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The hidden impact: frailty and malnutrition in patients with diabetic foot ulcers

Levent Demir[1], Mustafa Avcı[2], Murat Kahraman[3], Selahattin Kılıç[4]

[1]Department of Underwater and Hyperbaric Medicine, Kayseri City Hospital, Kayseri, Turkiye
[2]Department of Emergency Medicine, Antalya Traning and Research Hospital, Antalya, Turkiye
[3]Department of Orthopedics and Traumatology, Kayseri City Hospital, Kayseri, Turkiye
[4]Department of Family Medicine, Kayseri City Hospital, Kayseri, Turkiye

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ABSTRACT

Aims: Diabetic foot ulcers (DFUs) are a significant complication affecting over 30% of individuals with diabetes, leading to increased morbidity and mortality. This study investigates the relationships between frailty, nutritional status, and quality of life in patients aged 50 and older diagnosed with DFUs.

Methods: A total of 100 participants with DFUs were prospectively included in the study, with assessments conducted using the Edmonton Frailty Scale and the Mini Nutritional Assessment Scale. Quality of life was evaluated using the EQ-5D-3L scale. Demographic data, concomitant diseases, medications, HbA1c levels, and participants' height, weight, and circumferences of the upper arm, calf, and waist were recorded. The data analysis was performed using statistical software.

Results: The findings revealed that 50% of patients exhibited varying degrees of frailty, and 85% were at risk of malnutrition. Both frailty and malnutrition were associated with a significant decline in quality of life. Notably, patients with normal nutritional status reported higher quality of life scores compared to those at risk of malnutrition or malnourishment.

Conclusion: This study underscores the need for a holistic approach to managing DFUs that integrates frailty and nutritional status assessments. Targeted interventions addressing these factors are essential for improving health outcomes and enhancing the quality of life for individuals living with diabetes. The findings advocate a shift from a narrow focus on wound management to a broader, more comprehensive care strategy.

Keywords: Diabetic foot ulcers, frailty, nutrition, quality of life

INTRODUCTION

The prevalence of diabetes worldwide is increasing, especially among the elderly, due to longer life expectancies.[1] Frailty is an increasingly significant complication of diabetes in older adults. It refers to a state of diminished physiological reserve, which heightens an individual's vulnerability to negative health outcomes, including an increased mortality risk. Frailty is characterized as a multidimensional condition that enhances vulnerability in older individuals, leading to a decline in health status reduced resilience, and increased functional impairment.[2,3] This condition is associated with various physical changes, including reduced bone density, muscle weakness, low blood pressure, impaired vision, and problems with joints and hearing.[3,4] The recognition of frailty is increasingly emphasized in diabetes management guidelines for older adults. These recommendations often lack specificity and fail to consider the varying levels of frailty and other factors that impact clinical outcomes.[5]

Diabetic foot ulcers (DFUs) affect more than 30% of individuals with diabetes at some point in their lives. The global healthcare burden associated with DFUs is expected to rise significantly in the coming years. This increase is primarily due to the growing prevalence of DFUs, which is occurring alongside an aging population that is more vulnerable to both foot ulcers and other types of diabetic foot complications.[6] Individuals with DFUs have a higher risk of mortality compared to those with diabetes who do not have DFUs. This connection between DFUs and increased mortality cannot be explained by other major diabetes complications that also raise the risk of death.[7] The relationship between DFUs and frailty is significant, as frailty has been identified as an independent risk factor for poor healing outcomes and increased re-hospitalization rates in patients with DFUs.[8] It is also possible that a DFU is a marker of increased medical frailty, necessitating increased healthcare provider vigilance in the care of the patient.[7]

Corresponding Author: Levent Demir, drldemir@yahoo.com

Nutritional status significantly contributes to frailty, making it a modifiable risk factor. Studies indicate that dietary changes can play a crucial role in preventing and treating frailty.[9,10] Patients with DFUs often have poor nutritional status, which is associated with an impaired healing process. These patients require comprehensive care from a multidisciplinary team to optimize wound healing. However, one crucial aspect often overlooked is their nutritional status.[11] Research has shown that nutrition deficiencies are linked to an increased risk of amputation[12] and mortality[13] in patients with DFUs.

