Association of Balance deficits and Risk of fall in Patient with Diabetes Mellitus

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ABSTRACT

Background: Diabetes Mellitus (DM) is a long-term metabolic disease majorly typified by hyperglycemia. The purpose of this study was to explore the association between balance deficits and the risk of falls in diabetic patients. **Methodology:** A descriptive cross-sectional study was carried out to analyze the relationship between balance deficits and risk of falling among 101 diabetic patients aged between 18 and 40 years. The research was conducted between November 2024 and April 2025 at Lady Reading Hospital, Peshawar. Balance functions were assessed with the use of the Berg Balance Scale (BBS), and falling risk was determined with the Timed Up and Go test. Informed consent was taken from all the participants, and ethical clearance was provided by the Departmental Research Committee of the City University of Science and Information Technology. **Results:** The findings indicated that 30.7% of the participants had poor balance, 24.8% had fair balance, and 44.6% had good balance. On evaluating fall risk, 45.5% had normal mobility, 18.8% were in the borderline group, and 35.6% had abnormal mobility. There was a statistically significant correlation between balance deficits and fall risk (p = 0.000) with increased abnormal mobility in poor balancers. These findings emphasize the importance of early detection and focused rehabilitation programs in young diabetic individuals. **Conclusion:** Even with poor balance considered, diabetes remains a major risk factor for falls, influenced by higher medication use and reduced cognitive function. Risk of falling increases as balance worsens. The study found that about half the participants mostly men had poor balance and elevated fall risk, with a strong link between balance deficits and fall risk.

INTRODUCTION

Diabetes Mellitus (DM), a long term metabolic disorder with persistently elevated levels of blood glucose. It results from the failure to secrete enough insulin, a hormone produced by the pancreas, or the inability to use insulin. More than 90% of those with DM have type 2 diabetes. Complications of DM can actually diminish life expectancy by a great extent, and the disease is now ranked as the ninth leading cause of death in the world. Almost 1 out of every 11 adults has diabetes. The principal causes of the spread of diabetes are the rising obesity rates, eating habits of high-calorie diets, population aging, poor dietary habits, and inactive lifestyles. Diabetic retinopathy and diabetic peripheral neuropathy are some of the general complications. Diabetic retinopathy, which is caused by prolonged poor control of blood sugar, causes loss of vision, while DPN causes pain and ulcers in the feet, which impair quality of life (Suleman & Fatima, 2019).

Balance is the ability of the body to stay upright and stable by keeping its center of gravity above its base of support. When the balance system is working well, it provides for unobstructed vision in motion, perception of direction and speed of movement, precise positioning of the body in space, and postural stabilization as a reflex under dynamic circumstances (Ahmad et al.). This intricate process is based on sensory information from three primary systems: vision, body awareness (propriopception), and the vestibular system (which controls balance, movement, and spatial awareness) (H. Y. Khan, Shahzad, et al., 2025). The brain interprets these messages and issues orders to the eyes and muscles to preserve balance (H. Y. Khan, Adnan, et al., 2025). Aging, some medical conditions, trauma, or medications may affect one or more of these systems, leading to balance and gait problems. Diabetes sufferers can have sensory nerves damaged, particularly in the feet, which places them at risk of falling, breaking a bone, and even death(Jia et al., 2019).

Diabetes Mellitus is a very common non-communicable disease, and at present, it affects approximately 246 million individuals globally. In Pakistan, the population with Type-II Diabetes Mellitus was 5.2 million in 2000 and is estimated to increase to 13.85 million by the year 2030. The World Health Organization (WHO) indicates that Pakistan is at number

seven in the world regarding the prevalence of DM, impacting over 6.9 million individuals. This prevalence is projected to grow to about 11.5 million by 2025. The total DM prevalence in Pakistan varies between 7.6% and 11%. Urban centres have a prevalence of 22.04%, whereas rural centres exhibit a prevalence of 17.15%(Suleman & Fatima, 2019).

