**ASSESSMENT OF FACTORS THAT INCREASE RISK OF FALLING OLDER WOMEN BY FOUR DIFFERENT CLINICAL METHODS**

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**Abstract**

**Background:** Women aged 65 years and over are at increased risk of falling. Falls in this age group increase the risk of morbidity and mortality.

**Aims:** The aim of the present study was to find the most common factors that increase risk of falling in older women, by using four different assessment methods.

**Methods:** 682 women, who attended a geriatric outpatient clinic and underwent comprehensive geriatric assessment, were included in the study. History of falling last year, the Timed Up and Go (TUG) test, Performance-Oriented Mobility Assessment (POMA), and 4-meter walking speed test were carried out on all patients.

**Results:** The mean age (SD) of patients were 74.4 (8.5) years. 31.5% of women had a history of falling in the last year. 11%, 36.5%, and 33.3% of patients had a falling risk according to POMA, TUG and 4-meter walking speed test, respectively. We identified the following risk factors that increase risk of falling, according to these four methods: urinary incontinence, dizziness and imbalance, using a walking stick, frailty, dynapenia, higher Charlson comorbidity index and Geriatric Depression Scale score and lower Basic and Instrumental Activities of Daily Living scores (p<0.05). We found a significant correlation between all the assessment methods (p<0.001).

**Conclusion:** There is a strong relationship between fall risk and dizziness, using a walking stick, dynapenia, high number of comorbidities, low functionality, and some geriatric syndromes such as depression, frailty, and urinary incontinence in older women. Therefore, older women should routinely be screened for these risk factors.

**Key words:** Falls, risk factors, older, women

**Introduction**

Falling is one of the most common geriatric syndromes and public health problem for older adults and their caregivers (1,2). According to the World Health Organization (WHO) data, falls are the second leading cause of accidental or unintentional injury deaths worldwide. Each year, approximately 28-35% of people aged 65 years and over fall and the frequency of falls increases with age and frailty level (3,4).

Falling is important for older adults because it leads to functional impairment, disability, decreased quality of life, premature nursing home admission, increased length of stay in hospitals, and mortality (5,6). In addition, the high incidence and long-term effects of falls cause high costs and have an adverse effect on health care systems. For this reason, it is necessary to identify causes of falls and risk factors, and take precautions for modifiable factors.

Previous falls; strength, gait, and balance impairments, and use of specific medications are among the strongest risk factors for falling (2). Other identified risk factors are advanced age, female sex, visual impairment, polypharmacy, cognitive decline, depression, chronic diseases, and environmental factors such as poor fitting footwear, slippery floor or loose rugs, lack of railings or bars, unstable furniture, and poor lighting (6,7). Falls and the risk factors also differ between genders. While non-fatal fall injury rates were higher among women, fatal fall rates are known to be higher among men (8). Although the reasons for the different fall rates between genders are not fully clarified, it is shown that differences in physical activity levels, bone mass, gait patterns, anthropometric structures, and some other sex-specific risk factors can affect this situation (8–10). A number of studies have reported that there are different fall risk factors, different consequences, and different fall characteristics between women and men. (8–10) Furthermore, the results of these studies are not similar since the studies evaluated the patients with different methods. Therefore, the present study aims to identify risk factors that increase risk of falling in only older women using four different but all common fall risk assessment methods. These methods include history of falling last year, Performance-Oriented Mobility Assessment (POMA), Timed Up and Go (TUG) test and 4-meter walking speed test.

**Materials and methods**

A total of 682 women who were admitted to Dokuz Eylul University, Department of Geriatrics between 03.2014-04.2018, underwent comprehensive geriatric assessment, and who have no exclusion criteria were included in this retrospective study. The investigation conformed to the Declaration of Helsinki and was approved by the local ethics committee.

**Exclusion criteria**

The exclusion criteria are as follows:

- Patients who have a history of severe illness that may impair general health status, such as acute cerebrovascular event, gastrointestinal bleeding, sepsis, acute renal failure, acute coronary syndrome, acute liver failure, and acute respiratory failure

- Patients under 65 years of age

- Patients with a pacemaker (because of contraindication to electrical bioimpedance)

- Patients who did not agree to undergo the CGA.

