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Evaluating the reliability and validity of the geriatric assessment of disability scale in older adults undergoing hemodialysis

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Abstract

Background Nearly 50% of patients undergoing maintenance hemodialysis are aged ≥ 60 years, highlighting a growing population with unique health challenges. This study aimed to evaluate the reliability and validity of a functional impairment screening tool for older adults undergoing maintenance hemodialysis.

Methods Convenience sampling was used to investigate 283 older adults (160 men and 123 women) undergoing maintenance hemodialysis across four hemodialysis centers. The reliability and validity of the Functional Impairment Screening Tool were evaluated using psychometric indices: Cronbach's α to assess internal consistency, split-half reliability to determine scale consistency, factorial analysis to inspect construct validity, and correlation with the Barthel Index as a comparator measure for criterion validity.

Results The screening tool comprised three dimensions and 16 items. Exploratory factor analysis revealed two common factors with eigenvalues > 1, explaining 80.49% of the cumulative variance. The factor-loading range across all items varied from 0.702–0.860. The tool demonstrated 100% acceptance and qualification rates. The Cronbach's α coefficient was 0.940, indicating excellent internal consistency. When analyzed by dimension, Cronbach's α coefficients were 0.940 for personal life, 0.928 for family life, and 0.948 for social activity function. Split-half reliability, as measured by the Spearman–Brown coefficient, was 0.940 for the overall scale, with corresponding coefficients of 0.943, 0.891, and 0.947 for personal life, family life, and social activity functions, respectively. Additionally, the Guttman split-half coefficient was 0.920 for the overall scale, ranging from 0.929–0.877 across dimensions.

Finally, the Spearman rank correlation coefficient between the total score of the functional impairment screening scale and the Barthel Index, as a measure of convergent validity, was $r = 0.886$ ($P < 0.001$), indicating a strong positive relationship.

Conclusions These findings showcase that the Functional Impairment Screening Tool scale demonstrated strong reliability and validity, implying its suitability for evaluating daily functioning in older adults undergoing maintenance hemodialysis.

Keywords Hemodialysis, Older adults, Functional impairment assessment scale, Reliability, Validity

Background

Hemodialysis (HD) is the primary renal replacement therapy in patients with advanced acute and chronic renal failure [1]. With advancements in blood purification technology, the clinical outcomes and prognoses of patients with uremia have improved remarkably.

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However, despite regular HD treatment, these patients, particularly older adults, experience a substantial decrease in daily activities, with an approximately 50% reduction compared to healthy individuals [2]. Notably, the proportion of patients undergoing maintenance HD (MHD) aged ≥ 60 has nearly reached 50% [3], highlighting a growing population with unique health challenges.

Among older adults undergoing MHD, a decline in organ function is accompanied by an increasing prevalence and severity of impaired physical function, which significantly affects their quality of life and poses considerable burdens on families and society [4]. Therefore, it is essential to assess the functional status, identify functional impairments early, and prolong the transition period from impairment to disability among older adults undergoing MHD to foster healthy aging. Furthermore, the management of older adults on dialysis presents a formidable challenge for healthcare providers in hemodialysis centers, underscoring the urgency for more comprehensive and tailored assessment tools.

Currently, research on functional impairment in older adults remains sparse. Despite the significant impact of functional decline on this patient population, studies addressing this critical issue are limited. In 2021, Zhang et al. from Xuanwu Hospital, Capital Medical University, China, developed the Function Impairment Screening Tool (FIST) [5] based on the framework of the International Classification of Functioning, Disability and Health (ICF) [6]. This innovative tool demonstrated reliability in assessing physical function in older inpatients and community-dwelling older adults [7, 8].

Our decision to select the Barthel Index (BI) as a comparator for the FIST scale was influenced by its widespread application and recognition in functional impairment assessment. The BI, a mature and user-friendly assessment instrument, has a solid foundation in clinical practice and has been frequently employed by researchers to assess patients undergoing HD. This broad application facilitates the comparison and integration of our research findings with those in the existing literature.

Despite these advancements, a knowledge gap exists regarding the specific performance and applicability of the FIST scale in older adults undergoing MHD. Therefore, this study aimed to bridge this gap by further evaluating the feasibility, reliability, and validity of the FIST scale in this unique patient population. Our findings contribute to a better understanding of functional impairments in older adults undergoing MHD and inform the development of tailored interventions to improve their quality of life.