Complications of diabetic foot, especially loss of sensation, significantly impact balance and greatly increase the risk of falls and associated injuries. Understand the association among foot sensation, balance, and fall risk is critical for improving patient outcomes. This has been studied with instruments like the 39-item Rotterdam Diabetic Foot Study Test Battery (RDF-39) to measure foot sensation and the Brief-BESTest to assess balance performance. The variables of cerebral artery disease, type 2 diabetes mellitus, body Height, as well as Age have been shown to affect balance. Repeated falls are commonly linked with sensory impairments, age, male gender, and diabetes status. The medical expenses related to fall-related injuries further underscore the clinical and economic significance of such incidents. RDF-39 could prove to be an useful screening tool for the detection of high-risk subjects and adoption of targeted preventive measures.(Jia et al., 2019).

Diabetes significantly raises the risk of falls, particularly among elderly subjects. Diabetic older adults have a higher likelihood of developing severe fall-related injuries, which increase treatment charges and length of hospital stay. Falls are among the most common causes of disability and potentially avoidable death in older adults. Between 30% of those aged 65 and over have falls per year, rising to 32% to 42% for those aged over 75. Some fall risk factors occur more frequently in older diabetics, such as peripheral neuropathy, physical and cognitive impairment, blindness, and higher use of antidepressants. (K. S. Khan & Andersen, 2022) In a case-control study in 2016 in Iran, the study identified strong correlations between falls and urinary incontinence, hearing and vision impairment, pain in legs, and the use of anticoagulant drugs among older patients with type 2 diabetes(Iram, Kashif, Hassan, Bunyad, & Asghar, 2021).

Although most research focuses on the elderly, it is also pertinent to study modifiable risk factors among middle-aged adults. Evidence shows that individuals with type 2 diabetes have a greater risk of falling than that of people without diabetes. Surprisingly enough, even though diabetic patients have greater bone mineral density—a parameter that typically shields against fractures—these patients are at greater risk for falls, a phenomenon known as the "diabetes bone paradox." Significant contributing conditions are cognitive impairment, diminished physical capacity, diabetic peripheral neuropathy, visual and hearing impairments, and joint disorders (Catikkas, Tunc, & Soysal, 2023).

Diabetic peripheral neuropathy (DPN) can weaken muscles, blunt ankle reflexes, and disrupt balance, coordination, and motor control—changes that markedly elevate fall risk and injury rates. People with DPN, regardless of severity, also tend to fear falling; that fear often prompts them to curtail everyday activities they would otherwise manage, reducing physical activity and

paradoxically raising fall likelihood. Researchers suggest that both physical factors (for example, sensorimotor deficits) and psychological factors (such as fear of falling) shape fall risk. Fear itself appears tied to a person's confidence in staying balanced. Many individuals with diabetes especially those with DPN—report low confidence performing routine tasks because of balance and gait challenges. Whether this low balance confidence directly increases fall risk in DPN, however, remains uncertain. The present study therefore examined how balance confidence, balance performance, and fall risk interrelate in people with DPN (Korkusuz, Seçkinoğulları, Yürük, Uluğ, & Kibar, 2024).

Earlier work has not investigated how motor dysfunction intersects with other sensory problems, such as visual or vestibular deficits. To date no study has jointly analysed multiple sensory impairment, motor dysfunction, as well as balance performance in older adults with type 2 diabetes. Likewise, the interplay among sensory loss, lower-limb muscle strength, and balance remains unclear. Clarifying these links could guide rehabilitation plans that tackle both motor and sensory contributors to poor balance. Accordingly, the present research compared balance performance as well as leg-muscle strength in older adults with type 2 diabetes with and without sensory impairments against a non-diabetic control group, and explored whether the severity of sensory deficits and muscle weakness predicts balance outcomes (Nogueira, Nogueira, da Silva, Luvizutto, & de Sousa, 2024).

Body equilibrium relies on sensory information as of the vestibular, visual, along with somatosensory systems; disturbances in any of these pathways can trigger balance disorders. People with type 2 diabetes frequently develop peripheral neuropathy, which degrades sensory feedback from the feet and can detrimentally affect both balance and gait patterns (Reyhanıoglu, Yıldırım, Sengun, & Kara, 2024)