- Immobile patients who cannot be evaluated with TUG, POMA and 4 meters walking test.

**Patients' characteristics**

Patients were evaluated for their age, level of education and year, self-reported comorbidities (hypertension, diabetes mellitus, cerebrovascular disease, depression, osteoarthritis), Charlson Comorbidity Index, using a walking stick, and the number of the drugs used by the patients were recorded. Using five or more drugs was considered polypharmacy and using ten or more drugs was considered hyperpolypharmacy (11). It was recorded whether the patients had self-reported dizziness and imbalance, pain, urinary incontinance and whether they had fallen in the last year. Dementia was diagnosed according to the diagnostic and statistical manual of mental disorders - fifth edition (DSM-5) Major cognitive impairment diagnostic criteria (12). Orthostatic hypotension was diagnosed according to the active standing test (13). Serum glucose, Thyroid-stimulating hormone, vitamin D, vitamin B12, folic acid levels, and glomerular filtration rates were performed to evaluate metabolic status of the patients.

**Comprehensive Geriatric Assessment**

The following assessments were used for detailed geriatric evaluation, The Mini-Mental State Examination (MMSE) (14), The Clinical Dementia Rating scale (CDR) (15), were used for neurocognitive assessment, The Yesavage Geriatric Depression Scale (YGDS) (16,17) for emotional state assessment, The Lawton-Brody Instrumental Daily Living Activity Scale (IADL) (18) and Barthel index (BI) (19) for daily living activities, Mini Nutritional Assessment (MNA)(20) for nutritional evaluation, and FRAIL frailty index (21) for frailty evaluation. We considered walking speed <0.8 m/s as slow walking for all cases, and hand grip power <20 kg were low. We diagnosed “Sarcopenia”, with decreased muscle strength and/or walking speed together with decreased muscle mass and, “Dynapenia” with decreased muscle strength(22).

**Evaluation for risk of falling**

A fall is defined as an event which results in a person coming to rest unintentionally on the ground or other lower level, not due to any intentional movement, a major intrinsic event or extrinsic force. To perform the TUG test as described in the original derivation study, the patient is timed while they rise from an arm chair (approximate seat height 46 cm), walk at a comfortable and safe pace to a line on the floor three meters away, turn and walk back to the chair and sit down again. The subject walks through the test once before being timed to become familiar with the test(23). Records of ≥13.5 seconds are defined as the risk of falling (24). We also used the Tinetti POMA Scale to assess the gait with seven components (initiation of gait, step length, step symmetry, step continuity, path, trunk and walking stance; maximum 12 points) and balance abilities of participants with nine components (sitting balance, arises, attempts to arise, immediate standing balance, standing balance, nudged, eyes closed, turning 360°, and sitting down; maximum 16 points). Each subscale was measured as abnormal = 0 or normal = 1; in some cases, adaptive = 1 and normal = 2. The maximum sum-score of both gait and balance components are 28 points. POMA total scores <19 are defined as the high risk of falling (25,26). We instructed the patient to walk at their normal pace. Then we asked the patient to walk down a hallway through a 1-metre zone for acceleration, a central 4-metre “testing” zone, and a 1-metre zone for deceleration (the patient should not start to slow down before the 4-metre mark). We started the timer with the first footfall after the 0-metre line, and stop with the first footfall after the 4-metre line. We considered walking speed below 0.8 m/s as a risk factor for falls (27).

**Statistical Analyses**

Analysis of the data was carried out us the Statistical Package for the Social Sciences 22. Descriptive statistics are shown as mean±standard deviation for continuous variables, and percentage (%) for nominal variables. The variables related to the risk of falling were adjusted for the age, education level and the living environment of the patients. The variables were modeled using multiple logistic regression analysis. Relations between the parameters indicating the risk of falling (history of falling, POMA, TUG, low walking speed) were calculated using the chi-square test. Results for p<0.05 were considered statistically significant. The required number of samples was calculated to be at least 292 patients with an acceptable error of 5% and a 95% confidence level.

