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# Evaluation of malnutrition and cognitive performance in patients with acute stroke

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## *Abstract*

*Objective:* To evaluate nutritional risk using Global Leadership in Malnutrition (GLIM) criteria and Mini Nutritional Assessment Test (MNA) score, cognitive performance using Montreal Cognitive Assessment (MoCA) and Mini Mental State Examination (MMSE) scores, and the association of nutritional risk with cognitive status. *Methods:* The study sample consists of 135 acute stroke patients hospitalized in a neurology clinic in Turkey. A questionnaire was used to determine the sociodemographic characteristics of the patients. MNA and GLIM criteria were used to evaluate nutritional status, the Modified Rankin Scale was used to determine the severity of stroke, and MMSE and MoCA tests were used to determine cognitive performance using a face-to-face interview technique. Anthropometric measurements of the patients were also taken. *Results:* Univariate ANOVA analysis found significant association of stroke severity and malnutrition status on cognitive performance scores separately ($p<0.005$). However, no significant association was observed with multivariate analysis. When various risk factors association were examined against dementia according to MMSE and MoCA, with univariate logistic regression analysis, gender, age, and education status was associatred with dementia. The risk of dementia increased 6.6 times in women and 1.1 times as age increased according to the MMSE score. The risk of dementia increased 4.2 times in women and 1.1 times as age increased according to the MoCA score. However, with multivariate analyses, it was found that only age had significant effect.
*Conclusion:* Evaluation of cognitive function and nutritional status is essential for stroke patients. Evaluation of stroke patients with a multidisciplinary approach can contribute to the prognosis of the disease.

*Keywords:* MNA, GLIM Criteria, MMSE, MoCA, stroke

## INTRODUCTION

Stroke is one of the leading causes of death and acquired disability, with the highest prevalence in people over 80 years of age.[1] It is not only the leading cause of death and disability worldwide[2] but also has a significant social and cost implications.[3,4] It often results in sensory deficits, motor impairments, cognitive impairments, psychosocial disorders and neurological disabilities.[1] The persistence of severe motor function impairment in individuals after rehabilitation is seen as a predictor of mortality in the following years.[5]

Severe motor function impairments, such as the inability to perform activities of daily living or dysphagia, often accompany malnutrition.[6] Malnutrition has been defined by the European Society for Clinical Nutrition and Metabolism (ESPEN) as a condition resulting from inadequate nutrition, leading to changes in body composition, decreased physical and mental functions, and increased complications from the disease.[7] Malnutrition negatively affects the diagnosis, prognosis, and clinical course of various acute or chronic diseases.[8] It is commonly seen in stroke survivors and may occur due to various disease-related factors such as dysphagia. It has been reported that its prevalence varies between 3% and 87%, and this rate increases from the acute to the post-acute stage.[4] Malnutrition worsens the quality of life. It is also negatively associated with various clinical outcomes such as short- and long-term mortality, functional recovery, infections, and hospital stay.[9] However, the nutritional status of high-risk stroke groups in the community is

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often neglected, leading to worse outcomes for the patient. Therefore, it is essential to perform nutritional screening and assessment, diagnose malnutrition, and initiate treatment.[10]

Nutritional screening is the process used to identify patients who may be at risk for malnutrition. It represents the first step in the nutritional care of patients. However, it is often not sufficiently considered in the multidisciplinary approach to diagnosing and treating patients affected by acute or chronic diseases. Assessing whether the risk of malnutrition is associated with poor functional status can improve clinical assessment in the short and long term.[4] Various nutritional screening tools are available for this purpose.[8]

Cognitive impairment, a common complication of stroke, is closely associated with ischemic stroke recurrence and has become the main source of post-stroke morbidity and mortality over time.[11,12] Studies have determined that approximately 53.1% of stroke survivors have cognitive dysfunction and are more likely to develop dementia within the next three years. This condition has been shown to reduce their quality of life seriously, affect their mental health status, and increase the burden of care for the family.[13,14]

Malnutrition has also been shown to affect the prognosis of dementia negatively. It is also known that malnutrition predicts poor short-term functional outcomes and mortality after ischemic stroke.[15] A study has shown that nutritional support improves cognitive outcomes after stroke.[16] Therefore, since optimal dietary intervention can improve cognitive performance in malnourished stroke patients, it is very important to assess nutritional status following ischemic stroke.

