

## GRACEFUL AGING: A CROSS-SECTIONAL STUDY ON THE FREQUENCY, RISK FACTORS, AND PREDICTORS OF FALLS USING THE BERG BALANCE SCALE (BBS) AND TIMED UP AND GO (TUG) TEST

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### ABSTRACT

#### OBJECTIVES

*We aimed to determine the frequency, risk factors, and predictor of falls in the aged population using the Berg Balance Scale and the Timed up and test.*

#### METHODOLOGY

*A cross-sectional study was conducted for 1 year from 2023 to 2024 on 376 subjects selected from outpatient clinics of tertiary hospitals; those above 65 years of age, physically and mentally handicapped subjects were excluded. A thorough history of physical examinations was made, and they were assessed through timed up-and-go tests and the Berg balance scale to screen for fall risk. Non-probability serial sampling technique was used, and the sample size was determined through the openEpi.com sample size calculator by keeping a 95% confidence interval, 5% margin of error and 80 power of test; the calculated sample size was 376. Open epi calculator used following formula  $Sample\ size\ n = [DEFF * Np(1-p)] / [(d2/Z21-\alpha/2 * (N-1) + p * (1-p)]$ .*

#### RESULTS

*The frequency of falls in 65 plus older adults in the past 2 years was 20.7% (77) in the study. Fall was seen more in women, 38% (35). Of those who fell, 50 (22.4%) subjects belonged to a low socioeconomic class. The urban dwellers had a fall prevalence of 21.3% (76). Among various comorbidities, Diabetics (68.8%) were more prone to falls. Of all the diabetics who fell, neuropathy was found to be the most frequent complication, 48.9% (23). Visual impairment was a common finding among the fall subjects, 23.1% (74). Muscle relaxant use (81.3%) was the primary reason for falling among all medication-induced falls. The proportion of people who used assisted walking devices was 59.3% (16). Of the subjects who fell, 51.3 % had compromised BBS scores while 15.8% had compromised timed up and test, indicating that BBS score is a better marker of falls in age.*

#### CONCLUSION

*These results highlight the importance of targeted fall prevention strategies, particularly for high-risk populations, to mitigate the risk of injury and improve overall mobility and safety.*

**KEYWORDS:** BBS (Berg Balance Scale), TUG (Timed up and test), Falls in Aged

### INTRODUCTION

Falls among older adults are a critical global public health concern, contributing to significant morbidity, disability, and mortality. The prevalence of falls varies widely across different regions and populations. It is estimated that 28-35% of people aged 65 and over fall annually, increasing to 32-42% for those over 70.<sup>1</sup> Globally, the average prevalence of falls among older adults is 26.5%, with the highest rates in Oceania (34.4%) and the Americas (27.9%).<sup>2</sup> In the United States alone, over 14 million older adults experience falls annually, with approximately 37% resulting in injuries that require medical attention or restrict activity. Falls are not only the leading cause of injury-related deaths among older adults but also a growing

concern, with fall-related mortality rates increasing by 41% from 2012 to 2021.<sup>3</sup> Another study deduced that between 1999 and 2020, the MRR (Mortality Rate Ratio) by falls in adults aged 65 years or older increased by 2.63%.<sup>4</sup> In South Asia, falls among older adults also present a significant burden. In Pakistan, surveys have documented a prevalence of falls as high as 44%, with 8% resulting in injuries that elevate the risk of hospitalization and premature death.<sup>5</sup> Some data from the National Injury Survey of Pakistan indicate an annual incidence of fall-related injuries at 8.85 per 1,000 population, which shows an exceptionally high risk among children and laborers.<sup>6</sup> Interventions are needed to reduce the burden of fall-related injuries across age groups. Several risk factors contribute to the occurrence of falls. Female gender, advanced age (over

80 years), low cognitive status, and a history of previous falls have been identified as significant predictors. Additionally, visual impairments, hypertension, and rheumatologic conditions are associated with an elevated risk.<sup>7</sup> Several factors influence fall susceptibility, and they all need to be addressed to meet the demands of this health crisis. Given the substantial health and economic burden of falls, developing effective prevention strategies is essential to minimize their impact in Pakistan and worldwide. Falls and old age have always been closely linked with each other. This topic has been extensively researched worldwide, with a heavy emphasis on what increases the frequency of falls in the elderly.<sup>8</sup> Although we have substantial information about the risk factors for falls in older people from different regions like India, the United States, and China, there is a lack of relevant research in Pakistan.<sup>9,10,11</sup> These studies and most others on this topic have also been done on community-dwelling people. We aim to fill the gap by conducting our research out of outpatient clinics in Karachi, Pakistan. This study will follow a cross-sectional design spanning 1 year. The patients will be assessed through history, physical examination, timed up-and-go testing, and the BBS.

