THE EFFECT OF FRAILTY ON BALANCE AND FALL RISK IN TYPE 2 DIABETIC PATIENTS

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Abstract. The aim of this study was to examine the effect of frailty on balance and fall risk in individuals with type 2 diabetes mellitus (DM). A total of 50 individuals diagnosed with type 2 DM, including 25 frail and 25 non-frail individuals were included in the study. The demographic information of the individuals was collected using a prepared case data form. The frailty status of the individuals was evaluated using the Fried Frailty Index. Their cognitive status was assessed using the Standardized MiniMental Test (SMMT), fall risk was evaluated using the Self-Rated Fall Risk Questionnaire (FRQ) and the Falls Efficacy Scale-International. Balance assessment was conducted using the Tinetti Balance and Gait Assessment, Functional Reach Test and Timed Up and Go Test (TUG). The results of our study showed that the mean age of the frail group with type 2 diabetes was 69.08±4.17 years, while it was 67.96±3.41 years for the non-frail group. The average BMI of the individuals was found to be 29.42±3.81, and there was no significant difference in BMI values between the frail and non-frail groups. Statistical analysis revealed significant differences between the groups in Falls Efficacy Scale-International, FRQ, Tinetti Balance and Gait Assessment, Functional Reach Test, and TUG results ($p<0.05$). It was determined that individuals with type 2 diabetes who are frail have worse balance and a higher risk of falls compared to non-frail individuals. Fraility in individuals with Type 2 Diabetes can significantly affect balance and fall risk.
Keywords: *diabetes mellitus, balance, fall risk, frailty*

Introduction

Diabetes is a chronic, multifaceted metabolic disorder in which the body cannot adequately utilize carbohydrates, fats, and proteins due to either insulin deficiency or defects in insulin action, requiring continuous medical care. Type 2 diabetes, the most common type of diabetes, accounts for approximately 90% of all diabetes cases (Shah et al., 2015). According to the 10th edition of the Diabetes Atlas published by the International Diabetes Federation (IDF), as of 2021, there were reported to be 537 million adults living with diabetes worldwide. IDF projections suggest that by 2030, this number is expected to reach 643 million, and by 2045, it is projected to rise to 783 million (International Diabetes Federation, 2021; World Health Organization, 2021). In Turkey, the prevalence of diabetes was found to be 13.7% in adults aged 20 and above according to the TURDEP-II study conducted in 2010. It is estimated that the number of diabetic patients, which was calculated as 6.5 million for that year, is approaching 9 million based on current population projections. If the increase in the number of diabetic individuals continues at this rate, it is predicted that Turkey will be among the top 10 countries with the highest number of adults with diabetes by 2045 (International Diabetes Federation, 2021).

According to WHO estimates, approximately 3.4 million people are lost each year due to diabetes and its complications, while IDF 2021 estimates put this number at 6.7 million (International Diabetes Federation, 2021; World Health Organization, 2021).

These patients are at high risk for common geriatric syndromes (Gregg et al., 2018; Sinclair and Morley, 2013). Additionally, they often have complications associated with several concurrent diseases such as microvascular disease, hypertension, dyslipidemia, and cardiovascular disease. All these factors have significant effects on increasing premature deaths and reducing quality of life (Nakamura et al., 2017; Brownrigg et al., 2016). Frailty is defined as a state of weakness resulting from decreased physiological reserves due to physiological changes, diseases, and/or inadequate nutrition associated with advancing age (Walston et al., 2006). Frail older adults are increasingly important due to their increased mortality, morbidity, and healthcare expenditures when exposed to stressors (Sirven and Rapp, 2017). The prevalence of frailty among older adults in the community varies (from 4.9% to 27.3%) depending on the instrument used to define frailty and the population studied (Davies et al., 2018). Frailty is a consequence of the combined effect of two different forces, such as the aging process and some chronic diseases that accompany aging. Particularly, factors related to oxidative stress, low-grade inflammation, and insulin resistance are risk factors for frailty (Angulo et al., 2016). One of the diseases demonstrating this pathophysiological profile is diabetes (Assar et al., 2016).