**Results**

In the present study, we included a total of 682 women aged 65 years and over. The mean age (SD) of the patients are 74.4 (8.5). Characteristics and comorbidities of the participants are demonstrated in **Table 1**. 215 (31.5%) women have a history of falling. There are 75 (10.9%) women who had falling risk according to POMA, 249 (36.5%) women according to TUG and 227 (33.2%) women according to lower walking speed.

The risk factors that increase risk of fall and their odds ratios according to the history of falling, POMA, TUG and low walking speed are shown in **Table 2**. CCI, urinary incontinence, dizziness and imbalance, using a walking stick, frailty, dynapenia, high GDS, low BADL and IADL scores increase the risk of falling in women according to all of the four risk clinical assessments (p<0.05).

13.8% of patients was demented (CDR 1 52.3%, CDR2 34.7% and CDR 3 13.0%). Orthostatic hypotension, sarcopenia did not increase the risk of falls according to any risk assessment method (p>0.05). There was no significant difference in laboratory tests of patients with and without fall risk (p>0.05). Hypertension, cerebrovascular disease, and dementia increased the risk of falling according to only TUG (p<0.05).

Although the number of patients who were at risk of falling according to POMA was lower than the other three instruments, we found a significant correlation between all the clinical methods (p<0.001) (**Table 3**).

**Discussion**

Falling is one of the most common geriatric syndromes (1). In our study, the rate of falls in women over 65 years was 31.5% supporting findings from previous literature (3,28). Many studies have investigated risk factors for falls in older adults, multiple risk factors have been identified with conflicting findings (5). This may be owing to differences in the methods used to determine the risk of falling. Therefore, we performed four different assessment methods, that are most commonly used for the evaluation of older adults risk of falling and common risk factors that increase the risk of falling were identified including self-reported dizziness and imbalance, using a walking stick, high GDS and CCI scores, low BADL and IADL scores, urinary incontinence, dynapenia and frailty were associated with the risk of falling in older women by all four clinical methods. Additionally, although some risk factors and odd-ratios were different to detect fall risk, there was a significant correlation between the methods.

While evaluating older adults, assessment of basic and instrumental daily living activities gives important information about both physical and cognitive states of patients. In our study, it was also found that low scores of daily living activities were strongly correlated with the risk of falling and every 10 points in the BADL score increased the risk of falls from 8.79 to 9.61. There was also a similarly strong relationship for IADLs, which is consistent with previous studies (29–31). When a growing aging population and the proportion of people with functional disability and loss of independence is considered, it is likely that falls and falls related complications will exponentially increase in the future. Another important risk factor identified in the present study was having high GDS scores. An association between depression and increased risk of falling has also been shown (32,33), but the underlying mechanisms have not been clearly identified. Depressive symptoms can lead older people to fall through physiological and cognitive impairments, especially lack of attention (32).

On the other hand, in the first look, dementia seems like that is not a risk factor for fall by history of falling and POMA in the present study. Actually, this is not surprised, due to the fact that most of demented patients in our study group were in CDR 1. It was well known that slow gait and cognitive impairments are important risk factors for falls, and walking speed can be affected early stage of cognitive impairment as in Motoric cognitive risk syndrome (34,35). Therefore, dementia cannot be demonstrated as a risk factor for fall by history of falling and POMA in contrast to TUG and walking speed in here.

With advancing age, as a result of changes in body composition and musculoskeletal system, dynapenia and sarcopenia are also common (22). In our study, it was shown that one of the most common risk factors that increases falling was dynapenia. However, there was no significant relationship between sarcopenia and fall risk according to any clinical methods. Although some studies suggest that both sarcopenia and dynapenia increase the risk of falling (36,37), others, similar to ours, show that sarcopenia was not associated with falls, but dynapenia was (38). This may be because muscle strength is more important than muscle mass in achieving balance (39). In assessing the risk of falling, simply measuring muscle strength is more effective than muscle mass measurement methods. The frailty that is closely related to sarcopenia and dynapenia is another risk factor for falls (40). The relationship between frailty and falling has been shown in many studies. (28) This may be due to the fact that muscle weakness and gait alterations are part of frailty, increased comorbidities in frail older, and polypharmacy (41).

