Comparison of the Effectiveness of the Fried Frailty Phenotype Scale and the FRAIL Scale in the Assessment of Pre-frailty among Community-dwelling Elderly during Physical Examinations: A Postprint

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Abstract

Background: Pre-frailty is a risk state between health and frailty. Early and effective identification and intervention of pre-frailty can delay or even reverse the progression of frailty. However, there is currently no unified pre-frailty assessment tool suitable for older adults undergoing community physical examinations. Objective: To compare the effectiveness of the Fried Frailty Phenotype (FP) scale and the FRAIL scale in assessing pre-frailty among older adults during community physical examinations, providing a reference for selecting pre-frailty assessment tools for the community-dwelling elderly. Methods: Using convenience sampling, older adults aged 60 and above who underwent health examinations at five community health service centers in Beijing from 2024-12-01 to 2025-03-20 were selected as research subjects. General data were collected, and frailty assessments were conducted using the FP and FRAIL scales, respectively. The Modified Barthel Index (MBI) was used to assess activities of daily living (ADL), and the Short Form-36 Health Survey (SF-36) was used to assess quality of life. Spearman rank correlation analysis and Kappa values were used to analyze the consistency and correlation between the FP and FRAIL scales in assessing frailty status. Using MBI and SF-36 scores as validity evaluation criteria, Spearman rank correlation analysis, Receiver Operating Characteristic (ROC) curves, and Bayes discriminant analysis were employed to evaluate the validity of the two assessment tools. Results: The prevalence of pre-frailty in older adults undergoing community physical examinations assessed by FP was higher than that by the FRAIL scale (36.3% vs. 25.3%); the results of frailty status assessment by FP and the FRAIL scale showed a moderate positive correlation (r_s=0.713, P<0.001). The assessment results of the two tools were consistent for 81.2% (349/430) of the participants, with a Kappa value of 0.606 (P<0.001),

indicating moderate consistency. The degree of frailty assessed by both FP and FRAIL scales was positively correlated with ADL decline (P<0.05) and negatively correlated with the total SF-36 score, PCS, and MCS (P<0.05). Both FP and FRAIL scales showed a certain strength of association with ADL decline in older adults, with areas under the ROC curve of 0.736 and 0.735, respectively (P<0.001). Bayes discriminant analysis showed that the cross-validation accuracy of FP for ADL decline was higher than that of the FRAIL scale (86.3% vs. 85.1%). ROC curve analysis showed that FP had higher sensitivity for ADL decline (74.0% vs. 64.4%), while the FRAIL scale had better specificity (80.1% vs. 65.8%); the optimal cutoff value for both in predicting ADL decline was 0.5. Conclusion: FP and the FRAIL scale are moderately correlated and consistent, both are negatively correlated with quality of life scores, and both show moderate validation capability for ADL decline in older adults undergoing community physical examinations. Both can be used for pre-frailty assessment in this population. Due to its higher sensitivity and inclusion of objective indicators, FP is more suitable for pre-frailty screening aimed at "early detection and early intervention" in the context of community physical examinations. Meanwhile, the FRAIL scale, with its simplicity and high specificity, can serve as an alternative tool for rapid identification of high-risk individuals in resource-limited settings. The results of this study suggest that integrating frailty screening into routine community physical examinations and initiating interventions based on a cutoff value of 0.5 is of practical significance.

Full Text

Preamble

Comparison of the Efficacy of the Fried Frailty Phenotype and the FRAIL Scale in Assessing Pre-frailty Among Community-Dwelling Elderly During Physical Examinations

Abstract

Objective: To compare the efficacy of the Fried Frailty Phenotype (FFP) and the FRAIL scale in identifying pre-frailty among community-dwelling elderly individuals during routine physical examinations, and to provide a scientific basis for the early screening and intervention of frailty in primary care settings.

Methods: A cross-sectional study was conducted involving elderly individuals undergoing physical examinations in community health service centers. Participants were assessed using both the FFP and the FRAIL scale. The consistency between the two tools was evaluated using the Kappa coefficient. Sensitivity, specificity, and the area under the receiver operating characteristic (ROC) curve were calculated to compare the diagnostic performance of the FRAIL scale against the FFP (the gold standard).

Results: A total of [N] participants were included in the study. The prevalence of pre-frailty identified by the FFP and the FRAIL scale was [X]% and [Y]%, respectively. The consistency analysis showed a moderate agreement between the two scales (Kappa = [Z]). Compared to the FFP, the FRAIL scale demonstrated a sensitivity of [S]% and a specificity of [P]% for detecting pre-frailty.

Conclusion: Both the FFP and the FRAIL scale are effective tools for screening pre-frailty in community-dwelling elderly. While the FFP remains the gold standard for clinical research, the FRAIL scale offers a more time-efficient and convenient alternative for rapid screening in busy primary care physical examination settings.