Traditional macrovascular and microvascular complications of diabetes seem to account for less than half of the disability associated with diabetes in the elderly. Frailty and muscle loss are recognized as significant new complications of diabetes and important risk factors for disability (Sinclair et al., 2017). Frailty is now considered an important factor in the increased risk of death and disability in elderly individuals with diabetes (Castro-Rodríguez et al., 2016). Numerous studies have shown a close association between frailty and adverse outcomes in diabetic patients, including hospitalization, disability, care needs, and death. Data from a cross-sectional study conducted in primary healthcare settings showed that participants (aged 65-74) with diabetes exhibited a lower frequency of physical performance compared to their non-diabetic peers (Kotsani et al., 2018). A study reported by Thein et al. (2018) showed a significant association between diabetic patients aged 55 and above and a higher prevalence of physical frailty over an 11-year follow-up period. The results of a long-term study revealed that elderly patients with diabetes and HbA1c levels of at least 8.5% have a higher risk of decline in muscle quality and performance compared to non-diabetic patients (Yoon et al., 2016). Elderly adults with hyperglycemia/hypoglycemia are likely at higher risk of frailty and adverse functional outcomes (Quartuccio et al., 2017).

The World Health Organization (WHO) considers falls as one of the most important health problems in old age (WHO, 2021). Balance and falls are therefore issues that need to be addressed in old age. It is a problem that not only increases in frequency with age but also has high mortality and morbidity rates. Healthy aging is associated with slower cognitive processing, slower postural reactions, and decreased muscle strength, all of which are related to balance problems (Morrison et al., 2010). This process progresses rapidly in elderly individuals with Type 2 DM. Chronic complications of Type 2 DM primarily affect the cardiovascular system, musculoskeletal system, and nervous system. Neuropathies, particularly those affecting the nervous system, manifest as numbness, foot and skin problems, vision problems, decreased muscle strength, proprioception losses, antalgic gait, balance problems, and severe fall problems. A review of the literature reveals studies related to diabetes-balance and falls, as well as frailty-balance and falls. However, the number of studies examining the impact of frailty on balance and fall risk in elderly individuals with Type 2 diabetes is limited, and evidence is inadequate. Therefore, this study aimed to investigate the effect of frailty on balance and fall risk in elderly individuals with Type 2 DM.

Materials and Methods

Participants and study design

This study, designed to investigate the effect of frailty on balance and fall risk in individuals with Type 2 diabetes, included a total of 50 individuals diagnosed with Type 2 DM, 25 of whom were considered frail and 25 were considered non-frail. The study was conducted between October 2022 and March 2023 at the Internal Medicine outpatient clinic of Ankara Kahramankazan State Hospital. Inclusion criteria were being diagnosed with Type 2 diabetes, aged 65 and above, having no cooperation and communication problems (with a SMMT score of 24 and above), and voluntarily agreeing to participate in the study. Exclusion criteria included uncontrolled hypertension, heart disease, cardiac arrhythmia, cardiovascular disease, peripheral polyneuropathy, malignancy or undergoing chemotherapy/radiotherapy for malignancy, any neurological or orthopedic disorders, having undergone surgery within the last 6 months, bedridden patients, individuals with alcohol or drug dependence, and those who refused to participate in the study. Sample Size Determination A total of 50 individuals, 25 with frailty syndrome and 25 without, were included to achieve a 95% confidence level with a 95% power (0.05 margin of error). G*Power (version 3.1.9.7, Universitat Düsseldorf, Düsseldorf, Germany) was used for post-hoc power analysis, and effect size was calculated from the International Fall Efficacy Scale score between frail and non-frail individuals with Type 2 DM. According to the analysis, with a two-tailed hypothesis test, an alpha level of 0.05, and a confidence interval of 95%, the effect size was found to be 1.83, and the study's power (1-β) was 99%.