Methods

Participants

In this cross-sectional study, older adults undergoing MHD at four hemodialysis centers in Beijing were recruited as participants through convenience sampling. Inclusion criteria: (1) age ≥ 60 years; (2) patients receiving HD for ≥ 3 months; (3) ability to cooperate with the questionnaire survey; (4) voluntarily participate in this study and sign an informed consent form. The exclusion criteria were as follows: (1) dementia or severe cognitive impairment, (2) severe hearing or vision impairment or language problems, and (3) inability to understand the content of the study. This study was approved by the Ethics Review Board of China-Japan Friendship Hospital (2022-KY-175). This research strictly conformed to the guidelines in the STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) statement to ensure the reporting quality of cross-sectional studies.

All participants voluntarily participated in this study and signed an informed consent form after thoroughly comprehending the research purpose, methods, and potential risks and benefits. Based on the principle that the sample size should be 5–10 times the number of items [9], a sample size of 80–160 participants was required as the FIST scale has 16 items. In total, 283 older adults were included in this study.

Data collection

A self-designed demographic questionnaire, the FIST scale, and BI were used to collect data. The investigators were trained to ensure uniform instructions. After completion, the questionnaires were immediately retrieved to ensure completeness and accuracy of the data.

FIST scale

The FIST scale contains 3 dimensions and 16 items: personal life function (six items), family life function (five items), and social activity function (five items) [6]. Each item is scored according to the degree of dependence of older adults on the help of others, which is divided into three grades: complete dependence (0 points), partial dependence (0.5 points), and complete self-care (1 point). The total score ranged from 0–16. A higher FIST total score indicated better physical function.

Assessment of functional status in older adults

The BI was used to evaluate activities [10] of daily living in older adults undergoing HD. The scale mainly includes 10 dimensions: eating, bathing, grooming, dressing, stool control, urination control, toileting, bed and chair movement, walking on the ground, and going up and down

stairs, with scores ranging from 0–15. The total score ranges from 0–100. Higher scores indicated greater independence and less dependence.

Statistical methods

All statistical analyses were performed using Statistical Package for the Social Sciences, version 29.0. Appropriate descriptive statistical indicators were selected based on the distribution characteristics of the data before the in-depth analysis. For the normally distributed data, means ± standard deviations (means ± SDs) was adopted for description; for the non-normally distributed data, the median (M), 25th percentile (P25), and 75th percentile (P75) were utilized for representation. Categorical data were reported as frequencies (n) and percentages (%). Statistical significance was set at $P < 0.05$.

Internal consistency and reliability

Cronbach's α coefficient was employed as the primary indicator to evaluate the internal consistency of the scale. To verify the reliability of the scale more comprehensively, a split-half reliability test was conducted to confirm consistency between the two halves.

Validity assessment (Structural validity)

Factor analysis was used to examine the structural validity of the scale. To test the criterion validity of the scale, a correlation analysis was conducted between FIST and the BI (as a known and valid comparative measurement indicator). Although extensively employed in previous studies, the BI is not the gold standard for disability assessment. Consequently, our correlation analysis was intended to explore the correlations between the BI and other tools when measuring the same concept rather than validating its accuracy as the gold standard. We adhere to the guiding principles of assessment frameworks, such as the Consensus-based Standards for the selection of health Measurement Instruments (COSMIN) and scrupulously discuss the significance and limitations of these correlation analyses in the interpretation of the results.

Results

General information of the study participants

The average age of the 283 participants included in this study was 70.20 ± 6.81 years, including 160 men (56.50%) and 123 women (43.50%). The average dialysis age was 7.16 ± 5.00 years. Among the participants, 7 (2.50%) lived alone, while 276 (97.50%) lived with family members. The total scores for the BI and FIST were recorded as 88.07 ± 22.99 and 13.00 ± 4.56, respectively.

Feasibility

In total 283 questionnaires were distributed in this study, and all were successfully collected. The acceptance rate of the FIST scale was 100%, indicating that the participants demonstrated a high level of acceptance and cooperation. All 283 questionnaires met the qualification criteria, resulting in a 100% passing rate. This finding suggests that the research participants were able to comprehend and complete the questionnaire accurately.

Reliability

Internal consistency

The Cronbach's α of the FIST scale was 0.924. The Cronbach's α of its three dimensions—personal life function, family life function, and social activity function—as well as the corrected item-total correlation (CITC) of FIST and the Cronbach's α after the deletion of one item are presented in Table 1. A Cronbach's α value exceeding 0.7 indicates a high degree of internal consistency [11]. In this study, all measured scales of the FIST scale, including both the total scale and individual dimensions, exhibited Cronbach's α values greater than 0.7, thereby confirming a high level of internal consistency within the FIST instrument.