A recent literature review indicates that DFUs significantly impact patients' physical and mental health-related quality of life. Patients with DFU exhibit a more pronounced decline in quality of life across multiple domains, including social, psychological, physical, and economic aspects.[14] As a result of reduced mobility and associated lifestyle modifications, there is a further deterioration in the quality of life in these patients. The impact of DFUs on quality of life is so significant that patients with diabetic foot amputations who can mobilize have a higher quality of life than patients with DFUs.[15] Quality of life is a crucial indicator of active aging, significantly affecting life expectancy and mortality rates among older populations. The quality of life for older adults can be greatly affected by factors such as frailty and nutritional status.[16]

A holistic approach to diabetic foot management can help reduce the risk of complications. Although numerous studies have focused on individuals with diabetes, research examining the connection between frailty, nutritional status, and quality of life in patients with diabetic foot complications is still limited. This study investigates frailty, nutritional status, and quality of life in patients with DFUs. By addressing these factors through targeted interventions, the study seeks to provide recommendations to improve health outcomes and promote overall well-being for individuals with diabetes.

METHODS

Ethics and Study Desing

Patients with DFUs admitted to our outpatient clinic were consecutively and prospectively included in this study between February 2023 and May 2024. The research was conducted in accordance with the principles of the Declaration of Helsinki and was approved by the Kayseri Clinical Researches Ethics Committee (Date: 31.01.2023, Decision No: 794). Informed consent was obtained from each participant. A total of one hundred individuals aged 50 years and older who were diagnosed with DFUs and agreed to participate by signing the consent form were included in the study. Patients who did not cooperate were excluded from the study.

A questionnaire was administered using a face-to-face interview method to all participants. Demographic data, concomitant diseases, and medications used were noted in the questionnaire form. Glycosylated hemoglobin A1c (HbA1c) was recorded from patient files. The same investigator measured all participants' height, weight, upper arm, calf circumference, and waist circumference and recorded these measurements.

Frailty

The Edmonton Frailty Scale, developed by Rolfson et al.,[17] assesses frailty in patients. Aygör[18] validated and ensured its reliability in Turkiye. The scale consists of 11 questions and is evaluated on a 0-20 point scale. If the score obtained from the scale is in the range of 0-4, the elderly individual is not frail; 5-6 is visibly vulnerable; 7-8 is mildly frail; 9-10 is moderately frail, and 11 points and above is considered severely frail. This scale assesses frailty in older adults, including those with various health conditions, such as foot disorders. One study specifically aimed to evaluate the Edmonton Frailty Scale's validity, reliability, and sensitivity in predicting frailty outcomes in elderly patients with foot disabilities, which include conditions like diabetic foot syndrome.[19]

Assessment of Nutrition Statement

We utilized the mini nutritional assessment (MNA) scale to evaluate the nutritional status of participants. This scale is recommended by the European Society of Clinical Nutrition and Metabolism, the International Association of Gerontology and Geriatrics, and the International Academy of Nutrition and Aging. The MNA was first applied to patients in 1994 and consists of four sections with a total of 18 questions.[20]

The sections include;

Anthropometric assessment: This evaluates body mass index (BMI), weight, and arm and calf circumference measurements.

General assessment: This covers lifestyle factors, the number of medications taken, mobility, and symptoms of depression and dementia.

Short nutritional assessment: This focuses on meal frequency, food and fluid intake, and autonomy in nutrition.

Subjective assessment: This gathers information on individuals' self-perception of health and nutrition.

These assessments were conducted with the participants at the start of the study. The MNA scale was selected for nutritional evaluation due to its extensive validation as a reliable tool for assessing malnutrition across various populations, including older adults and individuals with chronic conditions.[20] MNA scores below 17 points indicate malnutrition, between 17 and 23.5 points indicate malnutrition risk, and ≥24 points indicate no malnutrition risk.