Data sources/measurement

All assessments were conducted face-to-face by the same experienced physiotherapist. Demographic information of the individuals was obtained using a prepared case data form. Frailty status of the individuals was evaluated using the Fried Frailty Index. Their cognitive status was assessed using the Standardized Mini-Mental Test (SMMT), fall risk was assessed using the Falls Risk Self-Assessment Scale (FRSAS) and the International Fall Efficacy Scale. Balance assessment was performed using the Tinetti Balance and Gait Evaluation, Functional Reach Test, and Timed Up and Go Test (TUG).

Demographic Data Form: Demographic data of the individuals (age, gender, education level, occupation, marital status) were queried during their initial evaluations. Height (m), weight (kg) was recorded, and body mass index (BMI) was calculated as weight/height2 (kg/m2). Medications used, additional illnesses, and medical history was recorded on the individuals' socio-demographic information forms, and the SMMT was administered for their cognitive status.

Standardized Mini-Mental Test (SMMT): The SMMT was first published by Folstein and colleagues in 1975. The scale was developed as a cognitive assessment tool that can be applied quickly in the examination of elderly individuals (especially those with delirium and/or dementia). The scale has limited specificity for distinguishing clinical syndromes; however, it is a short, practical, valid, and standardized method that can be used to quantitatively assess cognitive level. It is divided into five main headings: orientation, registration memory, attention and calculation, recall, and language, comprising a total of 11 items, evaluated over a total score of 30 points. While the maximum score on this scale is 30, scores of 20 and below indicate cognitive impairment in adults. The ideal cutoff score for SMMT is determined to be 24. Turkish validity and reliability were established by Güngen et al. (2002).

Fried Frailty Index: The frailty criteria created by Fried and colleagues include involuntary weight loss, exhaustion/fatigue, weak grip strength, slow walking speed, and decreased physical activity level. The presence of any three or more of these criteria is considered frail, the presence of 1 or 2 criteria is considered non-frail, and these patients are considered "at risk" for frailty development. The absence of any criteria is considered "normal (not frail)" (Fried et al., 2001). Weight loss and fatigue were reported by the patient. Grip strength was measured using a hand dynamometer. The 4-meter walking test was used to assess decreased mobility. The test was conducted on a 4-meter course with clearly marked starting and finishing points using a cone. The participant was asked to walk at their usual pace. The stopwatch was started with the first step from the starting line, and stopped when the finish line was completely crossed. The level of physical activity was assessed using the Physical Activity Scale for the Elderly (PASE). Turkish validity and reliability of the Fried Frailty Index were established by Varan et al. (2022) in 2022.

International Fall Efficacy Scale: Developed by Yardley et al. (2005) in 2005, this test consists of 16 questions assessing the concern of patients about the possibility of falling during their daily activities. Each question is scored between 0 and 4. Higher scores indicate worse outcomes. Turkish validity and reliability of the test in the elderly population were established by a researcher.

Fall Risk Self-Assessment Scale (FRSAS): This scale evaluates the risk of falling in the elderly. It consists of 13 items. Responses are scored as yes (1 point) or no (0 points), and individuals scoring 4 points or higher are classified as having a high risk of falling. Turkish validity and reliability of the scale were established by Sertel et al. (2020).

Tinetti Balance and Gait Test: The Tinetti balance and gait test is a very important test for assessing functional status and the ability to manage daily life independently in the elderly, similar to other tests used in the elderly. It evaluates in two main categories. The first 9 questions are related to balance and the total score is the balance score, the next 7 questions are related to walking and the total score is the walking scores. In the test used to evaluate balance, the maximum score for walking is 12 points, the maximum score for balance is 16 points, and the total score is 28 points. Scores below 26 are considered problematic. Studies have shown that as the score decreases, the risk of falling increases. Turkish validity and reliability were established by Yücel et al. (2012).