Given all this information, this study aims to evaluate nutritional risk using Global Leadership in Malnutrition (GLIM) criteria and Mini Nutritional Assessment Test (MNA) score, cognitive performance using Montreal Cognitive Assessment (MoCA) and Mini Mental State Examination (MMSE) scores, and to associate nutritional risk with cognitive status.

## METHODS

This research is a cross-sectional, descriptive study. The study sample consists of 135 acute stroke patients hospitalized in the Neurology Clinic of Kastamonu Education and Research Hospital between June and July 2024. Patients who were confused, had advanced dementia, were uncooperative, were aphasic after stroke, and had percutaneous endoscopic gastrostomy were not included in the study. A questionnaire was used to determine the sociodemographic characteristics of the patients, such as age, occupation, marital status, where they lived. The MNA and GLIM criteria were used to evaluate nutritional status, the Modified Rankin Scale was used to determine the degree of disease, and the MMSE and MoCA tests were used to determine cognitive performance using a face-to-face interview technique. Anthropometric measurements of the patients, such as body weight, height, and mid-upper arm circumference, were taken.[17] The body mass index (BMI) was calculated by dividing the body weight by the square of the height (Body weight (kg) / Height (m2)).[18]

### *Mini Nutritional Assessment (MNA)*

The mini nutritional assessment short form was developed by Rubenstein and colleagues in 2001 from the long form of the MNA, which consists of 18 subparameters, to determine the nutritional status of older adults. The mini nutritional assessment short form consists of six subparameters, including anthropometric measurements, lifestyle habits, medication use, food consumption, and subjective assessment of health problems.[19] Lover values indicate worse nutrition.

### *Global Leadership Initiative on Malnutrition (GLIM) criteria*

In 2019, to ensure global standardization of malnutrition diagnosis and prevent delays in diagnosis/treatment, clinical nutrition organizations came together under the "GLIM" and developed the GLIM criteria. GLIM's recommendation is a two-step approach. Accordingly, a second-stage approach has been proposed for diagnosing and grading malnutrition severity after identifying risky patients using one of the validated screening tests in the primary care setting. In the second stage, it is recommended that patients be evaluated for unintentional weight loss, low BMI, decreased muscle mass, decreased food intake, digestion, and disease severity/inflammation severity. In these criteria, the percentage of weight loss, low BMI, and reduced muscle mass are considered phenotypic criteria, while decreased food intake and digestion and disease severity/inflammation status are considered etiological criteria. According to GLIM, at least one phenotypic criterion and one etiological criterion are required to diagnose malnutrition.[20]

Modified Rankin Scale (mRS) was used to measure the degree of disability and dependency in patients due to stroke or another neurological problem, and it evaluates between 0-6 points.[21]

*Montreal Cognitive Assessment Scale (MoCA)*

MoCA, was developed to evaluate mild cognitive impairments was used in this study. It evaluates different cognitive abilities, including executive functions, visual-spatial skills, memory, language, attention and concentration, abstract thinking, calculation, and orientation. The highest total score that can be obtained from the test is 30. Accordingly, scores of 21 and above are considered normal.[22,23]

*Mini-Mental State Examination (MMSE)*

MMSE test, was developed by Folstein and his colleagues in 1975. It is the most commonly used and easily applied test in dementia screening.[24,25] The standard mini-mental state test is grouped under five main headings: orientation (10 points), recording memory (3 points), attention and calculation (5 points), recall (3 points), and language (9 points). The scale is evaluated out of a total of 30 points. Traditionally, scores between 24 and 30 are considered normal. A score below 24 indicates cognitive impairment. A score between 18-23 points is considered mild dementia, 12-17 points is considered moderate dementia, and below 12 points is considered severe dementia.

