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Article

"Is the Mini Nutritional Assessment Short Form (MNA-SF) an Effective Tool for Malnutrition Screening in Parkinson's Disease?" - A Prospective Cross-Sectional Study

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Abstract: Background/Objectives: Malnutrition is a frequently observed and essential problem among patients with Parkinson's Disease (PD) that significantly affects their overall health and quality of life. The Mini Nutritional Assessment Short Form (MNA-SF) is a standard tool for screening malnutrition in diverse clinical populations. However, the suitability of MNA-SF to detect nutritional deficiencies in PD patients requires a comprehensive evaluation. In this context, we determined the usefulness of MNA-SF as a tool to identify dietary problems in patients with PD. **Methods**: Demographic data, disease characteristics, and nutritional characteristics of 42 patients with PD were recorded. Patients were evaluated for malnutrition using clinical scoring. In addition, MNA-SF was applied to each patient, and the results were compared with clinical scores. **Results**: 22 of 42 patients (or 52.4%) were female, and the mean age of the patients was 59.33±10.19 years. In clinical malnutrition diagnoses, 76.2% of the participants were not malnourished, while the rate of malnourished patients was 23.8%. According to the MNA-SF assessment, 21.4% were malnourished, 38.1% were at risk of malnutrition, and 40.5% showed normal nutrition. The patients who were malnourished had a lower MNA-SF score when compared to the patients who were not malnourished (p =.004). The area under the curve (AUC) is 80.0 percent (CI: 62.1-97.9), effectively distinguishing those malnourished and those not (P=0.005). The sensitivity and specificity were 70.0% and 87.5%, respectively, using a threshold score below 8.5 (CI: 39.7-89.2) (CI: 71.9-95.0). **Conclusions**: The MNA-SF is a reliable and sufficient tool for identifying malnutrition in individuals with PD.

Keywords: Parkinson's disease; malnutrition; nutritional assessment; MNA-SF

1. Introduction

Parkinson's Disease (PD) is recognized globally as the second most prevalent neurodegenerative disease, following Alzheimer's disease, particularly among people over the age of 50. It affects approximately 1% of the population over 65[1,2]. PD is characterized by motor symptoms, including tremors, postural instability, rigidity, and bradykinesia. Additionally, non-motor symptoms such as dysphagia, reduced gastrointestinal motility, monotonous speech, fatigue, depression, and cognitive impairment may also develop[3] . These motor and non-motor problems cause alterations in weight and nutritional status, further complicating the morbidity profile of affected patients.

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Malnutrition has been defined as undernutrition due to inadequate nutrient intake, overnutrition due to excessive nutrient intake, specific nutrient deficiencies, and imbalance due to disproportionate nutrient intake [4]. Therefore, malnutrition can be seen in people who are normal or overweight. This situation reveals that malnutrition cannot be detected clinically only by inspection, and it is essential to increase clinicians' knowledge on this issue and suspect malnutrition. Malnutrition can significantly reduce the quality of life[5] worsen cognitive decline [6], negatively affect the success of treatment, cause susceptibility to infections[7], prolong hospitalizations[8], and cause rapid and aggressive progression of existing diseases[9], especially in people with neurodegenerative diseases[10]. The malnutrition criteria defined by the European Society for Clinical Nutrition and Metabolism (ESPEN) can be briefly summarized as the presence of at least two out of six malnutrition criteria, such as weight loss, low energy intake, muscle mass loss, loss of subcutaneous fat, fluid accumulation, and reduced hand grip strength[11]. PD patients are at a greater risk of malnutrition compared to healthy adults at every stage of the disease [10]. Mini Nutritional Assessment (MNA) is widely used and internationally validated for assessing nutritional status. MNA consists of 18 questions and can be performed by physicians, nurses, or trained persons, but it takes approximately 15 minutes to administer [12]. This period is quite long in outpatient clinics with intensive patient care. Therefore, a short form of MNA, Mini Nutritional Assessment Short Form (MNA-SF), has been recommended [13]. Studies have shown that MNA-SF is as good a tool for screening as MNA in various patient populations. MNA-SF is a simple, non-invasive, widely used form of MNA scale to screen for malnutrition. It is mainly used to detect the risk of early malnutrition in patients with normal body mass index (BMI) and albumin values. Beyond the screening method, it can also be used for nutritional follow-up of patients [14,15].

