 kg or >5 % of body weight in the past year without intentional dieting. (2) Slow Gait Speed: Time required to walk 4.57 m (15 feet). The cutoffs for gait speed are as follows: for men ≤173 cm, walking time should be ≥7 s; for men >173 cm, it should be ≥6 s; for women ≤159 cm, it should be ≥7 s; for women >159 cm, it should be ≥6 s. (3) Weak Handgrip Strength: Stratified by gender and BMI. For men: BMI ≤24.0 kg/m^2: ≤29 kg; BMI 24.1–26.0 kg/m^2: ≤30 kg; BMI 26.1–28.0 kg/m^2: ≤30 kg; BMI >28.0 kg/m^2: ≤32 kg. For women: BMI ≤23.0 kg/m^2: ≤17 kg; BMI 23.1–26.0 kg/m^2: ≤17.3 kg; BMI 26.1–29.0 kg/m^2: ≤18 kg; BMI >29.0 kg/m^2: ≤21 kg. (4) Low Physical Activity: <383 kcal/week for men (equivalent to 2.5 h of walking) and <270 kcal/week for women (equivalent to 2 h of walking). (5) Fatigue: Self-reported feeling that "everything was an effort" or "could not get going" for ≥3 days in the past week.[15]

FRAIL scale

The FRAIL scale comprises the following five items: (1) Fatigue: Have you felt tired most or all of the time in the past 4 weeks? (2) Resistance: Do you have difficulty climbing one flight of stairs without resting or aids? (3) Ambulation: Do you have difficulty walking 100 m without aids? (4) Illness: Do you have 5 or more illnesses? (Including hypertension, diabetes, acute heart attack, stroke, malignancy excluding minor skin cancer, congestive heart failure, asthma, arthritis, chronic lung disease, kidney disease, angina, etc.). (5)Loss of weight: Have you lost

≥6 kg in the past 6 months or ≥3 kg in the past month? Scoring: Each "Yes" response scores 1 point. A total score of 0 indicates non-frail, 1–2 indicates pre-frail, and ≥3 indicates frail.[16]

ADL

ADL was assessed using the Modified Barthel Index (MBI), which includes ten items: feeding, bathing, grooming, dressing, bowel control, bladder control, toileting, chair/bed transfer, walking on level ground, and stair climbing. The total score ranges from 0 to 100, classified as follows: 100 (fully independent), ≥60 (basically independent), 41–59 (partially dependent), 21–40 (severely dependent), and ≤20 (totally dependent).[17]

Quality of life assessment

Quality of life was evaluated using the 36-Item Short Form Health Survey (SF-36). As a generic instrument, the SF-36 is widely used in clinical research, health policy evaluation, and chronic disease management. It consists of 36 items covering eight dimensions: Physical Functioning (PF), Role-Physical (RP), Bodily Pain (BP), General Health (GH), Vitality (VT), Social Functioning (SF), Role-Emotional (RE), and Mental Health (MH). Raw scores for each dimension were converted to a 0–100 scale using the formula: Transformed Score = [(Actual Score - Lowest Possible Score) / (Highest Possible Score - Lowest Possible Score)]×100. The average scores of PF, RP, BP, and GH constitute the Physical Component Summary(PCS), while VT, SF, RE, and MH constitute the Mental Component Summary (MCS). The average of the transformed scores for the eight dimensions represents the total score. Higher scores indicate better health status and higher quality of life.[18]

Statistical analysis

Data analysis was performed using IBM SPSS Statistics 26.0. Categorical variables were expressed as frequencies and percentages and compared between groups using the Chi-square test. Continuous variables with a normal distribution were presented as mean±standard deviation (SD). Non-normally distributed continuous variables were presented as medians with interquartile ranges (IQR, P_{25}–P_{75}) and compared using the Mann-Whitney *U* test. Spearman's rank correlation analysis and Cohen's Kappa coefficient were employed to evaluate the correlation and agreement between the FP and FRAIL scales in assessing frailty status. Validity of the two assessment tools was assessed using Receiver Operating Characteristic (ROC) curve analysis and Bayes discriminant analysis. A *P*-value of <0.05 was considered statistically significant.