*Statistical analysis*

IBM SPSS 25 program was used in the evaluation of the data. The values of the descriptive variables are stated as number (n), percentage (%), arithmetic mean, standard deviation, median, minimum and maximum values. The conformity of the data to normal distribution was evaluated with the Kolmogorov-Smirnov test. Since the data did not show a normal distribution, Spearman's correlation test was used for correlation analysis. Kruskal Wallis test was applied to compare cognitive performance and disease severity according to GLIM criteria. The conformity of GLIM criteria and the MNA screening test was evaluated with the Cohen kappa test. Univariate ANOVA test was used to assess the effect of disease degree and malnutrition on cognitive performance. Risk factors affecting cognitive performance were evaluated with regression analysis. The significance level in the study was taken as $p < 0.05$.

## RESULTS

The general characteristics of the patients were given in Table 1. When the malnutrition of the patients was evaluated, 67.4% did not have malnutrition according to GLIM criteria, while 46.7% did not have malnutrition according to MNA. When the disease severity of the patients was evaluated, 3.7% of the patients had no symptoms, while 13.3% had very severe disability. When the cognitive performance of the patients was evaluated, 11.9% had normal cognitive performance according to MMSE and 8.9% according to MoCA.

GLIM criteria and MNA test had moderate agreement (Kappa = 0.595, $p<0.001$).

The correlation of malnutrition status with disease severity and cognitive status was given in Table 2. There was a positive correlation between GLIM criteria and Modified Rankin Score and a negative correlation between MMSE and MoCA Score ($p<0.001$).

The evaluation of cognitive performance scores according to Modified Rankin Score and malnutrition was shown in Table 3. Descriptive Statistics of Table 3 was shown in Table 4. The Modified Rankin Score's main effect was significant on MMSE scores ($p<0.001$). While MMSE score was 24.4 ± 3.9 in patients with no symptoms, it was 4.7 ± 7.3 in patients with severe disability. The main effect of GLIM criteria was significant on MMSE score ($p<0.001$). While MMSE score was 14.1 ± 8.6 in patients without malnutrition, it was 5.2 ± 6.6 in patients with severe malnutrition. MMSE scores of those with no symptoms and no significant disability were higher than those with slight, moderate, moderately severe, and severe disability ($p<0.001$). Those without malnutrition had the highest MMSE score. There was no difference between MMSE scores in patients with moderate and severe malnutrition ($p<0.001$). The Modified Rankin Score's main effect was significant on MoCA scores ($p<0.001$). While the MoCA score was 19.6 ± 4.3 in those with no symptoms, it was 3.5 ± 5.2 in those with severe disability. The main effect of the GLIM criteria was significant on MoCA scores ($p<0.001$). While the MoCA score was 11.2 ± 7.6 in those without malnutrition, it was 2.4 ± 3.4 in those with moderately severe malnutrition. The MoCA score of those with no symptoms and no significant disability was higher than those with slight, moderate, moderately severe, and severe disability ($p<0.001$). Those without malnutrition had the highest MoCA score.