Introduction

As the global population ages, frailty has emerged as a significant public health challenge. Frailty is a clinical syndrome characterized by decreased physiological reserve and increased vulnerability to stressors, leading to adverse health outcomes such as falls, hospitalization, disability, and mortality. Pre-frailty represents an intermediate state between robustness and frailty, where physiological declines have begun but have not yet reached the threshold of clinical frailty. Crucially, pre-frailty is a reversible stage; timely identification and intervention can effectively delay or even reverse the progression to full frailty.

Currently, the Fried Frailty Phenotype (FFP) and the FRAIL scale are the two most widely utilized instruments for frailty screening. The FFP, proposed by Fried et al. in 2001, assesses five components:

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背景

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

Abstract

Background: Pre-frailty is a high-risk state between health and frailty. Early identification and effective intervention in the pre-frailty stage can delay or even reverse the progression of frailty. However, there is currently no unified assessment tool specifically validated for pre-frailty among community-dwelling older adults undergoing health examinations.

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

Methods: Using convenience sampling, older adults aged 60 and above who underwent health examinations at five community health service centers in Beijing from December 1, 2024, to March 20, 2025, were selected as research subjects. General data were collected, and frailty status was assessed using both the FP and FRAIL scales. 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 Health Survey (SF-36). Spearman rank correlation and Kappa values were used to analyze the consistency and correlation between the FP and FRAIL scales. Using MBI and SF-36 scores as validity criteria, the validity of the two assessment tools was analyzed through Spearman rank correlation, Receiver Operating Characteristic (ROC) curves, and Bayes discriminant analysis.

Results: The prevalence of pre-frailty identified by the FP was higher than that identified by the FRAIL scale (36.3% vs. 25.3%). There was a moderate positive correlation between the FP and FRAIL scale results ($r = 0.713, P < 0.001$). The two tools showed consistent assessment results for 81.2% (349/430) of the participants, with a Kappa value of 0.606 ($P < 0.001$), indicating moderate consistency. The degree of frailty assessed by both FP and FRAIL scales was positively correlated with ADL decline ($P < 0.05$) and negatively correlated with the total SF-36 score, Physical Component Summary (PCS), and Mental Component Summary (MCS) ($P < 0.05$). Both scales showed a significant association with ADL decline, with areas under the ROC curve (AUC) of 0.736 and 0.735, respectively ($P < 0.001$). Bayes discriminant analysis showed that the cross-validation accuracy of FP for predicting ADL decline was higher than that of the FRAIL scale (86.3% vs. 85.1%). ROC curve analysis further revealed that the FP had higher sensitivity (74.0% vs. 64.4%), while the FRAIL scale demonstrated superior specificity (80.1% vs. 65.8%). The optimal cutoff value for predicting ADL decline for both scales was 0.5.

Conclusion: The FP and FRAIL scales are moderately correlated and consistent. Both are negatively correlated with quality of life scores and possess moderate predictive validity for ADL decline in community-dwelling older adults. Both tools are suitable for pre-frailty assessment in this population. Due to its higher sensitivity and inclusion of objective indicators, the FP is more suitable for pre-frailty screening aimed at "early detection and early intervention" within the context of community health examinations. Conversely, the FRAIL scale, with its simplicity and high specificity, serves as an excellent alternative for rapidly identifying high-risk individuals in resource-limited settings. These findings suggest that integrating frailty screening into routine community health examinations and initiating interventions based on a cutoff value of 0.5 is of significant practical value.

Keywords: Frailty; Pre-frailty; Older adults; Fried Frailty Phenotype; FRAIL

scale; Community health services; General practitioners

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- PANG S, SUN Y, JIANG C Y. 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[J]. Chinese General Practice, 2026.[Epub ahead of print] Editorial Office of Chinese General Practice. This is an open access article under the CC BY-NC-ND 4.0 license.

Chinese General Practice https frailty assessment tool tailored for community-dwelling older adults.

Objective To compare the effectiveness of Fried' s Frailty Phenotype (FP) and 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 (=0.713, 0.001) and moderate agreement (Kappa =0.606, 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 (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.

Keywords: Frailty; Pre-frailty; Aged; Fried phenotype; FRAIL scale; Community health services; General practitioners. Frailty is one of the most common geriatric syndromes, characterized by a diminished capacity to maintain physiological homeostasis when faced with stressors, which in turn increases the risk of adverse outcomes such as falls, mental abnormalities, and disability. Pre-frailty (also referred to as marginal frailty) is a high-risk state between health and frailty, encompassing multiple dimensions including physical, social, cognitive, and nutritional factors. In China, the prevalence of pre-frailty among community-dwelling elderly ranges from 26.8% to 62.8%. The pre-frail state significantly increases the consumption of medical service resources; medical expenses for pre-frail elderly in the community are $79.00 to $13,423.83 higher than those of the healthy group. Early screening and identification of pre-frailty in the elderly, followed by timely intervention, can delay or even reverse the progression of frailty while reducing the expenditure of medical resources and significantly improving the health levels of the aging population [**?**, **?**]. Furthermore, a 7-year follow-up by the Chinese Longitudinal Healthy Longevity Survey (CLHLS) found that pre-frailty represents a critical intervention window for mortality risk. In recent years, geriatric experts worldwide have advocated for routine screening of frailty status among community-dwelling elderly. Currently, physical examination programs in China' s primary healthcare institutions focus mainly on chronic diseases and routine physiological monitoring. However, systematic screening for frailty—especially pre-frailty—has not yet been integrated into routine processes. This results in a large number of pre-frail elderly missing the window for early intervention. Therefore, integrating pre-frailty screening into the primary healthcare physical examination system is a key measure to respond to the "Healthy Aging" strategy and optimize the allocation of medical resources.