Results

Pre-frailty state of community-dwelling older adults

A total of 430 community-dwelling older adults undergoing health examinations were included in this study, comprising 314 females (73.0 %) and 116 males (27.0 %). The age of participants ranged from 60 to 90 years, with a median age (interquartile range, IQR) of 69 (65–73) years. Scores for the FP ranged from 0 to 4, with a median (IQR) of 0 (0–1). Similarly, scores for the FRAIL scale ranged from 0 to 4, with a median (IQR) of 0 (0–1). Based on the FP assessment, the prevalence rates of non-frailty, pre-frailty, and frailty were 59.1 % (254/430), 36.3 % (156/430), and 4.7 % (20/430), respectively. According to the FRAIL scale assessment, the prevalence rates were 72.6 % (312/430) for non-frailty, 25.3 % (109/430) for pre-frailty, and 2.1 % (9/430) for frailty. There was a statistically significant difference in the classification distributions between the two assessment tools (X^2 = 337.509, $P < 0.001$). Regarding the specific components of the FP, the frequencies from highest to lowest were: weak handgrip strength (97 cases, 22.6 %), exhaustion (95 cases, 22.1 %), weight loss (28 cases, 6.5 %), slow gait speed (23 cases, 5.3 %), and low physical activity (8 cases, 1.9 %). For the FRAIL scale, the component frequencies were: fatigue (95 cases, 22.1 %), weight loss (28 cases, 6.5 %), resistance (26 cases, 6.0 %), illness (9 cases, 2.1 %), and ambulation (7 cases, 1.6 %). Results from both the FP and FRAIL scale assessments indicated that, compared to the non-frail group, older adults in the pre-frail group had significantly higher age, BMI, number of medications, and number of chronic diseases ($P < 0.05$) (see Table 1).

Correlation and agreement between FP and FRAIL scales in assessing frailty

Spearman's rank correlation analysis revealed a moderate positive correlation between the FP and FRAIL scale scores (r = 0.713, $P < 0.001$). The two assessment tools demonstrated consistent frailty classification in 81.2 % of the participants (Table 2). The Kappa coefficient was 0.606 ($P < 0.001$), indicating moderate agreement. The severity of frailty assessed by both the FP and FRAIL scales was positively correlated with ADL decline and negatively correlated with the SF-36 total score, PCS, and MCS (see Table 3).

Quality of life among community-dwelling older adults and its association with pre-frailty

The median scores (interquartile range) for PF, RP, BP, GH, VT, SF, RE, MH, PCS, MCS, and total SF-36 scores among the study participants were 85 (70–91), 100 (50–100), 74 (62–100), 65 (51.5–82), 80 (65–95), 100 (88–100), 100 (33–100), 76 (60–84), 78 (60–89), 82 (65–93), and 79 (63–89), respectively. Participants identified as pre-frail by either the FP or FRAIL scale exhibited lower scores across all aforementioned dimensions compared to non-frail participants (Table 1).

Association of FP and FRAIL scales with ADL decline in community-dwelling older adults

In this study, 83.0 % (357/430) of the participants were fully independent in activities of daily living (MBI score = 100), while 17.0 % (73/430) exhibited a decline in ADL. Results from both the FP and FRAIL scale assessments indicated that the proportion of participants with ADL decline was significantly higher in the pre-frail group compared to the non-frail group ($P < 0.05$) (Table 1).

ROC curve analysis was performed using ADL decline as the outcome variable.

The results demonstrated that both the FP and FRAIL scales were significantly associated with ADL decline in community-dwelling older adults, with AUC values of 0.736 and 0.735, respectively ($P < 0.001$) (Table 4). Furthermore, Bayes discriminant analysis was conducted with ADL decline as the dependent variable (Y) and the FP and FRAIL scale results as independent variables. The analysis revealed that the cross-validation accuracy of the FP for predicting ADL decline was higher than that of the FRAIL scale (Table 5).