**Table 1: General and clinical characteristics of the patients**

| | Female (n=75 %55.6) | Male (n=60 %44.4) | Total (n=135) |
|---|---|---|---|
| Age (Mean±SD) | 73.0±14.6 | 69.2±13.2 | 71.3±14.1 |
| Education status | | | |
| Not Primary School | 55 (73.3) | 8 (13.3) | 63 (46.7) |
| Primary school | 17 (22.7) | 44 (73.3) | 61 (45).2 |
| High school | 1 (1.3) | 6 (10.0) | 7 (5.2) |
| Undergraduate/graduate | 2 (2.7) | 2 (3.3) | 4 (3.0) |
| Marital status | | | |
| Married | 34 (45.3) | 49 (81.7) | 83 (61.5) |
| Single | 41 (54.7) | 11 (18.3) | 52 (38.5) |
| Place of residence | | | |
| Alone at home | 9 (12.0) | 5 (8.3) | 14 (10.4) |
| At home with spouse | 13 (17.3) | 24 (40.0) | 37 (27.4) |
| With children/relatives | 53 (70.7) | 31 (51.7) | 84 (62.2) |
| Income status | | | |
| Below minimum wage | 58 (77.3) | 36 (60.0) | 94 (69.6) |
| Above minimum wage | 17 (22.7) | 24 (40.0) | 41 (30.4) |
| Presence of other diseases | | | |
| No | 7 (9.3) | 13 (21.7) | 20 (14.8) |
| Yes | 68 (90.7) | 47 (78.3) | 115 (85.2) |
| Cardiovascular disease | 58 (77.3) | 35 (58.3) | 93 (68.9) |
| Diabetes | 27 (36.0) | 26 (43.3) | 53 (39.3) |
| Thyroid diseases | 5 (6.7) | 4 (6.7) | 9 (6.7) |
| Respiratory diseases | 7 (9.3) | 8 (13.3) | 15 (11.1) |
| Neurological diseases | 12 (16.0) | 6 (10.0) | 18 (13.3) |
| Autoimmune diseases | 1 (1.3) | - | 1 (0.7) |
| Sensory loss | 3 (4.0) | 2 (3.3) | 5 (3.7) |
| Nutritional screening tests | | | |
| GLIM criteria | | | |
| No risk of malnutrition | 45 (60.0) | 46 (76.7) | 91 (67.4) |
| Moderate malnutrition | 26 (34.7) | 13 (21.7) | 39 (28.9) |
| Severe malnutrition | 4 (5.3) | 1 (1.7) | 5 (3.7) |
| MNA | | | |
| Undernourished /Malnutrition) | 14 (18.7) | 2 (3.3) | 16 (11.9) |
| At risk | 33 (44.0) | 23 (38.3) | 56 (41.5) |
| Normal | 28 (37.3) | 35 (58.3) | 63 (46.7) |
| Modified Rankin scale | | | |
| No symptoms | 1 (1.3) | 4 (6.7) | 5 (3.7) |
| No sinnificang disability | 13 (17.3) | 13 (21.7) | 26 (19.3) |
| Slight disability | 17 (22.7) | 16 (26.7) | 33 (24.4) |
| Moderate disability | 16 (21.3) | 8 (13.3) | 24 (17.8) |
| Severe disability | 17 (22.7) | 12 (20.0) | 29 (21.5) |
| Very severe disability | 11 (14.7) | 7 (11.7) | 18 (13.3) |
| MMSE score | | | |
| Severe dementia | 47 (62.7) | 22 (36.7) | 69 (51.1) |
| Moderate dementia | 14 (18.7) | 5 (8.3) | 19 (14.1) |
| Mild dementia | 11 (14.7) | 20 (33.3) | 31 (23.0) |
| Normal | 3 (4.0) | 13 (21.7) | 16 (11.9) |
| MoCA score | | | |
| Abnormal | 72 (96.0) | 51 (85.0) | 123 (91.1) |
| Normal | 3 (4.0) | 9 (15.0) | 12 (8.9) |
| Anthropometric measurements | Ortalama±SS | Ortalama±SS | Ortalama±SS |
| BMI | 28.6±6.0 | 28.0±4.3 | 28.3±5.3 |
| Upper middle arm circumference | 27.9±3.7 | 29.6±3.5 | 28.6±3.7 |

MNA: Mini Nutritional Assessment, GLIM: Global Leadership Initiative on Malnutrition, MMSE: Mini Mental State Examination. MoCA: Montreal Cognitive Assessment, BMI: Body Mass Index,

**Table 2: Correlation of malnutrition status with disease severity and cognitive status**

| | GLIM Criteria | |
|---|---|---|
| | r | p* |
| Modified rankin scale | .763** | <0.001 |
| MMSE Score | -.707** | <0.001 |
| MoCA Score | -.682** | <0.001 |

* Spearmans' test. Kolmogorov smirnov test was applied for the conformity of the data to normal distribution. GLIM: Global Leadership Initiative on Malnutrition, MMSE: Mini Mental State Examination. MoCA: Montreal Cognitive Assessment

There was no difference between the MoCA scores in those with moderate and severe malnutrition (p<0.001). The combined effect of the modified Rankin score and GLIM criteria on MMSE and MoCA scores was not significant (p>0.05).