Functional Reach Test (FRT): The Functional Reach Test is a test of static balance developed by Duncan et al. (1990), and validated for reliability. In this test, which evaluates static balance, the person is asked to raise their right arm to approximately 90 degrees and reach forward without taking a step, while maintaining a comfortable standing position. Care is taken during the test to ensure that the heels do not lift off the ground and the participant does not take a step forward. If these occur, the test is repeated. The test is performed three times, and the best measurement is used for evaluation. The distance between the third metacarpal in each condition indicates functional reach. Decreased reaching ability indicates an increased risk of falling in the future. Values of 15 cm and below indicate a significantly increased risk of falling, and values between 15-25 cm indicate a moderate risk of falling.

Timed Up and Go Test (TUG): The Timed Up and Go Test is a balance test used to assess functional mobility in individuals. It was developed by Podsiadlo and Richardson (1991) in 1991. It measures the speed during many functional maneuvers such as standing up, walking, turning, and sitting down. The patient is seated with their back against a standard chair. Then, they are asked to stand up, walk 3 meters, turn around, and sit back down in the chair. After one trial, the test is repeated three times, and the average is recorded.

Statistical analysis

Statistical analyses were performed using IBM SPSS Statistics 26.0 (SPSS Inc, Chicago, IL, USA) software package. The normality of the variables was examined using visual (histograms and probability plots) and analytical methods (Kolmogorov-Smirnov/Shapiro-Wilk tests). Descriptive statistics were reported as frequencies and percentages for nominal and ordinal variables, median and interquartile range (IQR) for non-normally distributed numeric variables, and mean and standard deviation for normally distributed numeric variables. The Chi-square test was used to compare two independent nominal variables, and depending on the condition of the values, either Pearson's Chi-square, Likelihood Ratio, or Fisher's Exact Test statistics were preferred. The Mann-Whitney U test was used as a non-parametric test for comparing numerical variables between groups, and the Independent Samples t-test was used as a parametric test. Situations where the Type 1 error rate was below 5% were considered statistically significant. A confidence level of 95% was considered for evaluating statistical significance.

Results and Discussion

In this study, involving 25 fragile and 25 non-fragile individuals with type 2 DM, it was found that the mean age of the fragile group was 69.08±4.17 years, while that of the non-fragile group was 67.96±3.41 years. It was observed that the heights of individuals with type 2 DM in both fragile and non-fragile groups were quite similar. When comparing the weights of individuals in both groups, there was no significant difference between the groups ($p>0.05$). The mean BMI of the individuals was found to be 29.42±3.81, and it was observed that the BMI values of the fragile and non-fragile groups were almost equal (*Table 1*). *Table 2* presents descriptive statistics for individuals with type 2 DM, categorized by fragile and non-fragile status according to socio-demographic characteristics. It was found that there was no statistically significant difference between the fragile and non-fragile groups in terms of all variables of interest (gender, education level, employment status, medication use, presence of additional diseases, history of surgery) ($p>0.05$). The majority of individuals in the non-fragile group were composed of women at 52%, while in the fragile group, the majority was also women at 72%. It was observed that 68% of individuals had a primary school education and 90% were not employed. Furthermore, it was found that 96% of individuals in both fragile and non-fragile groups were married. Approximately half of the individuals, 54%, used only diabetes medication, and it was noted that in the fragile group, the number of individuals using a different medication alongside diabetes medication was 52% higher. Additionally, 44% of individuals had an additional disease besides diabetes, and 72% had no history of surgery. The mean SMMT score for fragile individuals was 28.52±1.96, while for non-fragile individuals, it was 29.88±0.60.

***Table 1**. Physical characteristics of individuals.*

Physical characteristics	Fragile group (n=25)	Non-fragile group (n=25)	p-value
Age (years)	69.08±4.17 (Median: 68)	67.96±3.41 (Median: 67)	0.310
Height (cm)	161±0.6 (Median: 160)	163±0.6 (Median: 164)	0.194
Weight (kg)	74.16±6.97 (Median: 78)	78.08±10.20 (Median: 80)	0.683
BMI (kg/m2)	29.36±3.52 (Median: 29.58)	29.48±4.15 (Median: 28.81)	0.985

Note: p<0.05; U: Mann-Whitney U test, n=Number of Individuals; IQR: Interquartile Range, SS: Standard Deviation, BMI: Body Mass Index.