However, there is currently no unified assessment tool for pre-frailty suitable for elderly individuals undergoing community physical examinations. Currently, the localized Chinese versions of tools available for pre-frailty assessment primarily include Fried' s Frailty Phenotype (FP), the FRAIL scale (Fatigue, Resistance, Ambulation, Illness and Loss of Weight Index), the Frailty Index (FI), the Study of Osteoporotic Fractures (SOF) index, and shared frailty screening tools.

[**?**]. Among these, the FI is defined as the ratio of the number of existing health deficits to the total number of health deficits assessed.

The FI involves as many as 30 to 70 assessment items. The SOF index is related to the frailty phenotype but only includes items across three physiological dimensions: weight loss, inability to rise from a chair without armrests five times, and reduced energy levels. The shared frailty screening tool is an online screening instrument containing five items: fatigue, appetite, grip strength, walking, and physical activity. Although some scholars have localized and validated this tool, it has not been widely used in China. The FP and the FRAIL scale are currently the most commonly used and relatively simple pre-frailty assessment tools both domestically and internationally. Both have been recommended in the *Chinese Expert Consensus on the Assessment and Intervention of Frailty in Elderly Patients*. However, there is no consensus regarding their effectiveness and applicability for assessing pre-frailty in elderly individuals during community physical examinations. Previous studies have indicated that frailty status is closely related to activities of daily living (ADL) and quality of life. Selecting appropriate assessment tools to promptly identify the pre-frailty status of the elderly—and using this to infer ADL and quality of life for targeted interventions—is of great significance for improving the quality of life of the elderly and achieving healthy aging.

This study utilizes the FP and the FRAIL scale to assess elderly individuals undergoing community physical examinations to understand the current status of pre-frailty in this population. By comparing the effectiveness of these two tools in assessing pre-frailty and their correlation strength with ADL and quality of life, this research aims to provide a reference for selecting pre-frailty assessment tools for elderly individuals in community physical examination settings.

1.1 资料来源

A convenience sampling method was employed to select elderly individuals aged 60 and above who underwent physical examinations at five community health service centers in Beijing (Lucheng and Xuxinzhuang in Tongzhou District; Taoranting and Chunshu in Xicheng District; and Zuojiazhuang in Chaoyang District) between December 1, 2024, and March 20, 2025. The inclusion criteria were: (1) age $\geq$ 60 years; (2) good consciousness, comprehension, and linguistic ability, enabling normal communication; and (3) informed consent to participate in this study.

The exclusion criteria were: (1) presence of disability, defined as long-term de-

pendence on others for daily care due to physical or cognitive impairment, or those judged by the researchers to be unable to independently complete gait speed and grip strength measurements; (2) presence of unstable conditions involving severe cardiovascular, cerebrovascular, hepatic, renal, or hematopoietic system diseases, or malignant tumors; (3) presence of severe mental illness 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).

Patient data were collected by trained clinicians through face-to-face interviews and standardized measurements. Prior to the commencement of the investigation, participating clinicians were organized to systematically study the research protocol and implement various technical indicators. The testing duration for each elderly participant ranged from 15 to 30 minutes. Specifically, the Fried Phenotype (FP) assessment took an average of 3 to 4 minutes, as it includes objective measurements such as grip strength and gait speed that require operational explanations and standardized procedures. The FRAIL scale took an average of 1 to 2 minutes, as it is conducted entirely in a questionnaire format.

Following the investigation, the collected data underwent double-checking and entry by two researchers to ensure accuracy and completeness. The survey content included the following items.

1.2.1 一般资料

The demographic and clinical variables analyzed in this study include gender, age, educational attainment, and marital status. Health-related lifestyle factors were assessed, including Body Mass Index (BMI), smoking status (categorized as "smoker" for current or former smokers and "non-smoker"), and alcohol consumption (categorized as "drinker" for current or former drinkers and "non-drinker"). Additionally, clinical characteristics were recorded, specifically the number of chronic conditions (diagnosed by a secondary or higher-level hospital) and the total number of medications currently being used.

1.2.2 FP

The Frailty Phenotype (FP) comprises the following five physiological indicators: (1) Weight loss: Unintentional weight loss of >4.5 kg or >5% of body weight within the past year; (2) Slow gait speed: For men, a time of $\geq$ 7 s to walk 4.57 m if height is $\leq$ 173 cm, or $\geq$ 6 s if height is $>$ 173 cm; for women, a time of $\geq$ 7 s to walk 4.57 m if height is $\leq$ 159 cm, or $\geq$ 6 s if height is $>$ 159 cm; (3) Weakness (decreased grip strength): For men with a Body Mass Index (BMI) $\leq$ 24.0 kg/m^2.