2. Materials and Methods

In this prospective cross-sectional study, forty-two patients diagnosed with PD were enrolled consecutively based on their admission to the outpatient clinic between January 2023 and January 2024. All participants met the diagnostic criteria for PD, as outlined by the United Kingdom Parkinson's Disease Society Brain Bank [16]. The study was approved by the Eskişehir Osmangazi University Medical Faculty Clinical Research Ethics Committee (Approval no/date: 36/20.12.2022) and was in accordance with national law, institutional ethical standards, and the 1964 Helsinki Declaration and its later amendments. Assessments were based on the Health Research Act 10. The study included patients with any stage of PD, regardless of ethnicity or sex, who were at least 18 years of age. Exclusion Criteria were as follows: PD patients presenting with potential confounding factors that might independently predispose to malnutrition (malignancies, autoimmune diseases, dementia, endocrine disorders; those with a clinical history of obsessive-compulsive disorder, antipsychotic medication usage, eating behavior disorders, or impulse control disorders). All tests were performed during the medication ON state.

MNA-SF was performed by a neurology specialist (NDC, author). If the patient is on a protein-restricted PD diet, it was noted. Protein-restricted diet is offered by the same dietician if needed. Clinical diagnosis of malnutrition was assessed using ESPEN diagnostic criteria. Demographic characteristics (age, gender, education), disease characteristics [Hoehn & Yahr stage, disease duration, levodopa equivalent daily dosage (LEDD), dopamine agonist use, duration after deep brain stimulation (DBS) surgery], body measurements [height (in centimeters), weight (in kilograms), BMI (kg/m^2), BMI category, body fat percent, muscle weight, skeletal muscle mass, lean body weight (LBM)] were recorded. The BMI of the participants were recorded. 1998 the National Heart, Lung, and Blood Institute (NHLBI) clinical guidelines designate a BMI of 25-29.9 as overweight. Additionally, a BMI of 30 or higher is obesity, and the NHLBI guidelines specify Class 1 obesity as a BMI of 30-34.9, Class 2 obesity as a BMI of 35-39.9, and Class 3 obesity, also known as extreme or severe obesity, as a BMI of 40 or above[17].

Bioelectrical impedance assessment is a non-invasive and quick method for estimating body composition, focusing on measuring body fat, muscle mass, and total body water. This assessment

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can be affected by hydration status, food intake, and physical activity[18]. LBM is the total weight of an individual's body minus all the fat mass. It comprises the weight of bones, muscles, organs, and other tissues, excluding fat. LBM is an essential indicator of metabolic health, physical function, disease prevention recovery, and healing processes. Body fat rate, also known as body fat percentage, refers to the proportion of an individual's body weight of fat tissue[19]. Skeletal muscle mass refers to the amount of muscle attached to the skeleton, enabling movement and supporting posture. This parameter is vital in overall health and physical function, particularly as individuals age. Adequate skeletal muscle mass is essential for maintaining mobility, balance, and strength. Reduced skeletal muscle mass, or sarcopenia, is linked to a heightened risk of frailty, falls, and chronic diseases [20]. To optimize the results, all the patients were standardized in the same conditions (consistent hydration, avoiding food, and exercise for 12 hours).

2.1. Statistics

IBM SPSS for Windows 20.0 (SPSS Inc. Chicago, IL) program was used, and $p<0.05$ was accepted as the limit of statistical significance in the evaluation. Mean, standard deviation, median, and minimum-maximum IQR values were given in descriptive statistics for continuous data, and number and percentage values were shown in discrete data. Mann-Whitney U test was used to compare continuous data between patients without and with malnutrition. Chi-square and Fisher's Exact test were used to compare nominal variables (cross-tabulations). The diagnostic performance of MNA-SF values was assessed by area under the ROC Curve (AUC). The best cut-off point was calculated using Youden's Index. The diagnostic accuracy of MNA-SF values was evaluated using diagnostic accuracy criteria (sensitivity, specificity, positive predictive, and negative predictive values).