Split-half reliability

The Spearman–Brown coefficient for the FIST scale was 0.940, whereas the Guttman split-half coefficient was 0.920. The Spearman–Brown coefficients for personal life, family life, and social activities were 0.943, 0.891, and 0.947, respectively; the corresponding Guttman split-half coefficients were 0.929, 0.871, and 0.877, respectively(Table 2). These results indicate that the split-half reliability of the FIST scale is satisfactory [12].

Validity

Construct validity

The results of exploratory factor analysis showed that the Kaiser–Meyer–Olkin measure (KMO) = 0.950, Bartlett spherical test $\chi^2 = 6098.241$, $P < 0.001$, suggesting that the scale was suitable for factor analysis [13]. Using the principal component analysis method, two common factors with initial eigenvalues > 1 were extracted after the orthogonal rotation of the maximum variance, and the cumulative variance contribution rate was 80.491%. The factor loading range of each item was 0.702–0.860, as shown in Table 1, all of which were > 0.45, suggesting good construct validity of the FIST scale.

Criterion validity

Spearman's correlation analysis was used to evaluate the criterion validity. The results showed that the

Table 1 The CITC, Cronbach's α, and factor loadings of the FIS scale following the removal of an item

Items	CITC	After deleting an entry Cronbach's α	Factor loadings
Personal Life function			
Eating	0.678	0.972	0.791
Wash and brush your hair	0.740	0.971	0.840
Go to the bathroom	0.847	0.969	0.858
Getting dressed and undressed	0.601	0.972	0.733
Getting in and out of bed	0.867	0.969	0.858
Shower	0.907	0.968	0.854
Home life functions			
Doing housework (indoor activities)	0.863	0.969	0.800
Managing finances	0.822	0.969	0.734
Managing medications	0.821	0.969	0.732
Lift 10 kg of weight	0.734	0.971	0.702
Go up and down one floor	0.892	0.968	0.848
Social activity function			
Ride and use transportation	0.916	0.968	0.877
Shopping (going out or online)	0.877	0.968	0.860
Walk half a km	0.878	0.968	0.837
Make telephone calls	0.808	0.970	0.710
Physical exercise	0.875	0.968	0.844

Table 2 Spearman-Brown coefficient and Guttman split-half coefficient of the total score and each dimension of the Functional Impairment Screening Tool (FIST) scale

Items	Spearman-Brown coefficient	Guttman split-half coefficient
FIST total score	0.940	0.920
Personal Life function	0.943	0.929
Family life functions	0.891	0.871
Social activities function	0.947	0.877

correlation coefficient between the total FIST and BI scores was 0.886 ($P < 0.001$), indicating that the FIST scale was highly correlated with the BI when assessing physical function, and FIST had high criterion validity, as shown in Fig. 1.

Discussion

With continuous advancements in dialysis technology, patients with uremia are undergoing prolonged periods of dialysis treatment. However, the mortality rate among older adults undergoing dialysis remains significantly high, approximately twice [14] that of observed in younger and middle-aged patients undergoing HD. Concurrently, owing to the impact of underlying diseases, HD treatment, and associated complications, the degree of functional impairment in older adults undergoing HD. Concurrently, owing to the impact of underlying diseases, HD treatment, and associated complications, the degree of functional impairment in older adults undergoing HD is more pronounced than that observed in healthy older adults of similar ages. As these patients age, a gradual decline in bodily function is observed, resulting in varying degrees of impairment [15, 16]. Consequently, the risk of adverse events such as falls, disability, and death is further elevated [17, 18]. To effectuate optimal functional status management in older adults undergoing HD, assessing the severity of their functional impairments accurately and efficiently is crucial. Medical professionals typically use appropriate assessment tools to evaluate a patient's conditions. However, discrepancies often arise in the assessment outcomes across different activities of daily living or functional status evaluation instruments, which can affect the relevance and effectiveness of functional status management in older adults. Furthermore, because of uremia, a significant majority of patients undergoing HD are anuric, rendering them unsuitable for evaluation using commonly employed clinical assessment tools. Therefore, meticulously comparing and selecting the most appropriate assessment tools to ensure accuracy and consistency in identifying the degree of functional impairment in older adults undergoing HD is essential. This approach will provide a theoretical foundation for the clinical development of personalized treatment and nursing programs tailored for older adults with compromised functional status undergoing HD in the future. The findings of this study indicate that the FIST scale demonstrates good reliability and validity in assessing the level