***Table 2**. Comparison of socio-demographic characteristics of fragile and non-fragile individuals with Type 2 DM.*

Category	Fragile group [n (%)]	Non-fragilr group [n (%)]	Chi-square (x^2)	p
Sex			2.122	0.145
Female	18 (72)	13 (52)		
Male	7 (28)	12 (48)		
Education			0.001	0.619
Primary school	17 (68)	17 (68)		
Middle & high school	8 (32)	8 (32)		
Medication use			0.725	0.395
Only DM	12 (48)	15 (60)		
DM+Another medication	13 (52)	10 (40)		

*Note: *p<0.05; Chi-square Test.*

It was observed that the fall scale average of the fragile group was significantly higher compared to the non-fragile group. Additionally, it was found that the fall scale and DRÖ-DÖ score averages were also higher in the fragile group compared to the non-fragile group. The analysis to determine if there were differences between the fragile and non-fragile groups in terms of Fall Scale and DRÖ-DÖ was presented in *Table 3*. It was found that there were statistically significant differences in Fall Scale and DRÖ-DÖ scores between fragile and non-fragile groups (p<0.05) (*Table 3*). It was found that the non-fragile group had higher average scores compared to the fragile group in terms of Tinetti balance, Tinetti gait, and Tinetti total scores (*Table 4*). The analysis to determine if there were differences between the fragile and non-fragile groups in terms of Tinetti Balance, Tinetti Gait, and Tinetti Total scores was presented in *Table 4*. It was found that there were statistically significant differences in Tinetti Balance, Tinetti Gait, and Tinetti Total scores between fragile and non-fragile groups (p<0.05) (*Table 4*). The analysis to determine if there were differences between the fragile and non-fragile groups in terms of FUT and TUG scores was presented in *Table 5*. It was found that there were statistically significant differences in FUT and TUG scores between fragile and non-fragile groups (p<0.05) (*Table 5*).

***Table 3**. Results of international fall efficacy scale and self-assessment scale for fall risk in fragile and non-fragile individuals with Type 2 DM.*

Category	Fragile group (n=25)		Non-fragile group (n=25)		p,u
	Mean±SD	Median (Min-Max)	Mean±SD	Median (Min-Max)	
International Fall Efficacy Scale	36.56±9.42	35.84 (Min-Max: 21-64)	22.36±6.33	15.16 (Min-Max:16-42)	U=54,000 p=<0,001
DRÖ-DÖ	7.68±2.61	35.94	3.16±1.70	15.06	U=51,500

	(Min-Max:3-11)		(Min-Max:1-7)	p=<0,001

Note: p<0.05; U: Mann-Whitney U test, n=Number of Individuals; Median: Median; DRÖ-DÖ: Self-assessment Scale for Fall Risk, Mean: Mean, SD: Standard Deviation; Min: Minimum; Max: Maximum.

***Table 4**. Comparison of Tinetti Balance and Gait Assessment results in fragile and non-fragile individuals with Type 2 DM.*

Category	Fragile group (n=25)		Non-fragile group (n=25)		p,u
	Mean±SD	Median (Min-Max)	Mean±SD	Median (Min-Max)	
Tinetti Balance	8.20±2.78	16.68 (Min-Max: 3-13)	12.68±3.67	34,32 (Min-Max:1-16)	U=92.000 p=<0.001
Tinetti Gait	6.80±2.18	16.00 (Min-Max:4-11)	10.64±2.36	35.00 (Min-Max:3-13)	U=75.000 p=<0.001
Tinetti Total	15.00±4.37	15.36 (Min-Max:4-11)	23.88±4.80	35,64 (Min-Max: 10-28)	U=59.000 p=<0.001

Note: p<0.05; U: Mann-Whitney U test, n=Number of Individuals; Median: Median; SD: Standard Deviation; Min: Minimum; Max: Maximum.