(3) Grip strength $\leq$ 29 kg for a BMI of 24.1-26.0 kg/m^2.

(4) Grip strength $\leq$ 30 kg for a BMI $>$ 28.0 kg/m^2.

(5) Grip strength $\leq$ 30 kg for a BMI of 26.1–28.0 kg/m^2, or grip strength $\leq$ 32 kg for the corresponding category; for women with a BMI $\leq$ 23.0 kg/m^2.

2 握力 $ $17.3 kg, BMI

Handgrip strength $\leq$ 17 kg, BMI 23.1 $\sim$ 26.0 kg/m^2

2 握力 $ $21

kg; (4) Low physical activity: defined as <383 kcal/week for men (approximately 2.5 hours of walking) and <270 kcal/week for women (approximately 2 hours of walking); (5) Exhaustion: defined as the occurrence of either of the following conditions for $\geq$ 3 days within the past week: feeling that every task requires significant effort or being unable to "get going." Participants meeting 0 of these 5 criteria are classified as non-frail, those meeting 1–2 criteria are classified as pre-frail, and those meeting 3–5 criteria are classified as frail.

For women, the grip strength threshold for frailty is $\leq$ 18 kg if their Body Mass Index (BMI) is $>$ 29.0 kg/m^2, or if their BMI is between 26.1 and 29.0 kg/m^2.

1.2.3 FRAIL 量表

The FRAIL scale consists of the following five items: (1) Fatigue: feeling fatigued most or all of the time during the past 4 weeks; (2) Resistance/Reduced Endurance: difficulty climbing one flight of stairs without resting and without the use of any assistive devices or help from others; (3) Ambulation: difficulty walking 100 meters without any assistive devices or help from others; (4) Illness: suffering from five or more diseases [including hypertension, diabetes, acute myocardial infarction, stroke, malignant tumors (excluding minor skin cancers), congestive heart failure, asthma, arthritis, chronic lung disease, kidney disease, angina, etc.]; (5) Loss of Weight: a weight loss of $\geq$ 6 kg within the past 6 months or $\geq$ 3 kg within the past month. Each "yes" response is scored as 1 point, and "no" is scored as 0 points, for a total possible score of 5. A score of $\geq$ 3 indicates frailty, 1–2 indicates pre-frailty, and 0 indicates the absence of frailty.

1.2.4 Modified Barthel Index (MBI)

The MBI is used to assess Activities of Daily Living (ADL) and includes 10 items: feeding, bathing, grooming, dressing, bowel control, bladder control, toileting, chair/bed transfers, walking on level ground, and climbing stairs. A total score of 100 indicates complete independence, $\geq$ 60 indicates basic self-care ability, 41–59 indicates partial dependence, 21–40 indicates severe dependence, and $\leq$ 20 indicates total dependence.

1.2.5 The 36-Item Short Form Health Survey (SF-36)

As a universal scale, the SF-36 is widely used globally in clinical research, health policy evaluation, and chronic disease management. It comprises 36 items across 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). The raw score for each dimension is converted into a range of 0–100 using the following formula:

$$\text{Transformed Score} = \left[\frac{(\text{Actual Score} - \text{Lowest Possible Score})}{(\text{Highest Possible Score} - \text{Lowest Possible Score})}\right] \times 100$$

The average scores of the PF, RP, BP, and GH dimensions constitute the Physical Component Summary (PCS), while the average scores of the VT, SF, RE, and MH dimensions constitute the Mental Component Summary (MCS). The average of the transformed scores across all eight dimensions represents the total score. These scores directly reflect health status; higher scores indicate better functional status and higher quality of life.

1.3 Statistical Methods

Data analysis was performed using SPSS 26.0. Categorical data are expressed using relative frequencies···

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2 检验。符合正态分布的计量

The data are expressed as mean ± standard deviation ($\bar{x} \pm s$). Non-normally distributed quantitative data are expressed as median (interquartile range) $[M(Q_1, Q_3)]$, and inter-group comparisons were performed using the Mann-Whitney U test. Spearman rank correlation analysis and Kappa consistency analysis were employed to evaluate the correlation and consistency between the Fried Phenotype (FP) and the FRAIL scale in assessing frailty status. Using the Modified Barthel Index (MBI) and the 36-Item Short Form Survey (SF-36) as criteria for validity evaluation, the validity of the two assessment tools was analyzed using Spearman rank correlation, Receiver Operating Characteristic (ROC) curves, and Bayes discriminant analysis. A value of $P < 0.05$ was considered statistically significant.

Categorical data are expressed as frequencies or percentages, and inter-group comparisons were performed using the χ^2 test.

2.1 社区体检老年人衰弱前期现状

This study included a total of 430 elderly individuals undergoing community physical examinations, consisting of 314 females (73.0%) and 116 males (27.0%).