Discussion

Selecting an appropriate screening tool for pre-frailty among community-dwelling older adults is a prerequisite for the implementation of early interventions. This study compared the performance of the FP and the FRAIL scale in assessing pre-frailty among older adults undergoing community health examinations. The results indicated that both tools are rapid (completed within 5 min) and simple to administer, making them suitable for use in community health centres. The severity of frailty assessed by both scales demonstrated a negative correlation with the SF-36 total score, PCS score and MCS score. However, the prevalence of pre-frailty identified by the FP (36.3 %) was significantly higher than that identified by the FRAIL scale (25.3 %). Furthermore, regarding the prediction of ADL decline, the FP demonstrated higher cross-validation accuracy (86.3 % vs. 85.1 %) and sensitivity

Table 1
Comparison of general characteristics, quality of life and activities of daily living between non-frail and pre-frail older adults assessed by FP and FRAIL scale.

Variable	FP				FRAIL Scale			
	Non-frailty (n = 254)	Pre-frailty (n = 156)	*Z* (χ^2) *value*	*P* value	Non-frailty (n = 312)	Pre-frailty (n = 109)	*Z* (χ^2) *value*	*P* value
Age [M (P_{25}–P_{75}), years]	68(64–71)	70(65–75)	-3.725	<0.001	68(65–73)	70(65–75)	-2.134	0.033
Number of medications [M (P_{25}–P_{75})]	1(0–3)	3(1–4.5)	-5.291	<0.001	2(0–3)	3(2–5)	-5.415	<0.001
Number of chronic diseases [M (P_{25}–P_{75})]	1(0–2)	1(1–2)	-4.815	<0.001	1(0–2)	2(1–2)	-4.929	<0.001
BMI [M (P_{25}–P_{75}), kg/m^2]	24.3(22.4–26.3)	25.0(22.6–27.3)	-2.061	0.039	24.4(22.4–26.4)	25.1(23.0–27.7)	-2.327	0.020
Age category [n (%)]			11.921	<0.001[a]			5.665	0.017[a]
<75 years	219(86.2)	113(72.4)			259(83.0)	79(72.5)		
≥75 years	35(13.8)	43(27.6)			53(17.0)	30(27.5)		
Gender [n (%)]			7.469	0.006[a]			0.397	0.529[a]
Male	58(22.8)	55(35.3)			87(27.9)	27(24.8)		
Female	196(77.2)	101(64.7)			225(72.1)	82(75.2)		
Education level [n (%)]			0.718	0.869[a]			7.325	0.062[a]
Illiterate	4(1.6)	3(1.9)			7(2.2)	0(0.0)		
Primary school	8(3.1)	7(4.5)			11(3.5)	9(8.3)		
Middle school	180(70.9)	106(67.9)			221(70.8)	70(64.2)		
College or higher	62(24.4)	40(25.6)			73(23.4)	30(27.5)		
Marital status [n (%)]			2.037	0.153[a]				
Married	210(82.7)	120(76.9)			252(80.8)	86(78.9)	0.178	0.673[a]
Unmarried/Divorced/Widowed	44(17.3)	36(23.1)			60(19.2)	23(21.1)		
Smoking[n (%)]			2.245	0.134[a]			0.381	0.537[a]
Current/Former smoker	39(15.4)	33(21.2)			52(16.7)	21(19.3)		
Non-smoker	215(84.6)	123(78.8)			260(83.3)	88(80.7)		
Alcohol consumption [n (%)]			0.307	0.579[a]			0.090	0.765[a]
Current/Former drinker	59(23.2)	40(25.6)			76(24.4)	25(22.9)		
Non-drinker	195(76.8)	116(74.4)			236(75.6)	84(77.1)		
ADL[n(%)]			21.607	<0.001[a]			44.102	<0.001[a]
Normal	235(92.5)	119(76.3)			286(91.7)	71(65.1)		
Decline	19(7.5)	37(23.7)			26(8.3)	38(34.9)		
SF-36								
PF[M(P_{25}-P_{75})]	88(75–95)	75(60–90)	-5.609	<0.001	88(75–95)	70(55–85)	-7.360	<0.001
RP[M(P_{25}-P_{75})]	100(75–100)	75(0–100)	-7.682	<0.001	100(75–100)	25(0–100)	-8.234	<0.001
BP[M(P_{25}-P_{75})]	84(72–100)	72(52–84)	-6.262	<0.001	84(72–100)	62(51–74)	-8.294	<0.001
GH[M(P_{25}-P_{75})]	75(60–92)	56(45–72)	-7.309	<0.001	74(57–92)	51(40–62)	-9.352	<0.001
VT[M(P_{25}-P_{75})]	85(70–95)	70(60–85)	-7.211	<0.001	85(70–95)	65(50–75)	-9.552	<0.001
SF[M(P_{25}-P_{75})]	100(88–100)	88(75–100)	-6.229	<0.001	100(87.5–100)	88(75–100)	-7.201	<0.001
RE[M(P_{25}-P_{75})]	100(67–100)	67(33–100)	-5.924	<0.001	100(67–100)	33(0–67)	-9.316	<0.001
MH[M(P_{25}-P_{75})]	80(64–88)	72(56–80)	-4.983	<0.001	80(68–88)	64(52–74)	-7.059	<0.001
PCS[M(P_{25}-P_{75})]	83.625(74–92)	65(47–80)	-8.508	<0.001	83(72–92)	55(41–72)	-10.127	<0.001
MCS[M(P_{25}-P_{75})]	88(77–95)	73(56–86)	-7.417	<0.001	87(76–95)	60(52–75)	-10.183	<0.001
Total SF-36 score [M (P_{25}–P_{75})]	86(76–93)	69(53–82)	-8.569	<0.001	86(75–92)	58(46–73)	-10.666	<0.001