Quality of Life

The patients' quality of life was assessed with the EQ-5D 3L version of the general Quality of Life Scale (QOLS). The EQ-5D-3L QOLS is a general health scale. It consists of two parts. The EQ-5D-3L index score consists of 5 dimensions: movement, self-care, usual activities, pain/discomfort, and anxiety/depression. Patients also assessed their health on the EQ Visual Analog Scale (EQ-VAS). 100 mm indicates "the best imaginable health state," and 0 mm indicates "the worst imaginable health state".[21]

Statistical Analysis

The data collected in the study were analyzed using the IBM SPSS version 25 software package (SPSS Inc, Chicago, IL, USA). In descriptive statistics, continuous data were

presented as mean, standard deviation, median, minimum, and maximum values, and categorical data were presented as number and percentage values.

The chi-square test was used for statistical comparison of categorical data. Kolmogorov-Smirnov analysis evaluated normal distribution for continuous data, and one-way ANOVA and Kruskal Wallis tests were used to compare groups. Post hoc analysis of significance between frailty groups was performed using one-way ANOVA and Tamhane's T2 test. After the Kruskal-Wallis test, Bonferroni correction and Mann-Whitney U test were used. A p-value less than 0.05 was considered statistically significant at a 95% confidence interval. In chi-square post hoc analysis, significance was determined with Bonferroni correction for values less than 0.01 for the subgroups of the Frailty Scale and less than 0.017 for the Mini Nutrition Scale, and adjusted p values were used in other post hoc evaluations. The statistical tests used to create the tables are indicated as footnotes.

RESULTS

A total of 100 patients were included in the study. The mean age of the study participants was 66.75±7.14 years. It was found that 27.0% of the individuals in the sample were female, 91.0% of these individuals were married, 64.0% were primary school graduates, and 85.0% had income equal to expenses (**Table 1**).

The mean value of the Edmonton Frailty Scale was 6.35±3.04. It was also found that 8.0% of the individuals were severely frail, 22.0% were mildly frail, and 20.0% were moderately frail (**Table 1**).

Patients were categorized into five classes based on the Edmonton Frailty Scale. No significant differences were found between the demographic data and clinical characteristics (**Table 2**).

Our study also evaluated the EQ-5D-3L general QOLS. According to the scale, an increase in value indicates a decrease in quality; it was observed that quality of life decreased with increasing frailty. In addition, it was found that on a scale of 0-100, where patients rated their health status, the value rated by the patients decreased significantly with increasing frailty (**Table 3**).

The mean, median values, and distribution of the patients according to the Mini Nutrition Scale are given in **Table 3**.

According to the frailty score, 15 of the non-frail patients, 18 of the visibly vulnerable patients, 19 of the mildly frail patients, 15 of the moderately frail patients and 7 of the severely frail patients were at risk of malnutrition. It was determined that the mean value of the total assessment score decreased from the non-frail group to the severely frail group, while the patients were predisposed to malnutrition, with a significant difference between the groups (**Table 4**).

When the patients were classified according to the Mini Nutrition Score, a decrease in the general QOLS score from Normal Nutrition to Malnutrition, i.e., a decrease in the general quality of life, was determined (**Table 5**).

DISCUSSION

This study found that 50% of patients with diabetic foot disease aged 50 and over in our outpatient clinic exhibited varying degrees of frailty. Moreover, 25% of these patients were identified as vulnerable and at risk of developing frailty. Additionally, 85% were malnourished, and these results were associated with decreased quality of life. Wound healing in diabetic foot patients is associated with the patient's frailty,[8] nutritional status,[11] and quality of life.[22] The results of this study highlight the need for new strategies to improve the care of patients with DFUs. These strategies could encourage a shift from a limited focus on wound management to a broader, more holistic approach to patient care.