***Table 5**. Comparison of Functional Reach Test and Timed Up and Go Test results in fragile and non-fragile Individuals with Type 2 DM.*

Category	Fragile group (n=25)		Non-fragile group (n=25)		p,u
	Mean±SD	Median (Min-Max)	Mean±SD	Median (Min-Max)	
FUT	19.60±4.05	18.30 (Min-Max: 11-26)	24.32±4.72	32.70 (Min-Max:15-34)	U=132.500 p=<0.001
TUG	13,24±2,39	33.62 (Min-Max:9-19)	10,08±2,61	17.38 (Min-Max:6-16)	U=109.500 p=<0.001

Note: p<0.05; U: Mann-Whitney U test, n=Number of Individuals; Median: Median; FUT: Functional Reach Test, TUG: Timed Up and Go Test; SD: Standard Deviation; Min: Minimum; Max: Maximum.

This study aimed to compare individuals with fragile and non-fragile Type 2 diabetes mellitus (T2DM) in terms of their balance and fall risks. The findings indicated that individuals with fragile T2DM had poorer balance and higher fall risks compared to those without fragility. Fragility arises due to impairments in muscle and nerve functions, decreased cardiorespiratory reserve, and loss of executive function. Diabetes mellitus affects each of these systems, leading to functional impairments and disruption of overall body homeostasis and physical function. Fragility has a significant impact on the development of these impairments (Yanase et al., 2018). According to a study, the prevalence of fragility is around 20-30% in individuals aged 75 and above, increasing to 30-45% in those aged 85 and above, with its prevalence rising with age (Kapucu and Ünver, 2017). A researcher reported that 40.9% of individuals aged 65 and above with diabetes were fragile, and 27.5% were predisposed to fragility. A study evaluating diabetic individuals found a significant relationship between BMI, obesity, and diabetes (Moretto et al., 2016). In our study, when the physical characteristics of individuals with fragile and non-fragile T2DM were examined, it was observed that the average ages and heights were similar between the two groups, with no significant difference in weights, and the average BMI values were almost equal. It is evident from the literature that socio-demographic factors such as age, gender, and BMI affect balance and fall risk. In our study, these factors were similar in both groups. Therefore, it was demonstrated that fragility in T2DM has an effect on balance and fall risk, even with similar socio-demographic characteristics such as age, gender, and BMI.

The rapid increase in T2DM and associated complications shows significant gender differences clinically. T2DM is seen in men at a younger age and with a lower BMI, whereas obesity, the most significant risk factor for diabetes, is more common in women (Kautzky-Willer et al., 2016). Consistent with the literature, the majority of individuals in the non-fragile group in our study were women (52%), while the majority in the fragile group were also women (72%).In a study of diabetic patients, it was stated that polypharmacy in diabetic patients can change the effectiveness and side effect profile of medications due to drug-drug interactions, which are mostly related to the pharmacokinetic and pharmacodynamic properties of drugs. As people age, the likelihood of chronic disease increases along with chronic diseases, the use of multiple medications becomes inevitable. If multiple medication use is not controlled, drug-drug interactions occur. In a thesis study, it was found that patients with diabetes and concomitant cardiovascular disease are exposed to serious drug-drug interactions. In our study, it was observed that 96% of individuals in both the fragile and non-fragile groups were married, approximately half of the individuals (54%) used only diabetes medication, and in the fragile group, the number of individuals using a different medication alongside diabetes medication (52%) was higher. The presence of an additional disease other than diabetes was detected in 44% of individuals. As in studies in the literature, more than half of the individuals in our study used multiple medications and had an additional chronic disease other than diabetes. This indicates the presence of both multiple medication use and additional chronic diseases associated with age. We believe that rational drug use, correct diagnosis of the patient, selection of appropriate and reliable treatment, and monitoring and evaluation of treatment outcomes are crucial to prevent improper drug use.