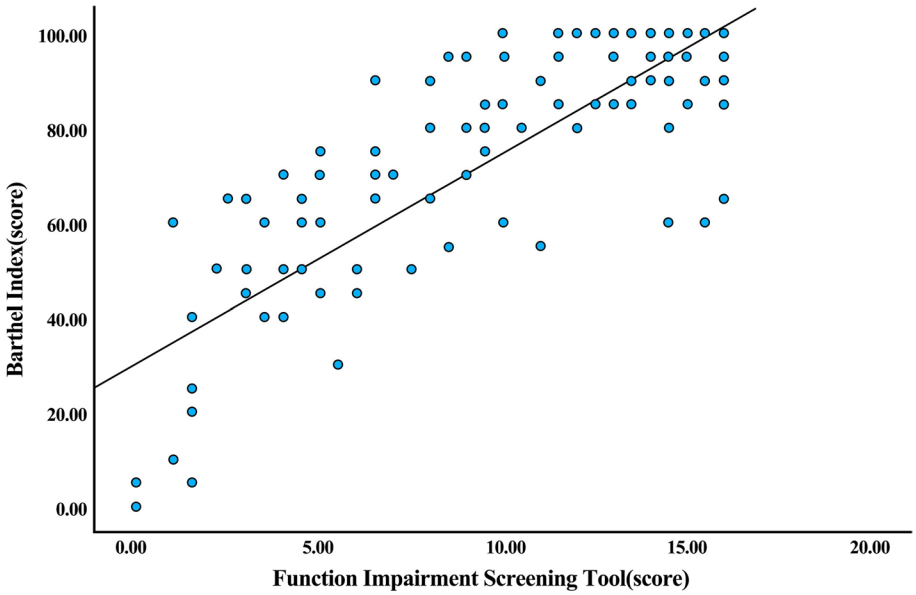

Fig. 1 Correlation analysis between the total score of the functional impairment screening tool and the Barthel index

of functional impairment in older adults undergoing HD treatment, making it a suitable tool for evaluating physical function within this population.

FIST has good reliability and validity in older adults with MHD

Reliability of the FIST scale

The reliability reflects the closeness between the measurement results of the scale and the actual values of the tests [18]. Cronbach's α, the Spearman–Brown coefficient, and the Gutman split-half coefficient were employed to assess the internal consistency reliability of the FIST scale. The findings indicated that Cronbach's α for both the overall scale and each individual dimension exceeded 0.7. Specifically, the total Cronbach's α for the FIST scale was calculated to be 0.940, aligning with findings from previous studies [19] and confirming that the FIST scale demonstrates strong internal consistency and stability. The Spearman–Brown coefficient for the FIST scale was found to be 0.940, whereas the Guttman split-half coefficient was 0.920. The Spearman–Brown coefficients for the three dimensions of personal life, family life, and social activity were 0.943, 0.891, and 0.947, respectively; the correspondingly, Guttman split-half coefficients were 0.929, 0.871, and 0.877, respectively. These findings indicate that the split-half reliability of the FIST scale is robust [12]. Collectively, these results demonstrate that the FIST scale possesses high internal consistency reliability and can effectively assess physical functioning in older adults undergoing HD.

Validity of FIST scale

This study employed exploratory factor analysis to assess the construct validity of the FIST scale. The results indicated a KMO value of 0.950 and a Bartlett's test of sphericity with $P<0.001$, suggesting that the data were suitable for factor analysis [13]. Exploratory factor analysis revealed two common factors with eigenvalues > 1, explaining 80.49% of the cumulative variance. The factor loadings for each item within its respective dimensions ranged from 0.702–0.860, indicating a high level of construct validity for the FIST scale. Additionally, the reliability and validity of the BI, which is widely used in clinical practice to assess the activities of daily living of older adults, was confirmed in this population [20, 21]. The results of the correlation analysis showed that the FIST scale and BI presented a significant positive correlation (0.886) when measuring the daily functional activities of patients, indicating that both have a certain degree of consistency or convergence in evaluating the daily functional activities of older adults undergoing HD.