Diabetes is a complex condition that affects multiple body systems, including the vascular, neurological, and immune systems. A holistic approach to the management of diabetes involves an examination of the interactions between these systems and their contribution to diabetic foot complications.[23] This approach requires a comprehensive assessment of the individual's medical history, nutritional status, physical activity, and psychosocial factors in order to identify risk factors and enable individualized interventions.[24]

Few studies have investigated frailty in patients with DFUs, and the high frailty rate observed in this study aligns with the findings of those studies.[3,6,8] Frailty is a key predictor of clinical outcomes, and early detection can help slow functional decline. However, screening for frailty is often inadequate due to the lack of a universally accepted definition. Frailty indicates extreme vulnerability to low-intensity stressors, resulting from challenges in maintaining homeostasis and a loss of functional reserve. It represents a multisystem dysregulation and a pre-disability state marked by declining health and loss of independence. Additionally, frailty can be identified early through recognition of a pre-frailty state.[25] Frailty in patients with DFUs occurs at a younger age and is associated with impaired wound healing.[8] It is crucial to recognize frailty and identify individuals who are at risk. Health promotion, proper nutrition, social engagement, and light physical activity are effective strategies for preventing frailty.[26]

Our study, as well as other studies,[11,27-33] shows that malnutrition is very common in patients with DFU, but this is often overlooked.[11,27] Nutrient deficiencies are among the major risk factors in DFU development and healing. Nutrient deficiencies modify the physiological responses to infection by diminishing the immune response, predisposing the skin to become thin and flaky, thereby increasing the likelihood of developing a wound. The deficiencies also decrease subcutaneous fat at pressure points, exacerbating the vulnerability to pressure wounds. Nutrient deficiencies also reduce the collagen synthesis required for wound healing and promote immobility due to diminished energy reserves. Malnutrition adversely affects the complex wound-healing process.[27] In our study, 11% of patients were malnourished, and 74% were at risk of malnutrition. This result is similar to the proportions at risk of malnutrition (49% to 70%) or malnourished (15% to 62%) found in randomized controlled trials.[28] Dietary recommendations for patients

Table 1. Comparison of the stratification of frailty score categories and demographic data

Variable	No frailty group 1 n: 25	Visibly vulnerable group 2 n: 25	Mild frailty group 3 n: 22	Moderate frailty group 4 n: 20	Severe frailty group 5 n:8	p
Age (mean±SD)	66.40±5.38	66.12±6.01	65.73±7.59	64.88±6.92	64.88±6.92	0.084[a]
HbA1c (%) (mean±SD)	8.53±1.95	9.08±2.23	8.08±2.15	8.59±1.72	9.88±2.69	0.249[a]
Duration of diabetes (years) median (min-max)	18 (1-30)	18 (1-35)	14 (1-40)	20 (1-30)	21 (10-30)	0.485[b]
Gender (male), n	21	17	18	13	4	0.243[b]
Wagner grade, n						
2	14	7	6	8	0	0.090[b]
3	9	13	14	11	8	
4	2	5	2	1	0	
Marital status (married), n	24	22	20	18	7	0.883[b]
Health insurance, n						
Pension fund	4	8	4	4	1	0.749[b]
SSK	18	11	12	11	4	
Self-employed	3	4	3	4	3	
No insurance	0	2	3	1	0	
Education status, n						
Illiterate	1	2	0	5	1	0.195[b]
Primary school	11	15	17	14	7	
Secondary school	5	5	2	0	0	
High school	8	2	2	1	0	
License	0	1	1	0	0	
Occupation, n						
Housewife	3	7	4	7	4	0.125[b]
Retired	16	15	16	12	3	
Officer	2	2	0	1	0	
Self-employment	3	0	1	0	0	
Worker	1	1	0	0	1	
Other	0	0	1	0	0	
Income level, n						
Less than expenses	1	3	0	3	1	0.668[b]
Equals expenses	24	21	22	13	5	
More than expenses	0	1	0	4	2	
Occupation, n						
Working	0	1	0	0	0	0.109[b]
Not working	2	2	2	0	1	
Retired	20	17	16	12	3	
Housewife	3	5	4	8	4	
Living situation, n						
Alone	1	1	3	1	1	0.790[b]
Wife and children	8	10	4	4	2	
Wife	13	12	11	13	5	
Family	2	1	4	0	0	
With relatives	0	1	0	1	0	
Children	1	0	0	1	0	
Alcohol intake, n (yes)	1	1	0	0	1	0.418[b]
Smoking, n (yes)	3	5	6	3	0	0419[b]
Insulin therapy, n (yes)	18	21	18	19	8	0.198[b]