[a] indicates chi-square test for categorical variables.

Table 2
Agreement between FP and FRAIL scale in assessing frailty status among community-dwelling older adults.

FP	FRAIL Scale			Total
	Robust	Pre-frail	Frail	
Robust	249	5	0	254
Pre-frail	63	92	1	156
Frail	0	12	8	20

Table 3
Correlations between FP and FRAIL scale with ADL and SF-36.

	FP		FRAIL Scale	
	r	*P*	*r*	*P*
ADL decline	0.355	<0.001	0.394	<0.001
SF-36 Total Score	-0.492	<0.001	-0.549	<0.001
PCS	-0.491	<0.001	-0.526	<0.001
MCS	-0.436	<0.001	-0.521	<0.001

(74.0 % vs. 64.4 %), whereas the FRAIL scale exhibited superior specificity (80.1 % vs. 65.8 %). These findings provide critical evidence to guide the selection of pre-frailty screening tools in community health centres. The prevalence of pre-frailty, as assessed by the FP and FRAIL scales, was 36.3 % and 25.3 %, respectively. These rates are lower than those reported in studies conducted in Chongqing (41.5 %),[19] Chengdu (45.4 %),[20] Tianjin (42.9 %),[21] and Taiyuan (45 %),[22] but align closely with findings from Beijing (39.7 % and 34.4 %).[23] Furthermore, meta-analyses have reported a pooled prevalence of pre-frailty of 31.7 % in the Asia-Pacific region,[24] 38 % in the United Kingdom,[25] and 41.0 %

Table 4
Predictive efficacy of FP and FRAIL scale for decline in ADL among community-dwelling older adults.

Assessment Tool	AUC	*P*	95 % Confidence Interval	Sensitivity	Specificity	Youden Index	Optimal Cutoff
FP	0.736	<0.001	(0.668, 0.803)	0.74	0.658	0.398	0.5
FRAIL Scale	0.735	<0.001	(0.665, 0.805)	0.644	0.801	0.445	0.5

Table 5
Bayesian discriminant analysis for ADL decline prediction using FP and FRAIL scale.