3. Results

Of the 42 patients, 20 men (47.6%) and 22 women (52.4%), with a mean age of 59.33 years (SD = 10.19, range: 38-84 years), consented to participate in the study. The distribution of PD stages was captured using the Hoehn & Yahr Scale, where 42.9% of patients were classified as Stage 2. The demographic and clinical characteristics of the patients are summarized in **Table 1.**

Table 1. Demographic and clinical characteristics of the patients.

Demographic characteristics	**Mean± SD**	**Median (Min-Max)**
Age, years	59.33 ± 10.19	60 (38-84)
Height, cm	164.98 ± 11.82	165 (130-187)
Weight , kg	72.26 ± 15.93	74.8 (31.4-103.0)
BMI, kg/m^2	26.51 ± 5.27	25.6 (14.4-37.0)
	n	**(%)**
Gender		
Woman	22	52.4
Male	20	47.6
BMI group		
Underweight	2	4.8
Normal	17	40.5
Overweight	11	26.2
Obesity (Class 1)	10	23.8
Obesity (Class 2)	2	4.8
Education		
Primary School	16	38,1
Middle School	4	9.5
High School	7	16.7
University	15	35.7

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Disease characteristics	Mean± SD	Median (Min-Max)
Duration of disease, years	10.95 ± 5.84	10 (2-25)
LEDD, unit	961.81 ± 383.77	933 (300-1774)
Duration of DBS, years (n=23)	3.97 ± 3.63	3 (0.3-13.0)
	n	**(%)**
Hoehn & Yahr Scale		
Stage 1	1	2.4
Stage 1.5	9	21.4
Stage 2	18	42.9
Stage 2.5	9	21.4
Stage 3	3	7.1
Stage 4	2	4.8
Agonist use		
Yes	31	73.8
No	11	26.2

BMI: Body mass index; LEDD: Levodopa equivalent daily dose; DBS: Deep Brain Stimulation; SD: Standard deviation; Min-Max: minimum-maximum.

The MNA-SF indicated a mean score of 10.14, revealing diverse nutritional statuses among patients. Regarding MNA-SF assessments, 21.4% were clinically malnourished, and 38.1% were at risk of malnutrition, with 40.5% exhibiting normal nutrition. In clinical malnutrition diagnoses, 76.2% of the participants were not malnourished, contrasting with 23.8% who were. The data also underscored the implementation of Parkinson's diet recommendations, with 85.7% of patients advised to follow a specific diet, and 88.9% of those recommended were compliant. The nutritional characteristics of the patients are summarized in **Table 2.**

Table 2. Nutritional characteristics of the patients.

Nutritional characteristics	Mean ± SD	Median (Min-Max)
MNA-SF score	10.14 ± 3.24	11 (1-14)
	n	**(%)**
Parkinson's diet recommendation		
No not recommended	6	14.3
Proposed	36	85.7
Parkinson's diet (n=36)		
Did not apply	4	11.1
Implementing	32	88.9
MNA-SF assessment		
Malnutrition	9	21.4
Risk of malnutrition	16	38.1
Normal nutrition	17	40.5
Clinical diagnosis of malnutrition		
Malnutrition	10	23.8
Normal nutrition	32	76.2

* MNA-SF: Mini Nutritional Assessment-Short Form; SD: Standard deviation; Min-Max: minimum-maximum.

Body measurements revealed that the mean weight was 72.26 kg (SD = 15.93, range: 31.4-103.0 kg) and the mean height was 164.98 cm (SD = 11.82, range: 130-187 cm). The average BMI across the study group was calculated at 26.51 (SD = 5.27, range: 14.4-37.0), with the distribution indicating that 28.6% of participants were classified as obese, 26.2% as overweight, 40.5% as having a normal weight, and 4.8% as underweight. The reported mean body fat percentage previously provided was incorrectly associated with the height data and, therefore, requires correction for accurate

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representation. The mean body muscle mass was 47.51 kg (SD = 10.69, range: 20.2-64.6 kg), and the skeletal muscle mass was 21.02 (SD = 3.54, range: 15.6-34.9 kg). The mean LBM was also determined to be 17.28 kg (SD = 2.77, range: 11.9-21.9 kg). Serum albumin levels, assessed in 36 participants, averaged 4.54 g/dL (SD = 0.51, range: 3.5-6.8 g/dL), reflecting generally sufficient nutritional status within the cohort.

