ORIGINAL ARTICLE

# ASSOCIATION OF FRAILTY WITH NUTRITIONAL STATUS AND FUNCTIONAL INDEPENDENCE IN OLDER ADULTS WITH STROKE

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## Abstract

**Introduction:** Stroke can lead to a substantial reduction in quality of life and long-term functional dependency, in addition to increased mortality in the acute phase. The aim of this study was to investigate the relationship between frailty and nutritional status and functional independence in older adults with stroke.

**Materials and Method:** This retrospective observational study included 84 patients aged over 65 years with stroke. The Mini Nutritional Assessment was used to evaluate nutritional status, the Frail Scale and Clinical Frailty Scale were used to assess frailty before and after stroke, and the Katz Index was used to evaluate activities of daily living. The Modified Rankin Scale was used to assess disease prognosis, while the National Institutes of Health Stroke Scale was used to determine disease severity.

**Results:** Pre-stroke frailty was significantly associated with poorer nutritional status (MNA: $r = -0.55$, $p < 0.001$) and lower functional independence (Katz Index: $r = -0.55$, $p < 0.001$). A weak positive correlation was observed between frailty and stroke severity (NIHSS: $r = 0.25$, $p = 0.021$), whereas no significant association was found with functional outcome measured by the MRS ($p = 0.739$).

**Conclusion:** Frailty was significantly associated with nutritional status and functional independence in older adults with stroke. Frailty assessment may contribute to a more comprehensive evaluation of clinical vulnerability and support individualized rehabilitation and care planning; however, its prognostic value requires confirmation in prospective studies using validated predictive models.

***Keywords:*** Frailty; Stroke; Functional Independence; Rehabilitation; Geriatrics.

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## INTRODUCTION

Stroke is a leading cause of mortality and long-term disability worldwide, frequently resulting in reduced functional independence and impaired quality of life in older adults (1–3). Frailty, characterized by diminished physiological reserve and increased vulnerability to stressors, has emerged as an important determinant of adverse outcomes following acute medical conditions, including stroke (4-7). Previous studies have shown that frailty is associated with poorer recovery, functional decline, and increased mortality after stroke (8,9). However, its relationship with nutritional status, functional independence, and neurological outcomes in older adults remains incompletely understood.

Therefore, this study aimed to investigate the association between pre-stroke frailty and nutritional status and functional independence in older adults with stroke.

## MATERIALS AND METHOD

This study was designed as a retrospective observational study involving repeated retrospective assessments and was conducted between September 1, 2024, and September 1, 2025, at the Physical Medicine and Rehabilitation and Neurology outpatient clinics VM Medical Park Hospital. The study protocol received approval from the Clinical Research Ethics Committee of Mudanya University (No. 2025-3/4). All procedures were conducted in compliance with the principles of the Helsinki Declaration established by the World Medical Association. The study included 84 adult patients who had stroke, whose symptoms persisted for more than a week, and who were enrolled in an outpatient rehabilitation program. Patients who had stroke symptoms for less than a week, who had only clinical symptoms without imaging evidence, who had subarachnoid hemorrhage, traumatic brain injury, or who were being treated for terminal chronic disease or malignancy were excluded from the study.

The files of patients who met the inclusion criteria were reviewed. Medical records were used as the primary source of information for all study variables. When necessary, baseline information was missing from the medical records, additional data were obtained through structured telephone interviews with the patients or their primary caregivers. During these interviews, caregivers were asked standardized questions regarding the patient's functional, nutritional, and frailty status during the 6–12 months preceding the stroke. No separate analysis was performed according to the source of the information (medical records or caregiver interviews).

Demographic and clinical characteristics, including age, sex, and stroke type, were retrospectively extracted from the patients' medical records. Frailty Scale, CFS were used for frailty assessment, MNA-SF was used for nutritional assessment, and Katz index was used to evaluate activities of daily living. These scales were assessed three times: before the stroke (within the last 6-12 months before the stroke) and twice after the stroke.