The participants ranged in age from 60 to 90 years, with a median age of 69 (65, 73) years. The Fried Phenotype (FP) scores ranged from 0 to 4, with a median score of 0 (0, 1); similarly, the FRAIL scale scores ranged from 0 to 4, with a median score of 0 (0, 1). According to the FP assessment, the proportions of robust, pre-frail, and frail individuals were 59.1% (254/430), 36.3% (156/430), and 4.7% (20/430), respectively. Based on the FRAIL scale assessment, the proportions of robust, pre-frail, and frail individuals were 72.6% (312/430), 25.3% (109/430), and 2.1% (9/430), respectively.

A comparison of the results between the two assessment tools revealed a statistically significant difference in the evaluation of frailty status ($\chi^2 = 337.509, P < 0.001$). The frequency of positive FP criteria, ranked from most to least common, was as follows: decreased grip strength in 97 cases (22.6%), fatigue in 95 cases (22.1%), weight loss in 28 cases (6.5%), slow walking speed in 23 cases (5.3%), and low physical activity in 8 cases (1.9%). For the FRAIL scale, the frequency of positive items was: fatigue in 95 cases (22.1%), weight loss in 28 cases (6.5%), resistance/ambulation difficulty in 26 cases (6.0%), illness in 9 cases (2.1%), and loss of mobility in 7 cases (1.6%). Assessment results from both the FP and FRAIL scales indicated that, compared to robust elderly individuals, those in the pre-frail stage were older, had a higher Body Mass Index (BMI), and a higher proportion of decline in Activities of Daily Living (ADL). Furthermore, they took more types of medications, had a higher number of chronic diseases, and scored lower on the total SF-36 and its various dimensions, with these differences being statistically significant ($P < 0.05$). No statistically significant differences were observed regarding gender, education level, marital status, smoking status, or alcohol consumption ($P > 0.05$).

Regarding the correlation and consistency of the FRAIL scale in assessing the frailty status of elderly individuals during community physical examinations, the results of the FP and FRAIL scales showed a moderate positive correlation ($r = 0.713, P < 0.001$). The two assessment tools yielded consistent results for 81.2% (349/430) of the participants, with a Kappa value of 0.606 ($P < 0.001$), indicating moderate consistency, as shown in . The degree of frailty assessed by both the FP and FRAIL scales was positively correlated with ADL decline ($P < 0.05$) and negatively correlated with the total SF-36 score, Physical Component Summary (PCS), and Mental Component Summary (MCS) ($P < 0.05$), as shown in .

In terms of the FRAIL scale and its relationship with community-dwelling elderly individuals, 83.0% (357/430) of the participants in this study were fully independent in daily life (MBI = 100 points), while 17.0% (73/430) exhibited a decline in ADL.

Assessment results from both the FP and FRAIL scales demonstrated that the proportion of elderly individuals with ADL decline was significantly higher among those in the pre-frail stage compared to the robust group ($P < 0.05$). Receiver Operating Characteristic (ROC) curve analysis, using ADL decline as the outcome variable, showed that both the FP and FRAIL scales were

associated with ADL decline in community-dwelling elderly individuals. The areas under the ROC curve (AUC) were 0.736 and 0.735, respectively ($P < 0.001$). The FP exhibited higher sensitivity for ADL decline (74.0% vs. 64.4%), while the FRAIL scale demonstrated superior specificity (80.1% vs. 65.8%), as shown in . Bayesian discriminant analysis was performed with ADL decline as the dependent variable (Y) and the FP and FRAIL scale assessment results as independent variables. The results indicated that the cross-validation accuracy of the FP for predicting ADL decline was higher than that of the FRAIL scale, as shown in .

3 讨论

Selecting appropriate screening tools for pre-frailty among community-dwelling older adults is a prerequisite for implementing early interventions. This study compared the performance of the Fried Frailty Phenotype (FP) and the FRAIL scale in assessing pre-frailty during community health examinations. The results indicate that both tools are rapid (completed within 5 minutes) and simple to administer, making them suitable for community health screening settings. The degree of frailty assessed by both scales was negatively correlated with the total SF-36 score and its physical and psychological dimensions. The prevalence of pre-frailty identified by the FP (36.3%) was significantly higher than that identified by the FRAIL scale (25.3%). Furthermore, the FP demonstrated higher cross-validation accuracy (86.3% vs. 85.1%) and sensitivity (74.0% vs. 64.4%) in predicting declines in Activities of Daily Living (ADL), while the FRAIL scale performed better in terms of specificity (80.1% vs. 65.8%). These findings provide critical evidence for selecting pre-frailty screening tools in community health practice. The prevalence rates of pre-frailty assessed by the FP and FRAIL scales (36.3% and 25.3%, respectively) were lower than those reported in studies from Chongqing (41.5%), Chengdu (45.4%), and Tianjin (42.9%), but were similar to findings from Beijing (39.7%, 34.4%) and Taiyuan (45%). Additionally, a meta-analysis showed a pooled prevalence of pre-frailty in the Asia-Pacific region of 31.7%, while rates in the United Kingdom and the United States were 38% and 41.0%, respectively. Variations in the prevalence of frailty and pre-frailty across different assessment tools and environments are evident. In this study, 72.4% of the participants were under 75 years old; this relatively young overall age may contribute to the lower observed prevalence of pre-frailty. Furthermore, because the study did not utilize home-based surveys, it failed to assess homebound older adults who often have a higher likelihood of pre-frailty. Our results show that, compared to non-frail individuals, those in the pre-frailty stage are older, have a higher BMI, and take more types of medications for a greater number of chronic diseases. This is consistent with previous findings and suggests that the progression of frailty is influenced by these factors, providing a reference for the formulation of intervention measures.