FIST scale has a high clinical application value

Currently, researchers predominantly use the BI to assess the activities of daily living in older adults undergoing HD. However, owing to the limited specificity of the scale and the fact that most patients undergoing HD are anuric, evaluating the functional status of these patients may not yield accurate results. Consequently, it cannot be regarded as an optimal or reliable assessment tool [22, 23]. The findings of this study, which involved 283

older adults undergoing MHD across four dialysis centers, indicate that the FIST scale effectively evaluates the activities of daily living in older adults undergoing HD and possesses fewer dimensions, making it simple and feasible for use. Patients can complete the self-assessment within a brief period. The specific cutoff values of the FIST scale have not yet been thoroughly investigated and clearly delineated; however, the scores they yield can still provide a series of highly valuable information for clinicians. This information is particularly crucial when assessing the health of older adults undergoing HD. Specifically, FIST scores can reveal the changing trends in patients' functional statuses, aiding doctors in understanding changes in functional performance over time. Additionally, the scores can precisely delineate the extent of impairment in diverse functional domains, such as activities of daily living, social interaction, and cognitive ability, allowing doctors to gain a more comprehensive understanding of patients' functional status in clinical practice. First, they serve as an important foundation for formulating individualized treatment plans. Doctors can customize the most appropriate treatment plans for patients based on changing trends in their functional status and the degree of impairment in different functional domains, thereby enhancing the patients' functional status more effectively. Second, FIST scores play a critical role in evaluating treatment effects. By comparing score variations before and after treatment, doctors can intuitively determine whether the treatment plan is effective and whether adjustments are necessary to further optimize treatment outcomes. Finally, this information can be used to predict patient prognosis. Doctors can comprehensively determine the prognosis of patients by integrating the changing trends of their functional status and the degree of impairment in different functional domains, along with other factors such as the patient's age and underlying diseases, thereby providing more precise rehabilitation guidance and long-term care plans for patients. In summary, the specific cut-off values of the FIST scale remain undetermined; however, the information embodied in its scores still holds irreplaceable value for the clinical management and treatment decision-making of older adults undergoing HD. Furthermore, the FIST scale can be administered by nurses or family members and applies to patients with communication barriers. Consequently, the FIST scale has significant potential for widespread application in older adultsundergoing HD.

Limitations

This study adopted a convenience sampling method to select participants from four HD centers in Beijing, which potentially constrains the universality of the research findings. The outcomes of this study provide reference values for a specific sample; however, prudence is warranted when extending them to a broader population. Simultaneously, owing to the temporal and resource limitations of this study, we failed to conduct a longitudinal reliability assessment or correlation analysis of the patients' future adverse outcomes. To remedy this deficiency, we plan to conduct multiple tests on the same group of participants in future projects to evaluate the stability and consistency of the tool at different time points and to assess whether the FIST score can effectively predict future disability, hospitalization, or mortality in older adults undergoing dialysis by prolonging the follow-up period and augmenting the sample size. This will provide a deeper understanding of the potential applications of the FIST scale in clinical practice. Concurrently, we will endeavor to enhance the data collection process to ensure the acquisition of more comprehensive patient information for more comprehensive comparative analyses. This will facilitate a more comprehensive understanding of the performance of the tool and provide solid evidence for its efficacy in practical applications.

Additionally, correlation analysis offers a means of quantifying the relationship between the FIST scale and BI, facilitating our understanding of their resemblance when measuring the same concept. Nevertheless, correlation analyses fail to disclose causal relationships or directly evaluate the validity or reliability of the tools. Hence, when applying the FIST scale in clinical practice or scientific research, we need to comprehensively consider multiple lines of evidence and evaluation criteria to guarantee the accuracy and reliability of the assessment outcomes.

Conclusion

The implementation of the FIST scale can assist HD medical staff in swiftly and comprehensively identifying challenging activities of daily living among older adults undergoing HD. This approach enables a more accurate assessment of the severity of functional impairments in these patients and allows healthcare professionals to observe the evolving trends in their functional status with greater clarity. Consequently, this study provides a crucial foundation for the development of personalized treatment and nursing programs.

Abbreviations

HD	Hemodialysis
MHD	Maintenance hemodialysis
FIST	Functional Impairment Screening Tool
BI	Barthel index
CITC	Corrected item-total correlation coefficient
KMO	Kaiser–Meyer–Olkin

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Authors' contributions
J WN and H WW was responsible for conception, design and review the manuscript;Y L and L HT were responsible for the design of the questionnaire;J WN and D W were responsible for the design of the questionnaire.L H T and W H F were responsible for questionnaire survey and data collection.J W N and Y L were responsible for data analysis, visualization.J WN was a major contributor in writing the manuscript and preparing Fig. 1. All authors read and approved the final manuscript.

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Data availability
The datasets generated and/or analysed during the current study are not publicly available due their containing information that could compromise the privacy of research participants but are available from the corresponding author (Dong Wan) on reasonable request.

Declarations

Ethics approval and consent to participate
This study has obtained ethical approval from the Ethics Committee of China Friendship Hospital (Approval Number: [2022-KY-175]), and has strictly adhered to the Declaration of Helsinki and relevant ethical guidelines and laws and regulations in China.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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