Current research demonstrates that the Frail scale exhibits elevated sensitivity and specificity relative to phenotypic criteria (10). The scale comprises five elements: fatigue, resistance, walking, sickness, and weight loss. It is a widely used tool in frailty assessment, especially due to its practical applicability in the clinic, and is increasingly being studied in stroke patients. The Frail scale can be used to evaluate both baseline frailty before stroke and new frailty that develops after stroke. Before–and–after comparison is valuable to demonstrate the additional burden of stroke on frailty and to predict prognosis. This approach provides critical information, especially for rehabilitation planning and post-discharge care strategies (10).

The CFS used in this study is a rapid and low-cost clinical tool (11). The practicality of CFS allows it to be integrated into risk stratification in the subacute/



chronic period. The pre-stroke CFS score was used to represent baseline frailty. In contrast, the acute post-stroke CFS score was considered a measure of overall clinical vulnerability during the early post-stroke period because it may be influenced by acute neurological impairment and stroke-related functional disability. Therefore, acute CFS scores were interpreted cautiously and were not regarded as a pure measure of pre-existing frailty.

MNA-SF is a screening tool developed to quickly and reliably evaluate nutritional status in elderly individuals. Its relationship with fragility has also been examined extensively in recent years. It consists of six questions. Nutritional status, weight loss, appetite, mobility, acute illness/psychological stress, neuropsychiatric problems, and BMI (or calf circumference) are evaluated (12).

The Katz Index evaluates an individual's capacity to autonomously execute fundamental activities of daily living, including bathing, dressing, toileting, transferring, maintaining continence, and nourishment. The Katz Index is not a measure of frailty per se, but it assesses functional independence, one of the most important components of frailty. It can be used as a supportive tool in the assessment of frailty in patients with stroke (13).

The prognosis of the disease was assessed using the Modified Rankin Scale (MRS), while disease severity was measured with the National Institutes of Health Stroke Scale (NIHSS) on two occasions: during the initial post-stroke evaluation and one month thereafter. The WHO advocates the use of MRS to assess prognosis following a stroke (14). It is one of the "gold standard" indicators of stroke outcomes in clinical practice and research. When used in conjunction with frailty assessments, it more accurately reflects loss of independence after stroke. NIHSS is an internationally valid scoring system used to evaluate the severity of neurological impairment in stroke patients. Objectively measuring stroke severity, it was developed to guide treatment selection, predict the patient's prognosis, and provide standardized measurement in clinical studies (15).

**Statistical Analysis**

Statistical analysis was conducted utilizing IBM SPSS Statistics (Version 26.0, IBM Corp., Armonk, NY, USA). The Shapiro-Wilk test was employed to evaluate the normality of continuous variables. Continuous variables are presented as mean ± standard deviation (SD) to facilitate comparison with previous studies. Parametric tests were applied to normally distributed variables, whereas non-parametric tests were used for variables that were not normally distributed. Categorical variables were represented as frequency (n) and percentage (%). Categorical variables were represented as frequency (n) and percentage (%). The Independent Samples t-test was employed for normally distributed data, whereas the Mann-Whitney U test was utilized for non-normally distributed variables in comparisons between two independent groups. Categorical variables were analyzed using the Chi-square test or Fisher's exact test, as applicable. Alterations in repeated measurements (pre-stroke, acute, and follow-up periods) were assessed utilizing repeated-measures ANOVA for normally distributed data and the Friedman test for non-normally distributed data. Pairwise comparisons were conducted with the Wilcoxon signed-rank test with Bonferroni adjustment. Due to the non-normal distribution of the data, correlation analyses were conducted utilizing Spearman's rank correlation coefficient (ρ). The correlation strength was classified as follows: 0.00–0.19 extremely weak, 0.20–0.39 weak, 0.40–0.59 moderate, 0.60–0.79 strong, and ≥0.80 very strong. Because the correlation coefficients were obtained from the same participants and shared a common variable, differences between the correlations of the Frail Scale and CFS with clinical variables were evaluated using Williams' test for overlapping dependent correlations. As the primary correlations were Spearman rank correlations, the analysis was performed using rank-transformed variables. A two-

sided p value of <0.05 was considered statistically significant.

P value of less than 0.05 was deemed statistically significant.