[a]One way ANOVA test (Tamhane's T2 test), [b]Kruskal Wallis test, [c]Mann-Whitney U test, p<0.01, was considered significant. There is a significant difference between group 1 and group 3, between group 1 and group 4, between group 1 and group 5, SD: Standard deviation, Min: Minimum, Max: Maximum

Table 2. EQ-5D-3L General Quality of Life Scale and comparison results with frailty groups

Variable	No frailty group 1	Visibly vulnerable group 2	Mild frailty group 3	Moderate frailty group 4	Severe frailty group 5	p
EQ-5D-3L total[b] (median, min-max)	8 (5-15)	9 (6-11)	9 (5-14)	12 (9-15)	13 (8-14)	<0.001[a]
Current health status (%)[c] (median, min-max)	70 (15-100)	60 (40-100)	50 (0-90)	50 (5-80)	45 (0-70)	<0.001[a]

[a]Kruskal Wallis test, [b]Mann-Whitney U test, p<0.01 was considered significant. There is a significant difference between group 1 and group 2, group 1 and group 3, group 1 and group 4, and group 1 and group 5. There is a significant difference between group 2 and group 4; between group 2 and group 5. There is a significant difference between group 3 and group 4. [c]Mann Whitney U test, p<0.01, was considered significant. There is a significant difference between group 1 and group 4 and between group 1 and group 5. There is a significant difference between group 2 and group 4, Min: Minimum, Max: Maximum

Table 3. Mini Nutrition Assessment Scale evaluation results

Variable	Mean±SD	Median	Min-max
Evaluation		11.50	8.0-15.0
Screening score		9.0	4.0-14.0
Total evaluation	20.57±3.35		12.0-28.0

SD: Standard deviation, Min: Minimum, Max: Maximum

with DFUs should prioritize proper wound healing through the consumption of adequate energy sources and essential nutrients.[29] Nutritional supplementation with antioxidants,[30] other essential micronutrients,[31] and proteins, along with nutritional education,[32] may accelerate the wound healing process in patients with DFUs. National and international guidelines for wound healing are lacking, leading to the recent publication of an expert consensus and guidelines for nutritional interventions in adults with DFUs.[33]

Our study found a significant link between malnutrition and frailty in patients with DFU, both of which contribute to a reduced quality of life. Patients with DFUs often report a poor quality of life, which can deteriorate further if the ulcer recurs or fails to heal. Several factors influence this quality of life, including older age, weight, educational background, foot self-care practices, and the presence of peripheral neuropathy.[34] Frailty correlates with disability, lower quality of life, and cognitive impairment, with studies reporting a strong association in those examining these outcomes.[35] Pre-frailty and frailty are associated with increased risks of mortality and cardiovascular events, leading to higher healthcare utilization in patients with type 2 diabetes mellitus.[36] Reducing frailty can enhance the quality of life.[37] Frailty is a considerable concern for the aging population, and dietary nutrition is considered a key factor in preventing frailty.[38,39] Malnutrition in patients with diabetic foot conditions is linked to various factors. First, patients with higher grades of foot complications are at a greater risk of malnutrition compared to those with lower grades. This increased risk is due to the higher protein demands and susceptibility to malnutrition, that comes with more severe conditions. Additionally, wounds are linked to malnutrition because they trigger active inflammatory responses, raising metabolic rates and increasing protein breakdown. Strict dietary restrictions for glycemic control may also result in insufficient nutrient intake.[40] Nutritional interventions for patients with DFU may enhance wound healing, reduce frailty, and improve overall quality of life.[9,10,31,35,36,41]

Wound care, infection control, off-loading, glycemic control, vascular assessment, advanced therapies, and patient education are the primary treatments commonly discussed for DFUs.[42] In recent years, the individualization of treatment for DFUs has become an essential topic of discussion.[43] In this context, alongside the main treatments, it is necessary to consider factors such as frailty and nutrition when individualizing treatment plans, according to the current study's findings.