According to MMSE, risk factors affecting patients' dementia were examined using logistic regression analysis, and the analysis results are presented in Table 5. As a result of univariate analyses, the risk of dementia in women increased by 6.6 times compared to men (p=0.005). The risk of dementia increased by 1.1 times as age increased (p<0.001). A significant effect was found that the risk of dementia decreases as the MNA Score increases (p=0.002). As the Modified Rankin Score increased, the risk of dementia increased by 5.8 times (p<0.001). According to GLIM Criteria, as the presence of malnutrition increased, the risk of dementia increased by 8.5 times (p=0.042). As a result of multivariate analyses, the risk of dementia increased by 6.3 times as the Modified Rankin Score increased (p=0.013). No significant effect of other risk factors on the risk of dementia was found (p>0.05). The accuracy of the model was 88.1%. According to MoCA, the risk factors affecting the cognitive performance of the patients were examined using logistic regression analysis, and the analysis results are presented in Table 6. As a result of univariate analyses, the risk of dementia increased by 4.2 times in women compared to men (p=0.037). The risk of dementia increased by 1.1 times as age increased (p<0.001). A significant effect was found in the direction that the risk of dementia decreases as the MNA Score increases (p=0.013). As the Modified Rankin Score increased, the risk of dementia increased by 3.5 times (p=0.001). As a result of multivariate analyses, the risk of dementia increased by 1.3 times as age increased (p=0.018). No significant effect of other risk factors on the risk of dementia was detected (p>0.05). The accuracy of the model was 91.1%.

## DISCUSSION

Malnutrition is frequently seen in patients with acute stroke and is associated with disease severity. Therefore, the early detection of malnutrition is important. MNA and GLIM criteria are commonly used tests in malnutrition screening. International organizations have accepted their validity and reliability. These two screening tools were used to detect malnutrition in this study. Cognitive performance is another clinical outcome in which a decrease is seen in patients with acute stroke. This study used two measurement tools with international validity and reliability, MMSE and MoCA, to evaluate cognitive performance. Studies have shown that there is a relationship between nutritional status and cognitive performance in patients with stroke. Optimum nutrition is essential to preserve and improve cognitive function.[26-28] To the best of our knowledge, this is the first study to investigate the relationship between malnutrition and cognitive performance in stroke using GLIM, MMSE, and MoCA.

In our study, according to GLIM criteria, malnutrition status was negatively correlated with modified Rankin score and MMSE and MoCA scores. In the presence of malnutrition, cognitive performance scores decreased, and disease severity increased (p<0.005). Univariate ANOVA analysis found significant main effects of disease severity and malnutrition status on cognitive performance scores separately. However, no effect was observed with multivariate analysis. When risk factors for dementia, measured by MMSE and MoCA, were evaluated with univariate logistic regression analysis, gender, age, and education status affected the risk of dementia. According to univariate analyses, it was observed that the risk of dementia increased 6.6 times in women and 1.1 times as age increased according to the MMSE score and that the risk of dementia increased 4.2 times in women and 1.1 times as age increased according to the MoCA score. However, as a result of multivariate analyses, it was found that only age had an effect. Lee *et al*. conducted a study on post-stroke patients, reported that the risk of dementia increased in women, similar to our study.[29] Wang *et al*. found that the risk of cognitive impairment decreased as the education level increased.[26] In this study, some of the factors that increased the risk of dementia according to both MMSE and MoCA were found to be age,

**Table 3: Evaluation of cognitive performance scores according to Modified Rankin score and malnutrition status**

| | MMSE Score | | | | | | MoCA Score | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Sum of Squares** | **Sd** | **K.O.** | **F** | **p** | **Partial Eta Squares** | **Sum of Squares** | **Sd** | **K.O.** | **F** | **p** | **Partial Eta Squares** |
| Modified Rankin score | 3102.039 | 5 | 620.408 | 15.576 | <0.001 | 0.394 | 2121.770 | 5 | 424.354 | 13.698 | <0.001 | 0.363 |
| GLIM criteria | 974.661 | 2 | 487.331 | 12.235 | <0.001 | 0.169 | 922.507 | 2 | 461.253 | 14.889 | <0.001 | 0.199 |
| Modified rankin score * GLIM criteria | 226.903 | 7 | 32.415 | 0.814 | 0.578 | 0.045 | 89.179 | 7 | 12.740 | 0.411 | 0.894 | 0.023 |