## RESULTS

In this study, the relationships between frailty, nutritional status, functional independence, and stroke severity were evaluated in 84 patients with stroke. The male and female populations were equivalent, and no statistically significant differences were seen between genders in terms of age or stroke type. Baseline characteristics of the study population are shown in Table 1.

The distribution and mean comparisons of Frail and CFS scores are shown in Table 2. The mean Frail score increased significantly from pre-stroke (Frail1: 1.27 ± 1.37) to the early post-stroke period (Frail2: 3.43 ± 1.02, $p < 0.001$) and then decreased at follow-up (Frail3: 2.26 ± 1.14, $p < 0.001$), although it remained higher than baseline levels. Similarly, the mean CFS score increased from 2.54 ± 0.95 before stroke to 7.21 ± 0.93 in the acute period ($p < 0.001$), followed by a partial decrease to 4.55 ± 1.42 at follow-up ($p < 0.001$). The marked elevation in the acute CFS score should be interpreted cautiously, as it may reflect both increased clinical vulnerability and stroke-related neurological and functional disability.

Correlation analysis was performed to evaluate the relationship between the Frail score and clinical variables. Frailty was moderately associated with age and weakly associated with stroke severity

**Table 1.** Baseline Characteristics of the Study Population

| Characteristic | Value |
|---|---|
| Number of participants | 84 |
| Age, years (Mean ± SD) | 72.18 ± 5.88 |
| Female, n (%) | 42 (50.0) |
| Male, n (%) | 42 (50.0) |
| Body mass index, kg/m² (Mean ± SD) | 26.71 ± 4.47 |
| Ischemic stroke, n (%) | 74 (88.1) |
| Hemorrhagic stroke, n (%) | 10 (11.9) |
| Pre-stroke Frail Scale (Mean ± SD) | 1.27 ± 1.37 |
| Pre-stroke Clinical Frailty Scale (Mean ± SD) | 2.54 ± 0.95 |
| Pre-stroke Mini Nutritional Assessment–Short Form (Mean ± SD) | 11.33 ± 2.32 |
| Pre-stroke Katz Index (Mean ± SD) | 5.44 ± 0.83 |
| Admission NIHSS (Mean ± SD) | 2.52 ± 0.91 |
| Admission Modified Rankin Scale (Mean ± SD) | 3.24 ± 0.83 |

**Table 2.** Changes in Frailty Status (Frail and CFS)

| **Frail Scale - Mean Comparison** | |
|---|---|
| Time Point | Mean ± SD |
| Pre-stroke (Frail1) | 1.27 ± 1.37 |
| Acute (Frail2) | 3.43 ± 1.02 |
| Follow-up (Frail3) | 2.26 ± 1.14 |
| Overall test (Friedman): $\chi^2 = 121.62$, $p < 0.001$ | |
| **Pairwise Comparisons** | |
| Comparison | p-value |
| Frail1 vs Frail2 | $p < 0.001$ ($4.30 \times 10^{-13}$) |
| Frail2 vs Frail3 | $p < 0.001$ ($8.40 \times 10^{-12}$) |
| Frail1 vs Frail3 | $p < 0.001$ ($1.63 \times 10^{-10}$) |
| **CFS Scale - Mean Comparison** | |
| Time Point | Mean ± SD |
| Pre-stroke (CFS1) | 2.54 ± 0.95 |
| Acute (CFS2) | 7.21 ± 0.93 |
| Follow-up (CFS3) | 4.55 ± 1.42 |
| Overall test (Friedman): $\chi^2 = 163.19$, $p < 0.001$ | |
| **Pairwise Comparisons** | |
| Comparison | p-value |
| CFS1 vs CFS2 | $p < 0.001$ ($9.86 \times 10^{-16}$) |
| CFS2 vs CFS3 | $p < 0.001$ ($7.98 \times 10^{-16}$) |
| CFS1 vs CFS3 | $p < 0.001$ ($6.49 \times 10^{-15}$) |



(NIHSS). A strong negative correlation was observed with nutritional status (MNA) and functional independence (Katz), which suggests that higher frailty is associated with poorer nutrition and greater dependency. No significant relationship was found between frailty and functional outcome measured by MRS (Table 3).