Table 4. Distribution of malnutrition and mean scores of participants

Variable	No frailty group 1	Visibly vulnerable group 2	Mild frailty group 3	Moderate frailty group 4	Severe frailty group 5	Total, n
Malnutrition score						
Normal nutrition (24-30 points)	9	4	1	1	0	15
Malnutrition risk sub. (17-23.5 points)	15	18	19	15	7	74
Malnutrition (<17 points)	1	3	2	4	1	11
Total evaluation (mean±SD)	22.74±3.15	20.94±3.15	19.73±2.53	19.33±3.48	18.06±2.67	p<0.001[a]

[a]Kruskal Wallis test, [b]Mann Whitney U test, p<0.01 was considered significant. It was observed that there was a difference between group 1 and group 3 in favor of group 1 and group 1 and group 5 in favor of group 1. SD: Standard deviation

Table 5. Association between Mini Nutrition Scale score and overall quality of life

Variable	Mini nutrition score categories, median (min-max)			
Overall quality of life	**Normal nutrition**	**At risk of malnutrition**	**Malnutrition**	**p**
Total score (points)	8 (5-10)	9 (5-14)	10 (6-15)	0.009[a]
Health status level today %	70 (40-100)	50 (0-100)	50 (0-90)	0.003[a]

[a]Kruskal Wallis test, [b]Mann Whitney U test, p<0.017 was considered significant. It was observed that there was a difference between normal nutrition and at risk of malnutrition in favor of at risk of malnutrition and between normal nutrition and malnutrition in favor of Malnutrition. [c]Mann Whitney U test, p<0.017 was considered significant. It was observed that there was a difference between normal nutrition and at risk of malnutrition in favor of at risk of malnutrition and between normal nutrition and malnutrition in favor of malnutrition, Min: Minimum, Max: Maximum

Limitations

The study has several limitations that should be acknowledged. Firstly, the sample size of 100 participants may limit the generalizability of the findings to a broader population of DFU patients. The cross-sectional design restricts the ability to establish causal relationships between frailty, nutritional status, and quality of life. Furthermore, reliance on self-reported measures for assessing quality of life and nutritional status may introduce bias, and the lack of an intervention component limits the evaluation of specific management strategies.

CONCLUSION

In conclusion, this study highlights the critical interrelationship between frailty, nutritional status, and quality of life in patients with DFUs. The findings indicate that a significant proportion of older adults with DFUs exhibit varying degrees of frailty and malnutrition, both of which adversely affect their overall quality of life. As frailty emerges as a key predictor of clinical outcomes, healthcare providers need to adopt a holistic approach to DFU management that encompasses not only wound care but also the assessment and improvement of nutritional status. The evidence presented underscores the necessity for targeted interventions that address the multifaceted needs of patients with DFUs. By integrating nutritional support and frailty assessment into routine care, healthcare professionals can enhance healing outcomes and improve the quality of life for these vulnerable individuals. Future research should focus on developing and implementing comprehensive care strategies that prioritize the prevention and management of frailty and malnutrition in diabetic patients, ultimately contributing to better health outcomes and a reduction in the burden of diabetic foot complications.

ETHICAL DECLARATIONS

Ethics Committee Approval

The study was carried out with the permission of the Kayseri Clinical Researches Ethics Committee (Date: 31.01.2023, Decision No: 794).

Informed Consent

All patients signed a free and informed consent form.

Referee Evaluation Process

Externally peer-reviewed.

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

Financial Disclosure

The authors declared that this study has received no financial support.

Author Contributions

All of the authors declare that they have all participated in the design, execution, and analysis of the paper and that they have approved the final version.

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