MMSE $R^2$= 0.570, MoCA $R^2$=0.553, Univariate ANOVA test GLIM: Global Leadership Initiative on Malnutrition, MMSE: Mini Mental State Examination, MoCA: Montreal Cognitive Assessment

**Table 4: Descriptive statistics of Table 3**

| | MMSE Score | | | | MoCA Score | | | |
|---|---|---|---|---|---|---|---|---|
| | GLIM criteria | | | | GLIM criteria | | | |
| **Modified rankin score** | **No risk of malnutrition (n=91)** | **Moderate malnutrition (n=39)** | **Severe malnutrition (n=5)** | **Total** | **No risk of malnutrition (n=91)** | **Moderate malnutrition (n=39)** | **Severe malnutrition (n=5)** | **Total** |
| No symptoms (n=5) | 24.4 ± 3.9 | - | - | 24.4 ± 3.9[a] | 19.6 ± 4.3 | - | - | 19.6 ± 4.3[a] |
| No obvious disability (n=26) | 21.8 ± 4.1 | 16.4 ± 7.1 | - | 20.4 ± 5.5[a] | 18.3 ± 5.4 | 12.1 ± 7.8 | - | 16.7 ± 6.6[a] |
| Slight disability (n=33) | 14.8 ± 7.1 | 6.5 ± 8.9 | 9.0 ± 0.0 | 13.1 ± 7.9[b] | 11.3 ± 6.4 | 3.5 ± 4.3 | 5.0 ± 0.0 | 9.7 ± 6.7[b] |
| Moderate disability (n=24) | 9.4 ± 7.2 | 5.8 ± 6.8 | 15.0 ± 0.0 | 8.9 ± 7.1[b] | 8.1 ± 6.2 | 1.6 ± 3.6 | 7.0 ± 0.0 | 6.7 ± 6.1[b] |
| Severe disability (n=29) | 7.1 ± 7.0 | 2.1 ± 3.2 | 1.0 ± 0.0 | 5.0 ± 6.2[b] | 5.1 ± 6.0 | 1.5 ± 3.6 | 0.0 ± 0.0 | 3.6 ± 5.3[b] |
| Very severe disability (n=18) | 11.3 ± 8.8 | 1.6 ± 3.8 | 0.5 ± 0.7 | 4.7 ± 7.3[b] | 8.2 ± 5.8 | 1.4 ± 3.1 | 0.0 ± 0.0 | 3.5 ± 5.2[b] |
| Total (n=135) | 14.1 ± 8.6[a] | 5.7 ± 7.7[b] | 5.2 ± 6.6[b] | 11.3 ± 9.1 | 11.2 ± 7.6[a] | 3.7 ± 6.0[b] | 2.4 ± 3.4[b] | 8.7 ± 7.9 |

Univariate ANOVA test. a-b: No difference exists between scores with the same letter. GLIM: Global Leadership Initiative on Malnutrition, MMSE: Mini Mental State Examination. MoCA: Montreal Cognitive Assessment