The study compared 32 patients without malnutrition against ten patients with malnutrition, focusing on age, height, weight, BMI, and duration of illness. Although age and height did not show significant differences between the groups, there were notable disparities in weight and BMI. Patients with malnutrition had significantly lower weight (p=0.001) and BMI (p=0.001) than those without. Furthermore, when comparing the BMI classifications of malnourished and non-malnourished patients, the proportions of patients with underweight/normal and overweight/obese status were significantly different (p=0.026). **Table 3** summarizes the demographic characteristics of patients with and without clinical malnutrition.

Table 3. Demographic characteristics of patients with and without clinical malnutrition.

	Clinically normonourished (n=32)		**Clinically malnourished (n=10)**		
	Mean±SD	**Median (Min-Max)**	**Mean±SD**	**Median (Min-Max)**	***p***
Age, years	59.03±9.69	60 (38-82)	60.30±12.19	57 (43-84)	0.896[a]
Height, cm	165.69±11.44	167.5 (130-187)	162.70±13.33	163.5 (142-185)	0.531[a]
Weight, kg	76.64±13.59	78.6 (31.4-103.0)	58.23±15.26	53.4 (37.7-87.5)	**0.001**[a]
BMI	27.95±4.69	27 (18.6-37.0)	21.92±4.44	21.1 (14.4-30.3)	**0.001**[a]
Duration of disease, years	11.28±6.04	11 (2-25)	9.77±5.19	8 (5-20)	0.631[a]
	n	**%**	**n**	**%**	
BMI					
Underweight/Normal	11	34.4	8	80.0	**0.026**[b]
Overweight/Obesity	21	65.6	2	20.0	
Gender					
Woman	15	46.9	7	70.0	0.284[b]
Male	17	53.1	3	30.0	

[a]Mann Whitney U test, [b]Chi-Square Tests/Fisher's Exact test BMI: Body mass index; SD: Standard deviation; Min-Max: minimum-maximum.

Malnourished patients had significantly lower body muscle weight (mean 41.36 kg, p=0.036), skeletal muscle mass (mean 22.97, p=0.011), and LBM (mean 15.28 kg, p=0.012) compared to their non-malnourished counterparts. Although the body fat rate and serum albumin levels were lower in malnourished patients, these did not reach statistical significance (p=0.084 and p=0.926, respectively). **Table 4** summarizes the results of the impact of physical health parameters (body measurements, LEDD, serum albumin values) of PD patients with and without malnutrition according to the diagnosis of clinical malnutrition.

Malnourished patients had a lower MNA-SF score than non-malnourished patients (p=0.004). Furthermore, a significant proportion of malnourished patients (60%) were categorized as at higher risk of malnutrition compared to non-malnourished patients (20%) (p=0.006). Other parameters, such as the duration of DBS and Hoehn & Yahr Scale stages, did not show significant differences.

Out of the ten patients with clinical malnutrition, six were found to be malnourished according to MNA-SF scoring, and two were found to be at risk of malnutrition. Three clinically non-malnourished patients were found in the malnourished group according to MNA-SF scoring. Of the

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42 patients, three were malnourished only according to the score, two were malnourished only according to the clinic, and six were malnourished clinically and according to the score. Fourteen patients were not clinically malnourished but were found to be at risk according to the score **(Table 5).**

Table 4. The comparison of body measurements and serum biochemical markers between PD patients categorized by their malnutrition status.

	Clinically normonourished (n=32)		Clinically malnourished (n=10)		
	Mean±SD	**Median (Min-Max)**	**Mean±SD**	**Median (Min-Max)**	***p*[a]**
Body Fat Rate	31.80±8.27	31.7 (17.9-48.7)	25.21±7.83	26.3 (10.7-35.4)	0.084
Body Muscle Weight	49.43±9.73	49.2 (20.2-64.6)	41.36±11.80	37.8 (27.6-58.9)	**0.036**
Skeletal Muscle Mass	20.42±3.57	20.0 (15.6-34.9)	22.97±2.81	21.8 (20.1-27.2)	**0.011**
Lean Body Weight	17.91±2.43	18.2 (12.1-21.9)	15.28±2.97	14.7 (11.9-20.9)	**0.012**
LEDD	962.25±404.70	901.5 (300-1774)	960.40±326.80	1016 (399-1502)	0.850
Serum albumin (n=36)	4.57±0.53	4.4 (3.9-6.8)	4.43±0.41	4.5 (3.5-4.9)	0.926

[a]Mann Whitney U test LEDD: Levodopa equivalent daily dose; SD: Standard deviation; Min-Max: minimum-maximum.