It has been shown in many studies that vision and hearing loss increase the risk of falling (42) and have negative effect on gait and balance functions in older adults (43,44). However, in the present study, the risk of falling according to the history of fall was only related to cataract and hearing loss reported by the patients in accordance with the literature, and POMA, TUG and walking speed scores were found to be different from the literature (43,44). This is because sensory loss including visual and hearing disorders could not be elaborated in our study. Self-reported dizziness and imbalance are other common risk factors according to all clinical methods. In addition, using a walking stick increases the risk of falling. It is clear that these patients use more walking sticks for reasons such as balance problems, and fear of falling. All of these, suggest that patients with self-reported dizziness and using a walking stick should be examined more in detail about the risk of falling during clinical evaluation (45). Many women accept urinary incontinence as a normal part of aging. (46) However, it has a significant psychosocial, economic burden and can lead to low quality of life (47). Besides, it has been shown that urinary incontinence is a risk factor for falling (48,49). In our study, urinary incontinence was associated with an increased risk of falls in all groups. The reasons are limited. However, it is thought that there may be reasons such as rush to go to the toilet, or urinary incontinence may be more frequent in individuals with mobility limitation (49).

Interestingly, the present study found that each unit increase in CCI increased the risk of falls in all four groups. There is a limited number of studies in the literature that investigate the association between CCI and the risk of falls, however, our findings do support the limited literature in this area (50,51). These findings suggest that the use of comorbidity indexes may be more useful to assess the risk of falls rather than evaluating comorbidities separately. Within comorbidities, diabetes and osteoarthritis were the most frequently associated with falls according to different assessment methods. Osteoarthritis increased the risk of falls according to 3 different clinical methods. There are some controversial studies in the literature, but in many studies increased risk of falling in osteoarthritis has been shown (52,53). The older patients with knee and hip osteoarthritis adopt different compensator biomechanical strategies during walking. Changes in walking patterns can cause postural instability and difficulties with transfer of center of gravity, and increase the risk of falls (52). Additionally, another comorbidity, diabetes increase the risk of falls too. In the literature, the association of diabetes with the risk of falls has been established, which is thought to be related to many diabetic complications such as peripheral neuropathy, diabetic retinopathy and visual disturbances, hypoglycemia (54,55). Advancing age and increased comorbidity are often accompanied by polypharmacy. In studies, drug groups and comorbidities leading to the use of drugs, have been shown to be as important as the number of drugs for falls (56,57). In our study, polypharmacy also increased the risk of falling according to three assessment methods.

One of the strengths of this study is the large sample of older women allowing for the identification of sex specific risk factors. Four different fall risk assessment methods were used. Thus, falling history, balance, walking, and walking speed were evaluated and possible differences between these clinical methods were identified. On the other hand, this study has

a number of limitations. First, this was the retrospective designed. Second, fear of falling

could not have been assessed. Third, cut-off points of some instruments used in this study

varies in the literature, but we used the common cut points based on the literature.

**Conclusion**

In older adults, falling is a problem with important negative outcomes, affecting independence and quality of life. In our study, we identified nine risk factors that increased the risk of falling according to four different clinical methods. This demonstrates the importance of comprehensive geriatric assessment in older patients to evaluate falls risk factors. In order to prevent falls, it is important that the risk factors are clearly identified and modified.

**Statement of authorship**

Ozge DOKUZLAR performed data collection and manuscript writing; Saadet KOC OKUDUR, Ali Ekrem AYDIN contributed data collection; Idil YAVUZ conducted data analysis; Lee Smith manuscript writing, Pınar SOYSAL designed the study, manuscript writing; and Ahmet Turan ISIK designed the study and supported manuscript writing and conceptualism.

**Disclosure**

The authors declare no conflicts of interest.