**Table 5: Logistic regression analysis of risk factors affecting patients' risk of dementia according to MMSE**

| | MMSE score | | | |
|---|---|---|---|---|
| | Uni | | Multi | |
| | OR (% 95 CI) | p | OR (% 95 CI) | p |
| Gender (Male) | | | | |
| Female | 6.6 (1.8 - 24.6) | **0.005** | 21.9 (0.9 - 562.5) | 0.063 |
| Age | 1.1 (1.0 - 1.1) | **<0.001** | 1.0 (0.9 - 1.1) | 0.662 |
| Education (Not Primary School) | | | | |
| Primary school | 0.1 (0.0- 0.8) | **0.027** | 0.4 (0 - 21.5) | 0.666 |
| High school | 0.0 (0.0 - 0.3) | **0.002** | 0.0 (0.0 - 2.4) | 0.106 |
| Undergraduate/graduate | 0.0 (0.0- 0.1) | **0.001** | 0.0 (0.0 - 2.2) | 0.085 |
| Marital Status (Married) | | | | |
| Single | 0.3 (0.1 - 1.2) | 0.096 | 0.6 (0.0- 27.8) | 0.812 |
| Place of residence (At home with spouse) | | | | |
| With their children | 1.4 (0.2 - 8.5) | 0.732 | 3.9 (0.0- 1353.7) | 0.652 |
| Home Alone | 1.2 (0.2 - 6.3) | 0.802 | 2.2 (0.0- 240.7) | 0.742 |
| Presence of other diseases (No) | | | | |
| Yes | 0.3 (0.1 - 1) | 0.058 | 1.7 (0.1 - 20.3 | 0.674 |
| MNA | 0.6 (0.4 - 0.8) | **0.002** | 0.8 (0.4 - 1.6) | 0.529 |
| Modified Rankin score | 5.8 (2.4 - 13.9) | **<0.001** | 6.3 (1.5 - 26.9) | **0.013** |
| BMI | 0.9 (0.9 – 1.0) | 0.186 | 1.0 (0.7 - 1.2) | 0.739 |
| Upper middle arm circumference | 0.9 (0.8 – 1.0) | 0.171 | 1.1 (0.7 - 1.7) | 0.561 |
| GLIM criteria (No Malnutrition) | | | | |
| Malnutrition | 8.5 (1.1 - 66.5) | **0.042** | 0.1 (0 - 5.8) | 0.218 |
| Constant | | | 2.1 | 0.920 |
| Cox & Snell R Square=0.356 | Nagelkerke R Square=0.689 | | Accuracy= 0.881 | |

BMI: Body Mass Index, GLIM: Global Leadership Initiative on Malnutrition, MMSE: Mini Mental State Examination, MNA: Mini Nutritional Assessment

female gender, and presence of malnutrition. According to previous review, age, female gender, and previous nutritional deficiency are among the factors that increase the risk of malnutrition.[3]

Based on a result of univariate logistic regression analysis, we also found an increase in disease severity based on the Modified Rankin score increased the risk of dementia based on MMSE and MoCA (5.8 times; 3.5 times in the given order). However, this relationship could not be confirmed when multivariate analyses were used. Lee *et al*.[29] found that disease severity increased the risk of dementia. Wang *et al*. İn a post-stroke study, also found the risk of cognitive impairment increased 1.2 times as the severity of the disease increased.[26] Factors such as individual differences, localization of the stroke, and the quality of the rehabilitation program can also significantly affect this relationship. In our study, it was shown that disease severity reduced cognitive performance in the acute period. Studies conducted on post-stroke patients also report that cognitive performance decreased depending on the severity of the disease in the later periods.[26,29]

As a result of univariate logistic regression analysis, the risk of dementia increased 8.5 times, according to MMSE, in the presence of malnutrition, according to GLIM. As the MNA score increased indicating better nutrition, the risk of dementia decreased according to both scales (OR: 0.6). Wang *et al*. conducted on post-stroke patients, those who were poorly nourished according to the prognostic nutritional index (PNI) had a significantly lower MMSE score than those who were well nourished.[26] Similarly, Lee *et al*. examined the relationship between malnutrition and the risk of cognitive impairment in post-stroke patients, the risk of cognitive impairment