## METHODOLOGY

It was a cross-sectional study conducted over a period of 1 year from 2023 to 2024 in Keamari, Shireen Jinnah and North Nazimabad outpatient clinics, recruiting 376 participants. Inclusion criteria were all aged subjects, men and women, 65 years of age or above, with their free will to participate in the study. Exclusion criteria were physically and mentally disabled patients, including cognitive impairment. Non-probability serial sampling technique was used, and the sample size was determined through the openEpi.com sample size calculator by keeping a 95% confidence interval, 5% margin of error and 80 power of test; the calculated sample size was 376. Open epi calculator used following formula Sample size  $n = [DEFF * Np(1-p)] / [(d2/Z21-\alpha/2*(N-1) + p*(1-p)]$  Questionnaire was used for data collection. The questionnaire constituted demographic variables: gender, marital status, residence, education, socioeconomic status, income, family system, risk factors, Assistive device use, number of falls, hospital visit after fall, health consequences after fall, history of fall in past 2 years (in years), causes of fall, number of medications taken daily, medicines used, existing health condition.<sup>12</sup> Berg balance scale (BBS) was used to predict falls among them. For BBS scoring, a ruler, two standard chairs (one with armrests, one without), a footstool or step, a 15 ft walkway and a stopwatch or wristwatch will be

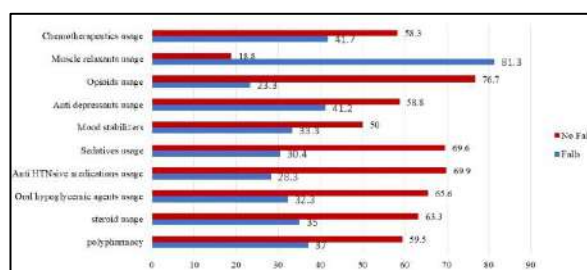
used. Cut-off scores for the elderly were reported by Berg et al. in 1992 as follows: A score of 56 indicates functional balance, and a score of < 45 indicates individuals may be at greater risk of falling.<sup>13</sup> The data was analyzed in SPSS version 21. The Shapiro-Wilk test was used to assess the normality of the quantitative variable. Quantitative variables like age, history of fall in the past 2 years (in years) and Berg balance score were presented as Mean  $\pm$  standard deviation. Qualitative variables such as gender, marital status, residence, education, socioeconomic status, income, family system, assistive device use, number of falls, hospital visits after fall, health consequences after fall, causes of fall, number of medications taken daily, medicine used, existing health condition were presented as frequency and percentages. P-value <0.05 was taken as significant.

## RESULTS

The frequency of falls in 65 plus older adults in the past 2 years was 20.7% (77) in the study. Fall was seen more in women, 38% (35). Of those who fell, 50 (22.4%) subjects belonged to a low socioeconomic class. The urban dwellers had a fall prevalence of 21.3% (76). Among various comorbidities, Diabetics (68.8%) were more prone to falls. Of all the diabetics who fell, neuropathy was found to be the most frequent complication, 48.9% (23). Visual impairment was a common finding among the fall subjects, 23.1% (74). Muscle relaxant use (81.3%) was the primary reason for falling among all medication-induced falls. The proportion of people who used assisted walking devices was 59.3% (16). Of the subjects who fell, 51.3 % had compromised BBS scores while 15.8% had compromised timed up and test, indicating that BBS score is a better marker of falls in age.