Assessment Tool	Discrimination Function	Accuracy Rate (%)
FP	Y=3.379X-3.417	86.3
FRAIL Scale	Y=3.734X-3.206	85.1

in the United States.[26] Prevalence rates of frailty and pre-frailty vary significantly depending on the assessment tools used and the study settings.[27]

In the current study, 72.4 % of participants were aged under 75 years, representing a relatively younger cohort, which may account for the lower observed prevalence of pre-frailty. Additionally, the study did not employ household surveys, homebound older adults who typically exhibit a higher likelihood of pre-frailty could not be assessed. Our results indicate that, compared to non-frail individuals, those with pre-frailty were older and had higher BMI, a higher number of medications, and a greater burden of chronic diseases. These findings are consistent with established literature,[28] suggesting that the progression of frailty is influenced by these factors, which provides valuable reference points for the development of targeted interventions.

In the present study, the prevalence of pre-frailty among community-dwelling older adults was higher when assessed using the FP compared to the FRAIL scale. The results from the two assessment tools demonstrated a moderate positive correlation and moderate agreement, which is consistent with previous findings.[23,29,30] Notably, 63 participants (14.7 %) were classified as pre-frail by the FP but were identified as healthy by the FRAIL scale. Further analysis revealed that these individuals predominantly exhibited reduced grip strength or slow gait speed, despite a lack of obvious subjective symptoms. The FP incorporates two objective, quantifiable physiological indicators: decreased grip strength and slow gait speed. The two indicators enable the detection of functional decline that may not be perceived or reported by the participants. In contrast, the FRAIL scale relies more heavily on self-reported functional decline (e.g., climbing stairs, walking 100 m) and disease burden. Its accuracy may be compromised by cognitive bias, recall bias, or variations in the interpretation of "difficulty".[23,29] Therefore, the FP may be more sensitive in identifying early, objective physiological functional decline, which explains the higher detection rate of pre-frailty observed with this tool. This finding suggests that in community health screenings aimed at "early detection and early intervention," the FP may be more advantageous for identifying pre-frailty.

Frailty is characterized by a decline in reserve and function across multiple physiological systems. Individuals with frailty typically exhibit multi-system dysregulation, particularly manifested as slowness and muscle weakness, which increases susceptibility to adverse outcomes such as falls, fractures, functional decline, hospitalization, and mortality.[31] Consequently, screening tools for frailty should demonstrate strong predictive validity for adverse outcomes.[32,33] ADL is closely linked to the progression of frailty in older adults,[34] identifying screening tools that can detect pre-frailty while demonstrating a strong association with ADL decline is crucial. Such tools facilitate the identification of older adults who can benefit from interventions.

In this study, Bayes discriminant analysis revealed that the FP and the FRAIL scale demonstrated comparable cross-validation accuracy in predicting ADL decline (86.3 % vs. 85.1 %), indicating that both tools possess robust discriminative performance. Regarding the selection of tools for predicting ADL decline, the trade-off between the superior sensitivity of the FP(10 % higher) and the superior specificity of the FRAIL scale(10 % higher) represents the core consideration.[29,32] In clinical practice, if the primary screening objective is to minimize the omission of potential pre-frail individuals to seize the optimal window for intervention, the FP is the superior choice. Its higher sensitivity results in fewer "false negatives," thereby maximizing the coverage of early intervention programs. Conversely, in settings with limited resources, where it is necessary to precisely target high-risk populations for priority intervention and prevent resource dilution caused by "false positives," the FRAIL scale serves as a more cost-effective rapid screening tool due to its high specificity and minimal administration time. Therefore, clinicians should flexibly select these tools based on specific screening objectives and available resources. ROC curve analysis in the present study identified the optimal cutoff value for predicting ADL decline as 0.5 points for both tools, rather than the standard diagnostic threshold of 1 point used for pre-frailty.

This finding carries significant practical implications. It suggests that among older adults undergoing community health examinations, even the presence of minimal frailty indications (where a score of 0.5 represents a transitional state toward 1 point) is associated with a significantly increased risk of ADL decline. Consequently, the intervention point for community-based pre-frailty management should be advanced. Currently, both the FP and the FRAIL scale utilize an integer scoring system. Future research should focus on refining the scoring criteria for pre-frailty assessment tools and validating this optimal cutoff value. For individuals with an FP or FRAIL scale score of≥0.5, primary interventions like health education and exercise guidance may delay ADL decline. These findings provide evidence supporting the integration of frailty screening into routine community health examination and the optimization of intervention thresholds.