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**Table 1. Characteristics of the participants (n=682)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| CHARACTERİCTİCS | VALUES | | CHARACTERİCTİCS | VALUES |
| Age-Mean (SD) | 74.4 (8.5) | |  |  |
| Level of education | | |  |  |
| * Equal or less than 5 years | 19.6 (%) | | * More than 5 years | 80.4 (%) |
| Living status | | |  |  |
| * Alone | 23.1 (%) | | * Roommate/Caregiver | 76.9 (%) |
| Comorbidities | | |  |  |
| * Hypertension | 71.3 (%) | | * Diabetes | 26.0 (%) |
| * Cerebrovascular disease | 4.4 (%) | | * Osteoarthritis | 47.6 (%) |
| * Dementia | 13.8 (%) | | * Charlson comorbidity index (SD) | 0.86 (0.97) |
| Cataract | 50.2 (%) | | * Hearing impairment | 29.6 (%) |
| Laboratuary findings | | | | |
| Vitamin D (SD) | 24.5(13.3) | | * Folat (SD) | 9.76(4.86) |
| Vitamin B12 (SD) | 452(310.5) | |  |  |
| Geriatric Syndromes and Comprehensive Geriatric Assessment | | | | |
| Fall history 31.5 (%) | | POMA 25.2 (4.2) | | |
| TUG (s) 13.6 (9.1) | | 4 meter walking speed (m/s) 1.1 (2.8) | | |
| * Polypharmacy | 48.4 (%) | | * Hyper-polypharmacy | 7.9 (%) |
| * Orthostatic Hypotension | 28.1 (%) | | * Dizziness / Dysbalance | 47.5 (%) |
| * Urinary Incontinence | 55.4 (%) | | * Frailty | 20.4 (%) |
| * GDS score ≥5 | 28.0 (%) | | * Dynapenia | 70.7 (%) |
| * Malnutrition | 1.9 (%) | | * Sarcopenia | 39.4 (%) |
| * MMSE (SD) | 23.94 (6.33) | | * BMI (SD) | 29.45 (5.4) |
| * BADL (SD) | 90.21 (0.9) | | * CDR | 0.48 (0.73) |
| * IADL (SD) | 18.46 (5.7) | |  |  |

BADL: Basic Activities of Daily Living, BMI: Body mass index, CDR: Clinical Dementia Rating Scale, GDS: Geriatric depression score, IADL: Instrumental Activities of Daily Living, POMA: Performance-Oriented Mobility Assessment