**Table 1: Demographic Characteristics of Participants**

Characteristics	Diabetic Group (n=50)	Healthy Controls (n=50)
Age (mean $\pm$ SD)	53 $\pm$ 7	51 $\pm$ 9
Gender (Male/Female)	26/24	25/25
Duration of Diabetes (years)	10 $\pm$ 5	N/A



**Figure 1: Falls Association with Various Medications Usage**

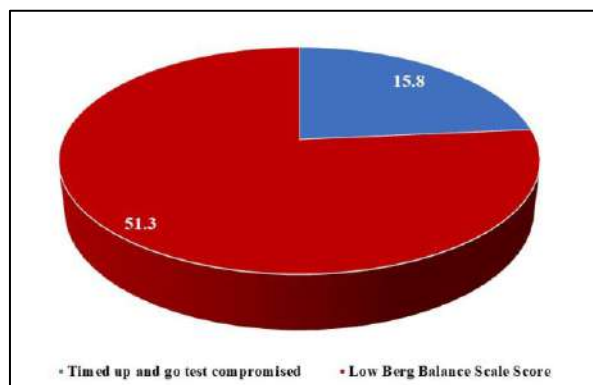


Figure 2: Predictor of Falls by Various Tools

## DISCUSSION

The present study highlighted several risk factors that older adults worldwide face and the need to address them to maintain a higher standard of care. The findings of this study, which report a fall prevalence of 20.7%, align with literature and prior studies in the region and worldwide. For example, a survey of hypertensive older adults by Abu Bakar et al. reported a slightly higher prevalence of 32.2%, which may reflect the additional fall risk conferred by hypertension.<sup>14</sup> Similarly, the FRAILS study by Castaldo et al., which was conducted on Italian nursing home residents, documented a prevalence of 27%<sup>13</sup>, similar to our findings. This suggests that the study data is reflective of global trends.<sup>15</sup> As Table 1 indicates, the study also found that 38% of women faced falls compared to just 14% of men during the study, which other studies can corroborate. A survey of fall-related injuries in India by Srivastava et al. found that older women were nearly twice as likely to report fall-related injuries as men, with an adjusted odds ratio (AOR) of 1.98 (95% CI: 1.43–2.75).<sup>16</sup> Similar trends were observed in the FRAILS study, where 82% of the fallers were women, reflecting biological and lifestyle differences between genders.<sup>15</sup> This disparity can be explained due to gender differences in bone density, as well as post-menopausal osteoporosis. From our gathered results, it was extrapolated that gender had a high significance (0.000) as a predictor of falls in older people. This result is validated by countless other studies conducted in various geographical locations. In a survey of 510 older adults, 256 (69.2%) were female. Almost half of the participants (188, 50.8%) had experienced a fall in the past two years. Sharif et al. also deduced that the number of medications had a direct proportion to falling.<sup>12</sup> A cross-sectional analysis deduced that the prevalence of falls was higher in women (10.1% vs. 5.8%) aged 70 years old.<sup>17</sup> The results also show in Table 1 that 59.3% of people who fell over the study

used assistive devices for walking. A similar trend can be observed in the survey conducted by Casteel et al. (2018), which found that falls were higher in homebound elderly patients, including those who used assistive walking devices.<sup>18</sup> The data deduces that the association of falls with polypharmacy is strong, with 37% of polypharmacy cases resulting in falls. Montero-Odasso et al. also arrive at the same conclusion. Each additional medication taken significantly increased fall incidence risk by 5-7%.<sup>19</sup> In a study from 2021, (31%) of a sample population of 400, constituting 65 or older community-dwelling people, had polypharmacy and a subsequent higher incidence of recurrent falls.<sup>20</sup> This supports the present study, which makes the same claim. The prevalence of falls in another study conducted in Saudi Arabia was (31.6), which is higher than the figure we obtained in our study (20.7%).<sup>21</sup> However, both studies identify polypharmacy as a key fall risk factor, with similar adjusted odds ratios (aOR: 2.40 vs 2.37). Alabdullgader et al. concluded that polypharmacy was one of the leading factors in the increase of falls with advancing age in Unaizah City, similar to our results in Karachi.<sup>21</sup> Additional data from the study supported our results, which showed the significance of gender (0.000). Females fell more frequently than males (34.5% vs 28.5%). This study also inferred that more educated patients had a lower risk of falling. The association between polypharmacy and falls (OR 1.43) observed in a nationwide prospective cohort study in China resonates with our findings, where 37.8% of polypharmacy cases resulted in falls. However, Zhang et al. was a hospital-based cohort study, whereas ours was conducted in an outpatient setting.<sup>22</sup> Another potential risk factor for falls is polypharmacy in older adults, especially for those with preexisting chronic conditions like diabetes. The fall prevalence in this study for diabetic patients was 68.8%. Our study found that, among several different classes of drugs, muscle relaxants had the most significant correlation with falls, with 81.3% of users reporting falls. The systematic review by Remelli et al. on polypharmacy in older adults with type 2 diabetes reported a pooled prevalence of polypharmacy at 64%, with a significant association between polypharmacy and adverse outcomes, including falls.<sup>23</sup> Additionally, the literature review on polypharmacy by Hammond et al. highlighted that specific drug classes, particularly sedatives and muscle relaxants, pose an even greater danger.<sup>24</sup> Abu Bakar et al. found that polypharmacy and certain medications, like diuretics, were associated with fall risk.<sup>24</sup> For instance, the odds of falling were more than doubled in individuals taking diuretics, with an adjusted OR of 2.803 (95% CI: 1.418-5.544).<sup>25</sup> Additionally, gait performance, a vital predictor of fall risk, was found to be negatively