METHODOLOGY

The study adopted a cross-sectional design to explore the association between balance impairments and the risk of falls among diabetic patients, with data collected at a single point in time without manipulating any variables. A non-probability convenience sampling technique was used to select participants due to its accessibility and cost-effectiveness, making it suitable for preliminary research. The sample size of 101 was calculated using OpenEpi software, based on a 7% anticipated frequency, 95% confidence interval, and 5% margin of error. The research was conducted at Lady Reading Hospital, Peshawar, a well-established tertiary care hospital in Khyber Pakhtunkhwa, known for managing chronic conditions like diabetes. Ethical approval was obtained from the Departmental Research Committee of the City University of Science and Information Technology (CUSIT), Peshawar, and written informed consent was taken from all participants prior to data collection. Inclusion criteria comprised diabetic patients aged 18–40 years of either gender, who were able to stand independently. Exclusion criteria included individuals with severe cognitive, visual, or hearing impairments, those unable to walk or complete balance assessments, and patients with limb amputations or

vertigo. Data collection was carried out using two validated tools: the Berg Balance Scale (BBS) to assess balance impairments and the Timed Up and Go (TUG) test to evaluate fall risk. Both tools have been widely recognized for their reliability and validity. Data analysis was performed using SPSS version 24, where descriptive statistics (mean, frequency, standard deviation) were used to summarize demographic and clinical variables. Categorical data were analyzed using frequencies and percentages, while continuous variables such as BBS scores and TUG times were examined using measures of central tendency. Relationships between balance impairments and fall risk were explored through cross-tabulation and the Chi-square test, and regression analysis was performed using ANOVA to assess associations with demographic factors such as gender.

RESULTS

Age of Participants

Table 1 shows that out of total 101 diabetic patients most of the patients lie in the category of 36-40(i-e 37.6%) followed by category 18-25(i-e 28.7%) and category 26-30 (i-e 17.8%).

Table 1

Age of participants

age of participants	frequency	Percent
18-25	29	28.7
26-30	18	17.8
31-35	16	15.8
36-40	38	37.6
Total	101	100

Gender of Participants

Table 2 and figure 2 shows that out of total 101 diabetic patients 68 (67.3%) were male and 33(32.7%) were female.

Table 2

Gender of participants

Gender of participants	frequency	percent
Male	68	67.3
Female	33	32.7
Total	101	100

Balance Deficits in participants

Table 3 and fgure 3 shows that out of total 101 diabetic patients 31 patients have poor balance, 25 have fair balance while 45 patients have good balance.

Table 3

Balance deficits in participants

Berg Balance scale of participants	frequency	percent
Poor balance	31	30.7
Fair balance	25	24.8
Good balance	45	44.6
Total	101	100

Risk of fall in Participants

Table 4 and figure 4 shows that out of total 101 diabetic patients 46 patients have normal mobility in time up and go test and 19 patients are on borderline while 36 patients falls in abnormal range in time up and go test.

Table 4

Risk of fall in participants

Column1	Frequency	Percent
Normal mobility	46	45.5
Borderline	19	18.8
Abnormal	36	35.6
Total	101	100

Cross tabulation and Chi square test between Balance Deficits and risk of fall

Among 101 diabetic patients 31 patients have poor balance including 1 patient with normal mobility,8 patients on border line and 22 falls in abnormal range. More over 25 patients have fair balance including 14 patients with normal mobility and 11 patients on border line. Furthermore 45 patients have good balance including 31 patients with normal mobility and 14 falls in abnormal range.

Table 5

*Berg balance scale * time up go test Crosstabulation*

Column1	Time up and Go Test	Normal mobility	Borderline	Abnormal	Total
Berg_balance_scale	Poor balance	1	8	22	31
	Fair balance	14	11	0	25
	Good balance	31	0	14	45
Total		46	19	36	101

Table 6

Chi square test

Column1	Value	Df	Asymptotic Significance (2-sided)
Pearson Chi-Square	55.900[a]	4	0.000
Likelihood Ratio	76.392	4	0.000
Linear-by-Linear Association	25.93	1	0.000
N of Valid Cases	101		

Regression Analysis between Gender and berg balance scale

The below table shows that with a Multiple R value of 0.03016, the regression analysis between gender and Berg Balance Scale (BBS) scores shows a weak correlation. Less than 1% of the variation in BBS scores can be attributed to gender, according to the R Square value of 0.00091. The model does not appear to explain any variance beyond chance, as indicated by the negative Adjusted R Square value (-0.00929). The average separation between the observed values and the regression line is indicated by the Standard Error of 0.470998. Overall, the results indicates that gender has no discernible effect on BBS-measured balancing ability