Regarding the association with quality of life, we found that frailty severity was negatively associated with SF-36 total scores as well as their physical and mental dimension scores. Furthermore, pre-frail older adults exhibited significantly lower scores across all dimensions on quality of life compared to healthy older adults, consisting with previous research.[14,35,36] These results indicate that both tools are capable of effectively identifying pre-frail populations at elevated risk of compromised quality of life. Consequently, both instruments demonstrate clinical utility for inferring quality of life in older adults based on frailty screening outcomes, with neither tool demonstrating absolute superiority.

In summary, both the FP and the FRAIL scale are effective tools for screening pre-frailty in community settings, though each possesses distinct clinical strengths. Based on the findings of this study, we propose the following recommendations: In community health examinations, the FP should be prioritized when the primary objective is to maximize screening sensitivity for the earliest possible detection of pre-frail individuals, provided that essential equipment such as grip strength dynamometers and timers is available. The objective indicator inherent to the FP minimize subjective bias, rendering it particularly suitable for the dynamic assessment of intervention efficacy. Conversely, in resource-constrained community settings where large-scale rapid screening is required, or when the priority is to utilize high specificity to target high-risk populations for focused resource allocation, the FRAIL scale represents a viable alternative. Furthermore, regardless of the scale selected, the clinical significance of the optimal cutoff value of "0.5" warrants attention. Consideration should be given to advancing the intervention threshold to this point to facilitate earlier management of the frailty trajectory.

This study is subject to several limitations. First, the sequential administration of the scales may introduce a potential order bias, thereby influencing the results. Second, the exclusion criteria, which omitted individuals with disabilities and complex health conditions, combined with the lack of home-based assessments for homebound older adults, may resulted in a selection bias favoring a relatively healthier cohort. Consequently, the generalizability of these findings to the broader population of community-dwelling older adults is limited. Future research should specifically evaluate the selection of pre-frailty screening tools for homebound older adults. Finally, the cross-sectional design precludes the assessment of long-term follow-up data and adverse outcomes such as disability, hospitalization, and mortality. Future prospective studies are warranted to compare the predictive validity of different pre-frailty assessment tools for these outcomes within the community setting.

Conclusion

Both the FP and the FRAIL scale are concise, easy to administer, and associated with quality of life and ADL. The two scales demonstrate moderate correlation and consistency, supporting their utility for the rapid screening of pre-frailty among older adults during community health examinations. However, the FP demonstrated superior cross-validation accuracy and sensitivity in predicting ADL decline compared to the FRAIL scale. Given its inclusion of quantifiable objective indicators(grip strength and gait speed), the FP is recommended as the preferred scale for pre-frailty screening in community-dwelling older adults, particularly in early screening requiring high sensitivity. Conversely, the FRAIL scale, characterized by its exceptional simplicity and high specificity, serves as an effective alternative for the rapid identification of high-risk individuals in resource-constrained settings. Furthermore, the identification of an optimal cutoff value of 0.5 suggests that the threshold for community-based pre-frailty intervention should be advanced, providing a novel perspective for optimizing frailty management pathways within routine community health examinations.

Declarations

Not applicable.

Authors' contributions

Conceptualization, P.S., S.Y. and J.C.; Methodology, Z.S.; Data curation, P.S.; Formal analysis, P.S.; Funding acquisition, not applicable; Project administration, not applicable; Resources, not applicable; Supervision, J.C.; Validation, J.C.; Writing—original draft, P.S.; Writing—review and editing, S.Y. and J.C.

All authors have read and agreed to the published version of the manuscript.

Ethical approval and consent to participate

The study received approval from Ethics Committee of Beijing Friendship Hospital, Capital Medical University (Approval No. 2024-P2-458).

Consent for publication

Not applicable.

Availability of data and materials

Not applicable.

Competing interests

All authors declare that there are no competing interests.

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