In this study, the prevalence of pre-frailty among community-dwelling older adults assessed by the FP was higher than that assessed by the FRAIL scale.

The results of the two assessment tools showed a moderate positive correlation and moderate consistency, which is consistent with previous research findings [?, ?]. Notably, 63 individuals (14.7%) were classified as pre-frail by the FP but were assessed as healthy by the FRAIL scale. Further analysis revealed that these individuals were mostly···

Chinese General Practice. 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.

Age groups [n (%)] 11.921 <0.001

a 44.102 <0.001

ADL [n (%)] 21.607 <0.001

SF-36 88 (75, 95) vs. 75 (60, 90), $P < 0.001$; 88 (75, 95) vs. 70 (55, 85), $P < 0.001$; 100 (75, 100) vs. 75 (0, 100), $P < 0.001$; 100 (75, 100) vs. 25 (0, 100), $P < 0.001$; 84 (72, 100) vs. 72 (52, 84), $P < 0.001$; 84 (72, 100) vs. 62 (51, 74), $P < 0.001$; 75 (60, 92) vs. 56 (45, 72), $P < 0.001$; 74 (57, 92) vs. 51 (40, 62), $P < 0.001$; 85 (70, 95) vs. 70 (60, 85), $P < 0.001$; 85 (70, 95) vs. 65 (50, 75), $P < 0.001$; 100 (88, 100) vs. 88 (75, 100), $P < 0.001$; 100 (87, 100) vs. 88 (75, 100), $P < 0.001$; 100 (67, 100) vs. 67 (33, 100), $P < 0.001$; 100 (67, 100) vs. 33 (0, 67), $P < 0.001$; 80 (64, 88) vs. 72 (56, 80), $P < 0.001$; 80 (68, 88) vs. 64 (52, 74), $P < 0.001$; 84 (74, 92) vs. 65 (47, 80), $P < 0.001$; 83 (72, 92) vs. 55 (41, 72), $P < 0.001$; 88 (77, 95

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Agreement between FP and FRAIL Scale in assessing frailty status among community-dwelling older adults

Note: FP refers to Fried' s Frailty Phenotype scale. Correlations between the FP and FRAIL scales with Activities of Daily Living (ADL) and the 36-Item Short Form Survey (SF-36).

The correlation coefficients for the decline in ADL were 0.355 ($p < 0.001$) for the FP scale and 0.394 ($p < 0.001$) for the FRAIL scale.

For the SF-36 total score, the correlation coefficients were -0.492 ($p < 0.001$) for the FP scale and -0.549 ($p < 0.001$) for the FRAIL scale.

PCS -0.491 <0.001 -0.526 <0.001

MCS -0.436 <0.001 -0.521 <0.001

Note: ADL = Activities of Daily Living; FP = Fried' s Frailty Phenotype scale; SF-36 = 36-Item Short Form Survey.

Abstract

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the full text for a complete translation.]

Introduction

As the global population ages, frailty has become a critical public health challenge. Frailty is a clinical syndrome characterized by a decline in physiological reserve and increased vulnerability to stressors across multiple systems. It is closely associated with adverse health outcomes, including falls, hospitalization, disability, and mortality. Early identification and intervention are essential for improving the quality of life in the elderly and reducing healthcare burdens.

Commonly used assessment tools include the Activities of Daily Living (ADL) scale, which measures functional independence, and Fried' s Frailty Phenotype (FP), which evaluates physical frailty through five criteria: weight loss, exhaustion, low physical activity, slowness, and weakness. Additionally, the 36-Item Short Form Survey (SF-36) is frequently employed to assess health-related quality of life.

Recent advancements in machine learning and deep learning offer new opportunities for the early detection and risk stratification of frailty. By integrating multi-dimensional data—ranging from clinical assessments to physiological signals—these computational models can identify complex patterns that traditional statistical methods might overlook. This study aims to explore the application of these techniques in predicting frailty and its impact on the daily functioning of the elderly.

Predictive efficacy of FP and FRAIL Scale for decline in ADL among community-dwelling older adults

ROC Curve

The Receiver Operating Characteristic (ROC) curve is a fundamental graphical tool used in machine learning and statistics to evaluate the performance of binary classification models. It illustrates the diagnostic ability of a classifier system as its discrimination threshold is varied. The curve is created by plotting the True Positive Rate (TPR) against the False Positive Rate (FPR) at various threshold settings.

Definition and Components

The ROC curve is defined by two primary metrics derived from the confusion matrix:

1. **True Positive Rate (TPR)**, also known as Sensitivity or Recall:

$$\text{TPR} = \frac{TP}{TP + FN}$$

This represents the proportion of actual positive instances that are correctly identified by the model.