Table 5. Comparison of disease and nutritional characteristics of patients with and without malnutrition according to the presence of clinical malnutrition.

	Clinically normonourished (n=32)		Clinically malnourished (n=10)		
	Mean±SD	**Median (Min-Max)**	**Mean±SD**	**Median (Min-Max)**	**p**
MNA-SF Score	11.12±2.19	11 (7-14)	7.00±4.11	7 (1-13)	**0.004[a]**
Hoehn & Yahr Scale		3 (1-4)		3 (1.5-4)	0.965[a]
Duration of DBS (n=23)	3.96±3.74	3 (0.3-13.0)	7.00±3.55	3 (1.0-9.0)	0.785[a]
	n	**%**	**n**	**%**	
Agonist use					
Yes	25	78.1	6	60.0	0.410[b]
No	7	21.9	4	40.0	
DBS					
Yes	19	59.4	4	40.0	0.468[b]
No	13	40.6	6	60.0	
Parkinson's diet (n=36)					
Did not apply	4	14.8	0	0	0.553[b]
Implementing	23	85.2	9	100	
MNA-SF Assessment					
Malnutrition	3	9.4	6	60.0	
Risk of malnutrition	14	43.8	2	20.0	**0.006[b]**
Normal nutrition	15	46.9	2	20.0	

[a]Mann Whitney U test, [b]Chi-Square Test/Fisher's Exact test DBS: Deep Brain Stimulation; MNA-SF: Mini Nutritional Assessment-Short Form; SD: Standard deviation; Min-Max: minimum-maximum.

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With an Area Under the Curve (AUC) of 80.0% (CI: 62.1-97.9), the MNA-SF effectively discriminated between malnourished and non-malnourished individuals (p=0.005). Using a threshold score of less than 8.5, the sensitivity and specificity were 70.0% (CI: 39.7-89.2) and 87.5% (CI: 71.9-95.0), respectively. Positive Predictive Value (PPV) and Negative Predictive Value (NPV) stood at 63.6% (CI: 47.3-77.4) and 90.3% (CI: 76.2-96.8). Further, analysis using Fisher's Exact test revealed significant differences in the prevalence of malnutrition among groups divided by the MNA-SF score, with a low score strongly associated with higher rates of clinically observed malnutrition (p=0.001).

4. Discussion

In the present study, 76.2% of participants were not clinically malnourished, while 23.8% were clinically malnourished. PD's motor and non-motor features alter patients' nutritional intake and eating behavior. Therefore, a significant proportion of patients with PD are prone to malnutrition or undernutrition due to the chronic and degenerative nature of the disease [21]. In a cross-sectional study investigating the relationship between malnutrition, clinical parameters, and health-related quality of life in 92 elderly patients hospitalized for PD organized by Gruber et al. [22], it was observed that one in two patients was malnourished or at risk of malnutrition. In multivariate analysis, male gender, longer disease duration, higher Hoehn & Yahr, and depression were associated with total MNA score. In the 3-year longitudinal study by Barichella et al.[23], the MNA score of 61 PD patients decreased from 24.9 ± 1.6 to 24 ± 2.5 at follow-up (P = 0.02), and the malnutrition risk rose from 22.9% to 34.3%. A linear correlation was observed between the MNA score and disease duration (P = 0.0096). Dietary assessment subscore and BMI decreased significantly The present study found no significant relationship between disease duration and malnutrition. Although the normal/low BMI ratio was higher in patients with malnutrition included in our research, malnutrition was detected in two patients with high BMI.