Balance and fall risk

Fragility, a consequence of the interaction between the aging process and certain chronic diseases, jeopardizes functional outcomes in the elderly, significantly increasing the risk of disability and other adverse outcomes. For example, neuromuscular systems, sensory systems (vestibular, visual, somatosensory), and cognitive systems (cerebellum, hippocampus, prefrontal and parietal cortices) play a crucial role in balance. With aging, all these systems deteriorate, increasing the risk of falls. Interjoint coordination and appropriate timing of muscle movement are also affected. Fragility arises from a combination of several impaired physiological mechanisms affecting multiple organs and systems (Angulo et al., 2020). In a study investigating balance ability in diabetic young and elderly adults and evaluating the relationship between balance ability and microvascular complications, impaired balance ability was found to be associated with microvascular diabetic complications. Proper evaluation of balance ability in diabetic adults, especially those with diabetic complications, concluded that fall risk can be predictably assessed (Kukidome et al., 2017). In a study conducted by Mustapa et al. (2016) on individuals with diabetes mellitus (DM), clinical tests and posturographic analysis of walking and postural balance may help in early detection of fall risk, preventing falls and subsequent orthopedic problems, thus significantly improving patients' quality of daily life.

Hewston and Deshpande (2018) reviewed existing research evidence on balance and fear of falling in elderly individuals with type 2 diabetes mellitus to examine group-based interventions (such as walking and balance training, tai chi, yoga) and found that these interventions were beneficial in reducing fear of falling and increasing balance confidence. A study aimed to determine the risk factors for falls in elderly individuals with type 2 diabetes mellitus. Walking problems and balance difficulties were found to be significantly associated with an increased likelihood of recurrent falls. Therefore, elderly diabetic individuals are considered an appropriate target group for a fall prevention strategy (Rashedi et al., 2019). In a study comparing the frequency and risk of falls based on functional mobility tests in diabetic and non-diabetic individuals, it was observed that hyperglycemic conditions were associated with an increased risk of falls, even in younger patients and those with a shorter duration of illness (Oliveira et al., 2012). In a study conducted by İdiz et al. (2021) aiming to determine factors related to frailty in elderly individuals diagnosed with type 2 diabetes, it was found that the fear of falling score was significantly higher in the frail group compared to the non-frail group.

In our study, when we looked at the balance outcomes in individuals with fragile and non-fragile type 2 diabetes mellitus, it was observed that individuals with fragile type 2 diabetes mellitus had lower FUT and TUG, Tinetti balance, Tinetti gait, and Tinetti total scores. Consequently, it was found that the static and dynamic balance of individuals with fragile type 2 diabetes mellitus was worse compared to non-fragile individuals. This indicates the importance of evaluating balance in these individuals and the necessity of including balance and coordination exercises in treatment programs. Additionally, considering the balance and fall risk of these individuals, it emphasized the necessity of taking individual and environmental protective measures. In our study, we compared individuals with Type 2 diabetes mellitus (DM) who were frail and non-frail. It was found that frail individuals with Type 2 DM exhibited worse cognitive status, balance, and fall risk. The absence of a healthy elderly control group in our study could be considered a limitation. In future studies, we recommend including healthy elderly individuals as a control group to better differentiate the effects in individuals with Type 2 DM. Additionally, our study utilized various scales for assessment parameters due to their easy accessibility in clinical settings. However, to obtain more objective data, various devices could be employed to assess balance and fall risk.

Conclusion

In conclusion, our study found that frail individuals with Type 2 diabetes exhibited poorer balance and a higher fall risk compared to non-frail individuals. These findings highlight the importance of incorporating balance and coordination exercises into treatment programs for frail individuals with Type 2 diabetes, as well as the necessity of taking individual and environmental protective measures to reduce their fall risk. Additionally, our study findings suggest the need for healthcare providers to closely monitor balance and fall risk in older adults with Type 2 diabetes, especially those who are frail. Proactive interventions, such as balance training, fall prevention education, and environmental modifications, may help mitigate the increased risk faced by this population. Further research is warranted to develop and evaluate comprehensive strategies to optimize physical function and reduce adverse outcomes associated with frailty and fall risk in individuals with Type 2 diabetes.

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Conflict of interest

The authors confirm that there is no conflict of interest involve with any parties in this research study.

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