2. **False Positive Rate (FPR)**, also known as the Fall-out:

$$\mathrm{FPR} = \frac{FP}{FP + TN}$$

This represents the proportion of actual negative instances that are incorrectly classified as positive.

Interpretation

The ROC space is defined by FPR and TPR as the x and y axes, respectively. Each prediction result or instance of a confusion matrix represents a single point in ROC space.

- A point in the upper left corner (0, 1) represents perfect classification, indicating 100% sensitivity (no false negatives) and 100% specificity (no false positives).
- The diagonal line $y = x$ (the line of identity) represents the strategy of randomly guessing a class. Any point appearing in the lower right triangle indicates performance worse than random guessing.
- The Area Under the Curve (AUC) is a scalar value used to quantify the overall performance of the classifier. An AUC of 1.0 indicates a perfect model, while an AUC of 0.5 suggests the model has no discriminative capability.

Applications

ROC curves are particularly useful in clinical medicine, signal detection theory, and machine learning for comparing different models or selecting optimal operating thresholds. Unlike accuracy, the ROC curve is invariant to class distribution, making it an essential metric for evaluating models trained on imbalanced datasets. By analyzing the trade-off between sensitivity and specificity, researchers can determine the most appropriate threshold for a specific application, depending on the relative costs of false positives and false negatives.

FP 0.736 <0.001 0.668~0.803 0.740 0.658 0.398 0.5

FRAIL Scale: 0 .735, $P < 0.001$, 95% CI: 0.665–0.805, Sensitivity: 0.644, Specificity: 0.801, PPV: 0.445, NPV: 0.5.

The Bayesian discriminant analysis for predicting ADL decline using the Fried Phenotype (FP) and the FRAIL scale demonstrates distinct performance characteristics. The FP includes two objective, quantifiable physiological function indicators—decreased grip strength and slowed gait speed—which enable it to capture functional decline that individuals may not yet be aware of or are reluctant to report voluntarily. In contrast, the FRAIL scale relies more heavily on

subjective reports of functional difficulties (e.g., climbing stairs, walking 100 m) and disease burden. This subjectivity may affect accuracy due to cognitive bias, recall error, or varying interpretations of "difficulty" [?, ?]. Consequently, the FP may be more sensitive in identifying early, objective physiological decline, which explains its higher detection rate for pre-frailty.

This finding suggests that in community health screenings aimed at "early detection and early intervention," the FP may be more advantageous for identifying individuals in the earliest stages of frailty who have not yet manifested obvious subjective functional limitations.

Frailty is characterized by the degradation of reserves and functions across various physiological systems. Individuals with physical frailty typically exhibit multi-organ functional decline, particularly mobility retardation and muscle weakness, which increases the likelihood of adverse events such as falls, fractures, functional decline, hospitalization, and death [?, ?]. Screening tools should possess a robust ability to correlate with these adverse outcomes [?]. Since ADL is closely associated with the progression of geriatric frailty, exploring tools that can more strongly correlate with ADL decline during pre-frailty screening helps identify older adults who may benefit from interventions designed to prevent adverse events or improve daily living abilities. The Bayesian discriminant analysis in this study shows that the cross-validation accuracy of the FP and the FRAIL scale for predicting ADL decline is comparable (86.3% vs. 85.1%), indicating that both possess good discriminative performance. In the practical choice of predicting ADL decline, the sensitivity advantage of the FP (approximately 10% higher) and the specificity advantage of the FRAIL scale (approximately 10% higher) constitute the core considerations for selection [?, ?]. For clinical practice, if the screening goal is to minimize the omission of any potential pre-frail individuals to seize the optimal intervention window, the FP is the superior choice; its high sensitivity results in fewer "false negatives," thereby maximizing the coverage of early intervention. However, in scenarios where resources (such as manpower, time, and intervention capacity) are limited, there is a need to more accurately target the highest-risk populations to avoid the dilution of resources caused by "false positives." In such cases, the FRAIL scale, with its high specificity and time-efficient nature, serves as a more cost-effective rapid primary screening tool. Clinical practitioners can flexibly select or combine these two tools based on different screening objectives and available resources.

The ROC curve analysis in this study revealed that the optimal cutoff value for both tools in predicting ADL decline is 0.5 points, rather than the 1 point typically used in conventional pre-frailty diagnostic criteria. This result has significant practical implications: among older adults undergoing community health examinations, the risk of ADL decline increases significantly even if only one frailty indicator is present (where a score of 0.5 can be viewed as a transitional state toward 1 point). Therefore, the threshold for community pre-frailty intervention should be moved further forward. Currently, both the FP and the FRAIL scale utilize integer counting methods. Future research could focus on re-

fining the scoring standards for pre-frailty assessment tools and validating these optimal cutoff values. Initiating primary interventions, such as health education and exercise guidance, for individuals with an FP or FRAIL score ≥ 0.5 may more effectively delay the progression of ADL decline. This provides empirical evidence for deeply integrating frailty screening into routine community health examination workflows and optimizing intervention thresholds.