Correlation analysis was performed to evaluate the relationship between CFS scores and clinical variables. CFS was found to be moderately to strongly positively correlated with age and moderately correlated with stroke severity (NIHSS), indicating that higher frailty is associated with older age and greater neurological impairment. A strong negative correlation with nutritional status (MNA) and a very strong negative correlation with functional independence (Katz) were observed, which suggests that increased frailty is closely linked to malnutrition and dependence on daily activities. No significant relationship was found between CFS and functional outcome measured by the MRS (Table 4).

The correlation of CFS with age was significantly stronger than that of the Frail Scale ($t = -2.23$, $df = 81$, $p = 0.028$). Similarly, CFS showed a significantly stronger association with functional independence measured by the Katz Index ($t = 2.76$, $df = 81$, $p = 0.007$). No statistically significant differences between the two frailty measures were observed for nutritional status (MNA), stroke severity (NIHSS), or functional outcome (MRS) (all $p > 0.05$) (Table 5).

**Table 3.** Correlation Between Frail Score and Clinical Variables

| Variable | Correlation (r) | p-value | Interpretation |
|---|---|---|---|
| Age | 0.36 | 0.001 | Moderate positive correlation |
| MNA | -0.55 | <0.001 | Strong negative correlation |
| Katz Index | -0.55 | <0.001 | Strong negative correlation |
| MRS | 0.04 | 0.739 | Not significant |
| NIHSS | 0.25 | 0.021 | Weak-to-moderate positive correlation |

**Table 4.** Correlation Between Clinical Frailty Scale and Clinical Variables

| Variable | Correlation (r) | p-value | Interpretation |
|---|---|---|---|
| Age | 0.51 | <0.001 | Moderate-to-strong positive correlation |
| MNA | -0.61 | <0.001 | Strong negative correlation |
| Katz Index | -0.70 | <0.001 | Very strong negative correlation |
| MRS | 0.04 | 0.700 | Not significant |
| NIHSS | 0.30 | 0.005 | Moderate positive correlation |

**Table 5.** Comparison of Correlation Strength Between Frail and CFS Scores

| | Frail ρ | CFS ρ | t | df | p |
|---|---|---|---|---|---|
| Age | 0.363 | 0.509 | -2.231 | 81 | **0.028** |
| MNA | -0.549 | -0.611 | 1.036 | 81 | 0.303 |
| Katz Index | -0.546 | -0.697 | 2.761 | 81 | **0.007** |
| MRS | 0.037 | 0.043 | -0.075 | 81 | 0.941 |
| NIHSS | 0.251 | 0.303 | -0.723 | 81 | 0.472 |

## DISCUSSION

This study revealed a strong correlation between frailty, nutritional status, functional independence, and neurological severity in elderly stroke patients. Our findings corroborate the expanding evidence that frailty is not merely a geriatric illness but also a significant predictor of clinical outcomes in stroke patients (8-10,16). Consistent with prior research, we discovered that pre-stroke fragility was markedly correlated with poorer post-stroke clinical outcomes (17-18). This can be explained by reduced physiological reserve and impaired adaptive capacity in frail patients, making them more vulnerable to the stress of cerebrovascular events (19). Recent systematic reviews and cohort studies have found analogous findings, highlighting that fragility elevates the likelihood of negative outcomes, including disability, institutionalization, and mortality following a stroke (8-9,20). Our investigation reveals a significant negative connection between frailty and both nutritional status (MNA) and functional independence (Katz Index) (21). This highlights the multidimensional nature of frailty, encompassing physical, nutritional, and functional domains (22). Malnutrition is known to exacerbate frailty by accelerating muscle loss and impairing recovery, while functional dependency further contributes to a decline in overall health status (23-24). Therefore, the close relationship between these parameters suggests that comprehensive geriatric assessment should be an integral part of stroke management. Although frailty showed a relationship with stroke severity (NIHSS), no significant association was found with functional outcome measured by MRS. This finding may be explained by the relatively short follow-up period or the limited sample size (25). Additionally, MRS, while widely used, may not fully capture the multidimensional impact of frailty, particularly in terms of subtle functional and cognitive decline (5). Future studies with longer follow-up durations and more sensitive outcome measures may better clarify this relationship. However, the interpretation of acute CFS scores requires caution. Because the CFS incorporates mobility, function, and dependence, its marked increase during the early post-stroke period may partly reflect disability directly caused by the acute neurological event rather than frailty alone. This overlap may also have contributed to the relatively strong associations observed between CFS, Katz Index, and NIHSS. Accordingly, the pre-stroke CFS assessment may provide a more appropriate estimate of baseline frailty, whereas the acute CFS score should be interpreted as a broader indicator of post-stroke clinical vulnerability.