Table 7

Regression Statistics between Gender and Berg balance scale

ANOVA					
	Df	SS	MS	F	Significance F
Regression	1	0.019794	0.019794	0.089226	0.765796
Residual	98	21.74021	0.221839		
Total	99	21.76			

Regression Analysis between Gender and Risk of fall

With a Multiple R value of 0.050859, the regression analysis between gender and the risk of fall shows a very

weak association. Gender accounts for less than 1% of the variance in the dependent variable, according to the R Square value of 0.002587. The model does not appear to explain any variance beyond chance, as indicated by the negative Adjusted R Square value (-0.00759). The mean difference between the observed values and the regression line is indicated by the Standard Error of 0.470602. The study comes to the conclusion that gender has no discernible effect on the fear of fall after 101 observations

Table 8

Regression Analysis between Gender and Risk of Fall

ANOVA					
	df	**SS**	**MS**	**F**	**Significance F**
Regression	1	0.056284	0.056284	0.254144	0.615304
Residual	98	21.70372	0.221466		
Total	99	21.76			

DISCUSSION

This descriptive cross sectional research study was carried out in Lady Reading Hospital in Peshawar with the main aim of determining the correlation between postural impairments due to balance and risk of falls in diabetic patient.

The research investigated the effect of diabetic neuropathy on fall risk and postural control in type 2 diabetes mellitus patients. A significant decrease in the Berg Balance Scale (BBS) score (40.5 vs 43.7 points; p = 0.034) was found in cases of diabetic neuropathy. In diabetic patients, the presence of DN is accompanied by compromised balance and a higher risk of falls. To prevent such risk, patients with DM and DN need to receive comprehensive balance assessments. If there are deficits, they should be enrolled in rehabilitation interventions consisting of both kinesiotherapy and physiotherapy to improve gait stability and postural control (Timar et al., 2016). Many previous studies investigating the influence of diabetic neuropathy lying on balance as well as the risk of falls are consistent with the findings of the present study.

A concurrent cross sectional research study was conduct in Brazil by Hudson Azevedo Pinheiro to evaluate muscle mass, risk of falls, moreover fear of falling in older adults With diabetic neuropathy. The sample consists of 50 older adults who were meeting the inclusion as well as exclusion criteria. All patients were diagnosed with diabetic peripheral neuropathy (DPN) and were divided into 2 groups: Group 1 consisted of patient who had a History of falls during the previous 6 months. This group (G1) was 67.8 ± 7.0 years of age with a total of 24 patients, 20 of whom were female. Group 2 (G2) consisted of 26 patient with a mean age of 65.5 ± 4.9 years, of whom 21 were women. Both groups were comparable in terms of a mean diabetes duration of 15.7 ± 9.1 years. Results showed that there was high correlation between BBS and FES-I scores, suggesting that fear of falling has a positive correlation with greater fall risk. Additionally, older adults with DN who recently reported falls had reduced muscle mass, higher risk of falling, and increased fear of falling (Pinheiro, Vilaça, & Carvalho, 2015). The results of the current study are generally supported by earlier research

on the assessment of muscle mass, fall risk, and fall fear in older adults with diabetic neuropathy.

A further randomized cross sectional research study was conducted to ascertain the prevalence of fear of falls in a population of the elderly and its association with Mobility Dynamic balance, fall risk, along with previous falls. The study included 147 elderly subjects aged between 60 and 92 years, consisting of 53 men (36.05%) and 94 women (65.95%). Fear of falling was assess by the FES-I-BRAZIL (FIB); Mobility was measured through the Timed Up and Go (TUG) test; fall risk via the Functional Reach Test (FRT); along with dynamic balance through Tandem Gait Test (TGT). Of the total participants, 80 individuals (54.42%) had a history of falls, while 133 (90.48%) reported fear of falling in at least 1 activity. The research summarized that fear of falling was very common in community-living older adults and had considerable correlations with age, fall risk, mobility, dynamic balance, and history of falls

This study found that older adults livelihood in the community have a high prevalence of fear of falling, along with that there was a significant relationship between the fear of falling and the participants' age, risk, mobility, dynamic balance, as well as heart failure.(Lopes, Costa, Santos, Castro, & Bastone, 2009). One difference between the two studies is the participants' age range; whereas the present study involved people between 18 and 40 years, the earlier study involved an older group between 60 and 90 years.