influenced by polypharmacy in another study by George et al., which observed slower walking speeds among individuals taking five or more medications.<sup>25</sup> Visual impairment in the present study was a significant factor ( $p=0.011$ ) in predicting falls. This data is supported by another study that established that older adults have an increased risk of experiencing falls if they have reduced visual function ( $p=0.001$ ).<sup>(13)</sup> Other visual factors in Mehta et al. that proved significant were specifically impaired stereo acuity and reduced high spatial frequency.<sup>26</sup> 51.3% of fallers had compromised BBS scores, while only 15.8% had compromised timed up-and-go scores, indicating that BBS is a better metric for fall screening. This finding is consistent with the study by Viveiro et al. that compared balance assessment tools in nursing home residents, demonstrating that BBS had high reliability and validity in identifying fall status. The area under the ROC curve (AUC) for BBS was reported at 0.762, indicating its strong predictive capability.<sup>27</sup> The study shows a correlation between urban residents and falls, as urban dwellers had a fall prevalence of 21.3% compared to 5.7% in rural residents. A survey of homebound and non-homebound older adults by Casteel et al. highlighted that urban-dwelling individuals using walking aids and with vision impairments exhibited a higher risk of falls.<sup>18</sup> The FRAILS study observed that living in specialized dementia units and higher autonomy in daily activities were significant predictors of falls in nursing homes.<sup>15</sup>

## LIMITATIONS

This study has several limitations. First, its cross-sectional design prevents establishing causal relationships between risk factors and falls. Second, the sample size may limit the generalizability of the findings to broader aging populations. Third, reliance on the Berg Balance Scale (BBS) and Timed Up and Go (TUG) test, while widely used, may not fully capture all aspects of balance and fall risk, as other factors like cognitive impairment, environmental hazards, and medication use were not considered. Lastly, self-reported fall history may introduce recall bias, potentially affecting the accuracy of the results. Future longitudinal studies with larger and more diverse populations are needed for a comprehensive understanding of fall risk predictors.

## CONCLUSIONS

The findings suggest that the Berg Balance Scale is a more reliable predictor of falls than the Timed Up and Go test. Additionally, women appear to be at a higher risk of falling than men. The lower socioeconomic strata of

the study participants were chiefly found to be prone to falls, with urban dwellers being more prevalent than residents of rural areas. Among individuals with comorbid conditions, those with diabetes demonstrate a greater susceptibility to falls. Furthermore, using muscle relaxants is strongly associated with an increased likelihood of falling. Visual impairment is a significant contributing factor towards falls. Falls resulted significantly in older people with slow walking speeds using assisted walking devices. Falls are closely linked to old age, and while extensive research exists globally, there is a lack of relevant studies in Pakistan. Our research in outpatient clinics in Karachi aimed to fill this gap. Using a cross-sectional design over one year, patients were assessed through history, physical examination, TUG testing, and the BBS better to understand the risk factors for falls in this population.

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