In a study aiming to determine the prevalence of malnourished individuals and those at risk of malnutrition among PD patients using MNA and anthropometric measurements, the mean total MNA score was not significantly different between 143 PD patients and 145 healthy controls. The study found that three (2.1%) PD patients suffered from malnutrition, and 37 (25.9%) were at risk of malnutrition. A similar pattern was observed in the control group (P = 0.228). The researchers investigated mean calf circumference and found it significantly lower in PD patients[24]. In a study by Pisciotta et al.[25], 195 PD patients underwent clinical assessment, including body composition, body mass index, and nutritional status (MNA). Linear regression modeling revealed a negative correlation between UPDRS III scores and total body fat in kg and percentage, percentage of android fat, trunk-limb fat, and android-gynoid fat ratio. After categorization by MNA score, all parameters of android-like fat distribution were negatively associated with UPDRS III in participants with MNA < 23.5 (malnutrition or risk of malnutrition). In the present study, body muscle weight, skeletal muscle mass, and LBM values were significantly lower in malnourished patients. These findings highlight the severe impact of malnutrition on muscle mass and body composition, critical factors that potentially exacerbate the physical decline observed in PD.

A protein-rich diet elevates the plasma level of large neutral amino acids (LNAAs). However, high plasma concentrations of LNAAs decrease the therapeutic efficacy ofLevodopa by reducing its absorption in the intestine and transport into the brain. For patients with motor fluctuations or on protein-restricted diets, low-protein diets (LPDs) and protein-redistribution diets (PRDs) may enhance the effectiveness of levodopa treatment. Protein-restricted diets can lead to various side effects, including malnutrition, sarcopenia, weight loss, constipation, and dyskinesia [26,27].In our study, it was observed that a protein-restricted diet did not have a statistically significant relationship with the risk of malnutrition.

Shidfar et al. conducted a study published in 2016 that revealed a significant subset of people with PD faced problems with their nutrition. The study followed 130 people diagnosed with PD[28]. When assessing their nutritional status using the MNA, only 30% were deemed normonourished;

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more than half (58.5%) were in the at-risk range for malnutrition, with a mere 11.5% being malnourished. Advanced stages of PD were significant as they related to progressive worsening of both muscle mass and nutritional status. In the current study, although the majority of patients with malnutrition according to the Hoehn & Yahr scale were at stage 2, malnutrition was also seen in stage 1 and stage 4 patients. No statistically significant correlation was found between malnutrition and Hoehn & Yahr stage. We think that the small number of patients in our study and the lack of an equal number of patients from each stage is a limiting factor in terms of the effectiveness of the comparison. Also, our study may suggest that factors other than motor severity may influence nutritional status, pointing out the complexity of malnutrition in PD and the need for early and continuous nutritional screening, independent of disease stage.

According to our results, 23.8% of PD patients had clinical malnutrition, and 21.4% of the patients had malnutrition according to MNA-SF. MNA-SF was effective in detecting malnutrition or risk of malnutrition in patients with PD. In the study conducted to investigate whether MNA-SF could define frailty according to Fried criteria in 1003 patients aged ≥ 65 years, Fried criteria consisted of involuntary weight loss, fatigue, low activity level, weakness, and slowness, and a score was assigned for each criterion. A score of 0 was considered not frail; a score of 1-2 was regarded as frontal frailty, and a score of 3 was considered frail. The MNA-SF with a cut-off point of 11.0 had a sensitivity of 71.2% and a specificity of 92.8% in detecting frail participants. In comparison, the MNA-SF with a cut-off point of 13 had a sensitivity of 45.7% and a specificity of 78.3%. [29]. A study by Sarikaya et al.[30] investigated the full-length MNA and the MNA-SF as malnutrition screening tools used with a sample of 236 Turkish male and female adults aged at least 65 years. The study's results were that both the full-length test and the short form showed essentially the same level of agreement with the clinical assessment of malnutrition. The kappa coefficients, which measure the level of agreement, between the two assessment methods were nearly identical, 0.68 for the full-length test and 0.66 for the short form of the test. When the researchers looked at how well the tests performed overall in diagnosing malnutrition, they found that the full-length test had a sensitivity of 92% and a specificity of 86%. The short form had a sensitivity of 94% and a specificity of 81%. In the study, which included 75 PD patients to determine whether MNA-SF is sufficient to detect malnutrition, participants were classified as "malnourished" and "not malnourished" according to their total MNA scores. PD patients with normal MNA-SF scores were evaluated according to their MNA scores. 58.7% of PD patients and 28.6% of controls were malnourished. The 32.5% of PD patients with normal MNA-SF scores were defined as malnourished according to the total MNA. MNA-SF had a sensitivity of 87.1% and a specificity of 70.5% in PD. Total MNA was sufficient to measure malnutrition in PD, but MNA-SF missed many patients who were malnourished [31]. In our study, we noted that the MNA-SF test could not identify all patients who were either at risk of malnutrition or malnourished. This may be because MNA-SF is not a PD-specific screening test. Weight gain in the early stages of treatment and motor and non-motor complications in PD patients may cause MNA-SF not to determine the nutritional status of some PD patients. However, the corresponding ROC curve demonstrated the robust diagnostic ability of the test. These findings underscore that MNA-SF is a reliable tool for early malnutrition screening in clinical settings.