Another important observation is that both the Frail Scale and the Clinical Frailty Scale (CFS) showed similar associations with clinical variables, although CFS demonstrated slightly stronger correlations, particularly with functional independence and nutritional status. This suggests that CFS may better reflect the multidimensional aspects of frailty in clinical practice (15-16,25).

Although both frailty instruments demonstrated comparable associations with most clinical variables, CFS showed significantly stronger correlations with age and functional independence measured by the Katz Index. These findings suggest that CFS may better reflect the multidimensional nature of frailty, particularly in relation to age-related decline and functional status. However, no significant differences were observed between the two instruments in their associations with nutritional status, stroke severity, or functional outcome, indicating that both scales provide similar information for these clinical domains. As no multivariable analysis was performed, these associations should not be interpreted as independent predictors or evidence of causality.

From a clinical perspective, frailty assessment may help identify patients with poorer nutritional status, greater functional dependency, and increased multidimensional clinical vulnerability. However, because frailty was not significantly associated with functional outcome measured by the MRS, and no independent predictive model was established, the present findings do not support the use of



frailty assessment as a stand-alone prognostic tool. Instead, frailty assessment should be considered as one component of a comprehensive geriatric evaluation that may assist clinical characterization and individualized rehabilitation planning. Future prospective studies with larger sample sizes and multivariable predictive models are needed to clarify its prognostic value.

Identifying frailty early can help clinicians stratify risk, predict recovery trajectories, and tailor rehabilitation programs accordingly. Interventions targeting frailty, such as structured exercise programs, nutritional support, and multidisciplinary care, may improve functional outcomes and reduce complications (8,22).

Strengths and limitations of the study: This research is one of the rare domestic studies that evaluates different dimensions of frailty (physical, functional, nutritional) with multifaceted scales. However, this study has several limitations. First, its retrospective design limits the ability to establish causal relationships. Second, pre-stroke Frail Scale and Clinical Frailty Scale (CFS) scores were reconstructed using medical records and caregiver reports obtained 6–12 months before stroke. Although medical records were used whenever available, these retrospective assessments are susceptible to recall bias and potential misclassification of baseline frailty status. Therefore, the observed associations should be interpreted with caution. In addition, the relatively small sample size and single-center design may limit the generalizability of our findings. Future prospective, multicenter studies with direct pre-stroke frailty assessments are needed to validate these results. Another limitation is the potential overlap between frailty and stroke-related disability in the acute CFS assessment. Because acute neurological impairment and dependence may increase CFS scores independently of pre-existing frailty, the acute CFS values may overestimate frailty during the early post-stroke period. Future prospective studies should use assessment strategies specifically designed to distinguish baseline frailty from disability caused by the acute stroke. Furthermore, no multivariable analysis was performed to adjust for potential confounding factors. Therefore, the observed associations should not be interpreted as independent predictors or causal relationships.

In conclusion, frailty was significantly associated with nutritional status and functional independence in older adults with stroke. Although frailty demonstrated a weak association with neurological severity as measured by the NIHSS, no significant relationship was observed with functional outcome assessed by the MRS. These findings suggest that frailty primarily reflects multidimensional clinical vulnerability rather than neurological recovery itself. Incorporating frailty assessment into comprehensive geriatric evaluation and stroke rehabilitation may improve individualized care planning and risk stratification. Further prospective studies with larger sample sizes are needed to clarify the relationship between frailty and long-term neurological outcomes.

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