**Table 6: Logistic regression analysis of risk factors affecting patients' risk of dementia according to MoCA**

| | **MoCA score** | | | |
|---|---|---|---|---|
| | **Uni** | | **Multi** | |
| | **OR(% 95 CI)** | **p** | **OR(% 95 CI)** | **p** |
| Gender (Male) | | | | |
| Female | 4.2 (1.1 - 16.4) | **0.037** | 28.2(0.6- 1399.9) | 0.094 |
| Age | 1.1 (1.1 - 1.2) | **<0.001** | 1.3 (1 - 1.6) | **0.018** |
| Education (Not Primary School) | | | | |
| Primary school | 0.1 (0.0 – 1.0) | 0.055 | 1.9 (0 - 133.6) | 0.764 |
| High school | 0.0 (0.0 - 0.3) | **0.002** | 0 (0 - 8.6) | 0.249 |
| Undergraduate/graduate | 0.0 (0.0 – 1.0) | **0.048** | 318.5 (0.1- 793320.9) | 0.149 |
| Marital Status (Married) | | | | |
| Single | 0.5 (0.1 – 2.0) | 0.321 | 110.8 (0.5- 22420.5) | 0.082 |
| Place of residence (At home with spouse) | | | | |
| With their children | 1.9 (0.3 - 12.7) | 0.513 | 0 (0 - 53.6) | 0.382 |
| Home Alone | 1.8 (0.3 - 9.9) | 0.481 | 0.4 (0 - 80.7) | 0.744 |
| Presence of other diseases (No) | | | | |
| Yes | 0.3 (0.1 - 1.1) | 0.071 | 0.7 (0 - 10) | 0.786 |
| MNA | 0.6 (0.4 - 0.9) | **0.013** | 0.4 (0.1 - 1.2) | 0.090 |
| Modified Rankin score | 3.5 (1.7 - 7.2) | **0.001** | 0.9 (0.2 - 3.8) | 0.942 |
| BMI | 0.9 (0.8 – 1.0) | 0.130 | 1.0 (0.7 - 1.2) | 0.751 |
| Upper middle arm circumference | 0.9 (0.7 – 1.0) | 0.082 | 1.0 (0.7 - 1.5) | 0.881 |
| GLIM criteria (No Malnutrition) | | | | |
| Malnutrition | 5.9 (0.7 - 47.3) | 0.094 | 0.3 (0.0 – 99.0) | 0.715 |
| Constant | | | 0.0 | 0.733 |
| Cox & Snell R Square=0.294 | Nagelkerke R Square=0.651 | | Accuracy= 0.911 | |

BMI: Body Mass Index, GLIM: Global Leadership Initiative on Malnutrition, MoCA: Montreal Cognitive Assessment, MNA: Mini Nutritional Assessme

in patients with a low geriatric nutritional risk index score was 2.6-fold increased.[29] In our study, the fact that malnutrition has a more significant effect on the risk of dementia compared to the studies conducted by Wang *et al*.[26] and Lee *et al*.[29] may be because our study was conducted in the early stages of the disease. The different periods in which cognitive performance was measured may cause the results to differ. Tsutsumiuchi *et al*.[28] In a retrospective study, when patients with acute stroke and cognitive impairment were admitted to the rehabilitation clinic, it was found that 75.6% of them were malnourished when their malnutrition status was examined. In this study, MMSE and MoCA scores were significantly higher in patients with acute stroke without malnutrition than in those with severe and moderate malnutrition. In light of these data, the relationship between malnutrition and cognitive performance in stroke patients is bidirectional. While malnutrition reduces cognitive performance, low cognitive performance also increases the risk of malnutrition. Inadequate intake of some nutrients, especially B vitamins and iron, negatively affects cognitive performance, and disorders in cognitive performance can increase malnutrition due to forgetting to eat, having difficulty preparing food, and rejecting certain foods.

One of the limitations of this study is that it was conducted in a single center and had a limited number of patients. It is possible that the results would be different in a more sociodemographically heterogeneous group. The sample of this study consists of patients with low education levels and economic power. This situation may have led to low cognitive performance. Since no long-term follow-up was performed in this study, changes

in cognitive performance could not be monitored. This study is a cross-sectional study conducted on acute stroke patients. Therefore, longitudinal changes in nutritional status during the follow-up period and their effects on prognosis could not be evaluated.

In conclusion, evaluation of both cognitive function and nutritional status is essential for stroke patients. Evaluation of stroke patients with a multidisciplinary approach can contribute to the prognosis of the disease. Malnutrition can cause decreased cognitive performance, and decreased cognitive performance can also cause malnutrition. To improve malnutrition, a personalized nutrition plan rather than standard hospital menus and support with enteral products, when needed, can effectively prevent malnutrition and decrease cognitive performance in stroke patients.

## DISCLOSURE

Ethics: Ethical approval for this research was received from Çankırı Karatekin University Health Sciences Ethics Committee (Date: 05.06.2024 Meeting no: 14).

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