Limitations

This study had several limitations. First, the number of samples was limited, also there was no healthy control group.

The cross-sectional design of our study is also a limitation, longitudinal studies would be able to account for changes in nutritional status and its association with its progressive nature. Besides, non-motor comorbidities like dysphagia and other gastrointestinal symptoms may influence the malnutrition and the tool's performance and further research may be needed. Also, protein-restricted diets commonly recommended patients to enhance the efficicacy of Levodopaa also potentiate the malnutrition risk. We reported compliance to these diets but the effect on nutritional deficiencies deserves more attention.

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Moreover, early-stage PD's nutritional risk profile may differ from more advanced stages. Future studies should examine these differences, which will need to stratify patients by disease onset. Furthermore, our sample size did not allow us to verify a correlation between impaired nutritional status and disease duration, as was favored in other studies. This requires validation in larger studies. Finally, Sensitivity and specificity of the MNA-SF tool are potentially affected by age, severity, and standards within specific regions. Larger studies are necessary to confirm that it can be applied to different populations and while MNA scores.

5. Conclusions

In conclusion this study revealed that malnutrition is common in PD and emphasized that MNA-SF is a suitable tool for screening. The MNA-SF demonstrated significant effectiveness in detecting nutritional deficiencies among PD patients. The test was evaluated as feasible under routine outpatient clinic examination conditions because it takes an average of three minutes to administer, can be performed interactively with patients and their relatives, and does not require laboratory test results. It can be used to screen for malnutrition in patients with PD.

Supplementary Materials: The following supporting information can be downloaded at the website of this paper posted on Preprints.org, The data of the research is added as a Supplement (Supplement 1)

Author Contributions: In this study, N.D.C., S.O., RTÇ, and E.Ç,. Methodology was developed by N.D.C., S.O., and A.T., who also handled the software aspects. Validation and formal analysis were performed by N.D.C. and R.T.Ç., E.Ç., who also led the investigation and data curation efforts. Resources were provided by N.D.C., S.O., E.Ç. and R.T.Ç. The original draft of the manuscript was written by N.D.C., S.O., M.Y., and A.Y.K., while review and editing were done by N.D.C., A.T., S.O.,and A.Y.K. Visualization was managed by N.D.C. and S.O., with supervision provided by S.O. Project administration was undertaken by N.D.C. and S.O.

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Institutional Review Board Statement: . The study was approved by the Eskişehir Osmangazi University Medical Faculty Clinical Research Ethics Committee (Approval no/date: 36/20.12.2022) and was in accordance with national law, institutional ethical standards, and the 1964 Helsinki Declaration and its later amendments. This study has been carried out by the Code of Ethics of the World Medical Association (Declaration of Helsinki) 1975, as revised in 2013. All patient details have been de-identified to prevent the possibility of patient identification. The reporting of this study conforms to STROBE guidelines[9]

Informed Consent Statement: Written informed consent was obtained from all subjects involved in the study before participation.

Data Availability Statement: The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding authors. We can confirm that the data supporting the findings of this study are available and can be shared (Supplement 1).

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Abbreviations

The following abbreviations are used in this manuscript:

BMI: Body mass index

DBS: Deep Brain Stimulation

ESPEN: European Society for Clinical Nutrition and Metabolism
LBM: Lean body weight
LEDD=Levodopa equivalent daily dose

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UPDRS III= Unified Parkinson's Disease Rating Scale III
MNA: The Mini Nutritional Assessment
NHLBI: The National Heart, Lung, and Blood Institute
PD = Parkinson's disease

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