**Table 2. Odds ratios for falling risk factors**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Female** | **Risk of falling according to Fall history** | | | **Risk of falling according to POMA score** | | | **Risk of falling according to Timed up and go test** | | | **Risk of falling according to Lower walking speed** | | |
| **Coefficient** | **Odds ratio** | **P value** | **Coefficient** | **Odds ratio** | **P value** | **Coefficient** | **Odds ratio** | **P value** | **Coefficient** | **Odds ratio** | **P value** |
| **Dementia** | 0.345 | 1.412 | 0.166 | 0.390 | 1.477 | 0.230 | 0.875 | 2.399 | **0.002** | 0.781 | 2.184 | **0.005** |
| **Diabetes** | 0.189 | 1.208 | 0.319 | 0.611 | 1.842 | **0.030** | 0.706 | 2.027 | **0.001** | 0.509 | 1.663 | **0.017** |
| **CCI** | 0.212 | 1.236 | **0.015** | 0.272 | 1.313 | **0.025** | 0.421 | 1.523 | **<0.001** | 0.348 | 1.416 | **0.001** |
| **Osteoarthritis** | 0.249 | 1.283 | 0.145 | 0.744 | 2.105 | **0.008** | 0.541 | 1.718 | **0.005** | 0.688 | 1.990 | **0.001** |
| **Polypharmacy** | 0.609 | 1.839 | **0.001** | 0.534 | 1.706 | 0.059 | 0.889 | 2.433 | **<0.001** | 0.733 | 2.082 | **<0.001** |
| **Hyper-polypharmacy** | 1.098 | 2.999 | **<0.001** | 0.514 | 1.671 | 0.197 | 0.933 | 2.542 | **0.006** | 0.582 | 1.790 | 0.083 |
| **Walking Stick** | 0.649 | 1.913 | **0.007** | 1.865 | 6.454 | **<0.001** | 2.217 | 9.183 | **<0.001** | 1.766 | 5.849 | **<0.001** |
| **Use of glasses** | -0.154 | 0.857 | 0.447 | -0.419 | 0.658 | 0.154 | 0.004 | 1.004 | 0.985 | -0.179 | 0.836 | 0.443 |
| **Urinary Incontinence** | 0.476 | 1.609 | **0.006** | 1.079 | 2.943 | **0.001** | 0.638 | 1.892 | **0.001** | 0.928 | 2.530 | **<0.001** |
| **Dizziness** | 0.930 | 2.535 | **<0.001** | 1.123 | 3.073 | **<0.001** | 0.682 | 1.979 | **<0.001** | 0.805 | 2.237 | **<0.001** |
| **Pain** | 0.278 | 1.320 | 0.118 | 0.476 | 1.610 | 0.105 | 0.553 | 1.739 | **0.006** | 0.839 | 2.315 | **<0.001** |
| **Cataract** | 0.492 | 1.635 | **0.006** | -0.069 | 0.934 | 0.808 | 0.081 | 1.084 | 0.682 | -0.075 | 0.928 | 0.714 |
| **Hearing Impairment** | 0.663 | 1.941 | **<0.001** | 0.201 | 1.223 | 0.478 | 0.046 | 1.047 | 0.828 | 0.341 | 1.407 | 0.111 |
| **Vitamin D** | 0.003 | 1.003 | 0.633 | -0.022 | 0.979 | 0.069 | -0.012 | 0.988 | 0.106 | -0.007 | 0.993 | 0.366 |
| **Vitamin B12** | <0.001 | 1.000 | 0.734 | <0.001 | 1.000 | 0.884 | <0.001 | 1.000 | 0.205 | <0.001 | 1.000 | 0.279 |
| **Folate** | -0.009 | 0.991 | 0.603 | 0.004 | 1.004 | 0.882 | -0.007 | 0.993 | 0.739 | 0.006 | 1.006 | 0.759 |
| **MMSE** | -0.008 | 0.992 | 0.660 | -0.076 | 0.926 | **0.002** | -0.067 | 0.935 | **0.001** | -0.057 | 0.945 | **0.005** |
| **GDS ≥5** | 0.926 | 2.524 | **<0.001** | 0.698 | 2.010 | **0.049** | 1.097 | 2.994 | **<0.001** | 1.040 | 2.828 | **<0.001** |
| **BADL** | -0.039 | 0.961 | **<0.001** | -0.117 | 0.890 | **<0.001** | -0.118 | 0.888 | **<0.001** | -0.128 | 0.879 | **<0.001** |
| **IADL** | -0.039 | 0.962 | **0.028** | -0.168 | 0.845 | **<0.001** | -0.157 | 0.854 | **<0.001** | -0.160 | 0.852 | **<0.001** |
| **BMI** | 0.017 | 1.017 | 0.287 | 0.020 | 1.020 | 0.414 | 0.085 | 1.067 | **<0.001** | 0.053 | 1.055 | **0.004** |
| **Malnutrition** | 0.939 | 2.557 | 0.119 | 1.129 | 3.092 | 0.083 | 1.520 | 4.570 | 0.097 | 2.925 | 18.633 | **0.017** |
| **Dynapenia** | 0.427 | 1.533 | **0.035** | 1.321 | 3.746 | **0.006** | 0.641 | 1.898 | **0.006** | 1.082 | 2.952 | **<0.001** |
| **Frailty** | 1.101 | 3.008 | **<0.001** | 3.323 | 27.738 | **0.001** | 1.419 | 4.135 | **<0.001** | 1.564 | 4.777 | **<0.001** |

BADL: Basic Activities of Daily Living, BMI: Body mass index, CCI: Charlson comorbidity index, GDS: Geriatric depression score, IADL: Instrumental Activities of Daily Living, MMSE: Mini-Mental State Examination, POMA: Performance-Oriented Mobility Assessment

\*All data are adjusted for age, education level and living environment

**Table 3. Chi-square test of association between the variables**

|  |  |  |  |
| --- | --- | --- | --- |
|  | Risk of falling according to  Fall history | Risk of falling according to  POMA | Risk of falling according to  Timed Up and Go test |
| Risk of falling according to  POMA | 14.303 (p <0.001) |  |  |
| Risk of falling according to  Timed Up and Go test | 25.506 (p <0.001) | 134.485 (p<0.001) |  |
| Risk of falling according to  Low Walking Speed | 21.381 (p<0.001) | 130.826 (p<0.001) | 268.696 (p<0.001) |