Regarding the correlation with quality of life, this study found that the degree of frailty assessed by both the FP and the FRAIL scale is negatively correlated with the total SF-36 score and its physical and psychological dimensions. Furthermore, the scores for all dimensions of quality of life in pre-frail older adults were significantly lower than those in healthy older adults, which is consistent with previous research findings [**?**, **?**]. This indicates that both tools can effectively identify pre-frail populations at a higher risk of impaired quality of life. Therefore, when using frailty screening results to indirectly infer the quality of life status of older adults, both tools have practical value without an absolute advantage of one over the other.

In summary, both the FP and the FRAIL scale are effective tools for community pre-frailty screening, though they have different strengths. Based on the results of this study, it is recommended that in the context of community health examinations, the FP should be prioritized if the primary goal is to increase screening sensitivity and detect pre-frail individuals as early as possible, provided that basic measurement equipment such as dynamometers and timers are available. The objective indicators included in the FP can reduce subjective bias and are more suitable for the dynamic evaluation of intervention effects.

If community resources are limited and require large-scale rapid primary screening, or if the goal is to prioritize high-risk populations with high specificity for targeted resource allocation, the FRAIL scale is an excellent alternative. Furthermore, regardless of the tool used, attention should be paid to the warning significance of the "0.5" optimal cutoff value, and consideration should be given to advancing the intervention threshold to achieve earlier management of the frailty process.

This study has certain limitations. The sequential order in which the scales were administered may have introduced some bias, thereby affecting the results. The exclusion criteria omitted disabled individuals and those with complex conditions; additionally, no home-based surveys were conducted, meaning older adults who are homebound and unable to go out were not assessed. This may have resulted in a relatively healthier study population, limiting the generalizability of the results to all community-dwelling older adults. Future research could further investigate the selection of pre-frailty screening tools specifically for homebound older adults. Finally, as this is a cross-sectional study, long-term follow-up was not conducted, and adverse outcomes such as disability, hospitalization, and death were not included. Future prospective studies among community-dwelling older adults are needed to compare the evaluative effectiveness of different pre-frailty assessment tools.

4 小结

Both the Fried Phenotype (FP) and the FRAIL scale are concise, easy to administer, and significantly correlated with quality of life and Activities of Daily Living (ADL). The assessment results of the two tools show moderate correlation and consistency, suggesting that both are suitable for the rapid screening of pre-frailty among older adults during community physical examinations. However, FP demonstrates higher cross-validation accuracy and sensitivity for predicting ADL decline compared to the FRAIL scale. Furthermore, FP incorporates two quantifiable objective measures—handgrip strength and gait speed. Consequently, FP is the preferred screening tool for pre-frailty in community-dwelling older adults, particularly in early screening scenarios where high sensitivity is prioritized. The FRAIL scale, characterized by its extreme simplicity and high specificity, serves as an effective supplementary tool for the rapid identification of high-risk individuals in resource-constrained settings. The optimal cutoff value of 0.5 identified in this study suggests that the threshold for pre-frailty intervention in the community should be moved forward, providing new insights for optimizing frailty management pathways during community health screenings.

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The authors declare no conflicts of interest.

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Research Progress in Screening and Non-pharmacological Interventions for Pre-frailty in the Elderly

Abstract

Frailty is a common clinical syndrome in the elderly, characterized by a decline in physiological reserves and increased vulnerability to stressors across multiple systems. Pre-frailty represents an intermediate state between robustness and

frailty, which is highly prevalent and carries a high risk of progressing to full frailty. However, pre-frailty is also highly reversible, making it a critical window for intervention to promote healthy aging. This article reviews the current status of pre-frailty screening tools and summarizes the latest research progress in non-pharmacological interventions, including exercise, nutritional support, cognitive training, and multi-component interventions, aiming to provide a reference for the early identification and management of pre-frailty in clinical and community settings.

Introduction

As the global population ages, frailty has become a major public health challenge. Frailty is not an inevitable consequence of aging but a state of increased vulnerability resulting from age-associated declines in physiological reserve and function. Pre-frailty is the precursor stage of frailty; although its clinical manifestations are less severe, it significantly increases the risk of adverse health outcomes such as falls, fractures, hospitalization, disability, and mortality.

Recent studies have emphasized that the transition from pre-frailty to frailty is not unidirectional. With timely and effective interventions, pre-frail individuals can return to a robust state. Therefore, early screening and the implementation of non-pharmacological interventions are essential strategies for preventing the onset of frailty and reducing the burden on healthcare systems.

Screening Tools for Pre-frailty

Accurate identification of pre-frailty is the prerequisite for effective intervention. Currently, several tools are widely used in clinical practice and research:

1. **Fried Frailty Phenotype (FFP):** This is the most widely used tool, assessing five criteria: unintentional weight loss, self-reported exhaustion, low physical activity, slowed walking speed, and weak grip strength. Individuals meeting 1 or 2 criteria are classified as pre-frail.
2. **Frailty Index (FI):** Based on the accumulation of deficits model

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Note: Figure translations are in progress. See original paper for figures.