In order to further examine the association among type 2 diabetes mellitus as well as risk of falls in the elderly, A prospective cohort study was conducted. The study included 64 subjects—42 with diabetes and 22 healthy controls—classified as "fallers" if they had had one or more injurious falls or at least two non-injurious falls. Based on univariate logistic regression, diabetes was identified as a strong predictor of recurrent falls (Odds Ratio = 2.25, 95% CI: 1.21–4.15, p = 0.010). Stepwise multiple regression analysis identified both diabetes and impaired balance as separate predictors for falls. Other contributing factors were low grip strength, higher variability in stride length, polypharmacy, slower walking speed, shorter stride length, and cognitive impairment. Significantly, even after the control of balance problems, diabetes continued to be an important independent risk factor. The association was also modified by the aforementioned mediators, highlighting the intricate interaction between diabetes, physical functioning, and fall susceptibility (Roman de Mettelinge et al., 2013). Although these results support the current research conclusions, it should be noted that the earlier study did not target a certain age group, unlike the present study that targeted people aged between 18 to 40. Recent papers have also pointed out that type 2 diabetes complications can hasten aging in various physiological systems. Hence, it is no wonder that older adults with type 2 diabetes have a higher tendency towards having difficulties in balance and subsequently falling than their non-diabetic counterparts(Roman de Mettelinge, Cambier, Calders, Van Den Noortgate, & Delbaere, 2013). These new findings also support the existing research in this study, as both gender

of research concur that diabetes plays a major role in balance disturbances that could lead to falls.

Recent papers have also pointed out that type 2 diabetes complications can hasten aging in various physiological systems. Hence, it is no wonder that aged people with type 2 diabetes have a higher tendency towards having difficulties in balance and subsequently falling than their non-diabetic counterparts (Hewston & Deshpande, 2016). These new findings also support the existing research in this study, as both bodies of research concur that diabetes plays a major role in balance disturbances that could lead to falls.

The previous study found higher rates of microalbuminuria and hypertension in youth-onset T2DM compared to T1DM, while retinopathy was more common in T1DM and neuropathy rates were similar. Constantino et al. reported double the mortality and higher macrovascular complications in T2DM patients aged 15–30, with no difference in retinopathy or neuropathy Song et al. observed increased cardiovascular disease and neuropathy risk in young-onset T2DM, with similar retinopathy risk to T1DM .balance problems are generally uncommon in adults aged 18–40, with diabetes unless other comorbidities are present.

The cross sectional study tells that elderly individuals with diabetes tend to have significantly higher risk of fall and poorer balance scores compared to those without diabetes. This is often linked to diabetes-related complications such as diabetic peripheral neuropathy (DPN), reduced sensory and motor function, and cognitive decline. Several tools are available to assess balance in this population, including the Mini-BESTest, Berg Balance Scale. In contrast, younger individuals with diabetes typically experience fewer balance impairments and a lower risk of falls, unless advanced complications are present.

CONCLUSION

When poor balance is taken into account, diabetes remains a significant risk factor for falls. The association between diabetes and falls was mediated by increased medication use and decreased cognitive functioning. One's ability to maintain balance is strongly correlated with the level of risk of falling. The fear of falling rises as one's ability to keep balance decreases. Accordingly, the current study found that about half of the population had poor balance and a higher risk of falling, and the majority of participants were men. Additionally, the study demonstrates a high correlation between fall risk and deficits in balance.

Recommendations

Incorporate balance assessments into regular diabetes check-ups, especially for patients with diabetic neuropathy, to identify fall risk early.

Promote coordination between endocrinologists, physiotherapists, neurologists, and geriatric specialists for comprehensive management of balance-related complications in diabetes.

Implement awareness initiatives to educate diabetic patients on the importance of fall prevention, early intervention, and adherence to rehabilitation protocols Encourage longitudinal studies focused on younger age groups (18–40 years) to explore early balance decline and create age-specific intervention strategies.

Limitations

This study only included people aged 18 to 40. Because of this, the results might not apply to older adults who usually have more problems with balance and falling.
Since the study was cross-sectional (done at one point in time), it can show a link between diabetes and balance problems but cannot prove that one causes the other
The sample size was very small that cannot cover the broader population.

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