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# Receiver Operating Characteristic Analysis of Posture and Gait Parameters to Prevent Frailty Condition and Fall Risk in the Elderly

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**Abstract:** Prevention strategies should be constantly improved to manage falls and frailty in the elderly. Therefore, we aimed at creating a screening and predictive protocol as a replicable model in clinical settings. Bioimpedance analysis was conducted on fifty subjects (mean age 76.9 ± 3.69 years) to obtain body composition; then, posture was analysed with a stabilometric platform. Gait performance was recorded by a 10 m walking test, six-minute walking test, and timed up and go test. After 12 months, subjects were interviewed to check for fall events. Non-parametric analysis was used for comparisons between fallers and non-fallers and between able and frail subjects. ROC curves were obtained to identify the predictive value of falling risk and frailty. Path length (area under the curve, AUC = 0.678), sway area (AUC = 0.727), and sway speed (AUC = 0.778) resulted predictive factors of fall events ($p < 0.05$). The six-minute walking test predicted frailty condition (AUC = 0.840). Timed up and go test was predictive of both frailty (AUC = 0.702) and fall events (AUC = 0.681). Stabilometry and gait tests should be, therefore, included in a screening protocol for the elderly to prevent fall events and recognize the condition of frailty at an early stage.

**Keywords:** older people; posture; gait; screening; prevention; ROC curve



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## 1. Introduction

Fall events in the elderly challenge public healthcare due to the high social and economic impact. The prevalence of fall events is increasing among the elderly (from 16.3 to 21.3% around the world) [1], leading to hospitalization, disability, and mortality [2]. The World Health Organization (WHO) estimates that globally around 660,000 falls among adults result in fatal events. Age is considered to be the major risk factor inducing falls in people aged 60–65 years old. Older adults often show age-related chronic conditions and comorbidities [3] that further affect their physical fitness in activities of daily life (ADL), making them more vulnerable to the risk of falling. Moreover, fall history generates fear of a second fall, reducing progressively all the ADL resulting in social isolation, anxiety, and depression. This brings a substantial weakening of physical fitness that increases the fall risk, disability and hospitalization or institutionalization [4]. Fall events are also involved in driving up medical costs worldwide. The economic impact on medical services in managing the consequences of falls run into billions, including hospitalization time, medical treatment, and long-term care services [5]. Due to the increase in fall events, healthcare stakeholders should increase prevention strategies directed at the elderly, with the aim of identifying fall-associated risk factors [6]. Population-based studies have shown that more than 30% of community-dwelling people over 65 years, and up to 50% of people who live in long-term care institutions fall at least one time during their life [7,8]. The fall risk further increases in people, women especially, over 75 years old [9]. Among all falls, 5% lead to fractures, lacerations, or hospitalization [10]. Fall events occur more frequently in clinical settings rather among the community-dwelling elderly [8,11]; however, although independent, the community-dwelling elderly are more susceptible to environment and home barriers and, thus, to fall [11]. The risk factors associated with fall events are (i) muscular and mobility alterations (especially with health equipment, such as walking aids and wheelchairs) [12], (ii) knee and/or hip osteoarthritis [13], (iii) sarcopenia [14], (iv) dementia, (v) comorbidity and poli-therapeutic treatment [15], (vi) fall events history. In addition, fall events in the elderly are associated with many variables and predisposing factors [2,16]: some clinical age-related conditions (i.e., vestibular, proprioceptive and visual disorders, cognition and musculoskeletal alterations, also at molecular level, etc.) and environment-related factors, such as home barriers, unsuitable shoes, etc. [10,17–20]. The aging process is also associated with frailty, a geriatric condition that further increases the vulnerability of elderly especially during ADL—such as dressing, feeding, personal hygiene, telephone use, home maintenance, etc. [21]. Frailty has already been linked with a higher prevalence of falling risk in old people [22]; however, there is no consensus in diagnosing the condition of frailty [23]. Fall events and frailty often impact the independent daily routine, generating fear of a second fall event and, consequently, a general mobility reduction, depression, anxiety, and social isolation. Quality of life in general is negatively affected; thus, prevention strategies should be planned as much as possible [24].

The elderly show gait alterations, a physiological deterioration in postural control mechanisms (interaction of musculoskeletal, sensory, and neuromuscular systems) and body orientation [25], reduced strength, and muscle tone [26,27]. Studies evaluating the proprioception and vestibular activity in response to external stimuli reported a reduction in the abilities of the elderly (people aged over 60) while coping with some destabilizing perturbations of posture (both visual stimuli such as shutter goggles, and mechanical vibrations applied to various parts of the body) [28,29]. The elderly also show a reduction in foot sensitivity and plantar pressure, affecting both standing and walking performance [30]. Posture and balance control become impaired during aging; the amplitude and frequency of body sway increase as compared to young adults, probably due to an impaired activation of agonist-antagonist muscles [29,31]. More generally, a reduction in the integration of recruited systems controlling posture characterizes the aging process [32]: among these, a visual-dependent behaviour while standing was associated with an elevated falling risk in the elderly, even if this dependency may vary among subjects and posture can be modulated through many other variables [33,34]. Gait disturbance prevalence increases about 10% among subjects aged 60–69 and is more than 60% in community-dwelling people in their eighties [35]. Both neurological and musculoskeletal alterations could negatively affect gait performance (i.e., ataxia due to polyneuropathy, vascular parkinsonism and encephalopathy with frontal gait disorders, dementia, schizophrenia, and hip and knee osteoarthritis) [36,37]. Gait parameters are indeed predictive of the health status of the elderly, and that is also influenced by age, behaviour, and state of mind [38]. The elderly that frequently fall have a reduced reaction time in response to the unexpected (unforeseen obstacles, environmental barriers, etc.) [7,39] and this could reduce their autonomy in the ADL, with a subsequent risk of hospitalization, disability and/or mortality. If impaired, gait and balance control mechanisms are predisposing factors to fall events [24,40]. Aging is thought to be characterized by increased postural instability in walking performance and altered gait cycle parameters: shorter stride and step length, an opposite trend between stance and swing phases (longer stance/shorter swing phase) [41], and reduced height from the floor during the swing phase [42]. Gait speed (m/s) has been shown to decrease by 1% per year, due to a reduced step length without any change in gait cadence (steps/minute). The reason could be attributed to proprioceptive along with visual signals, and musculoskeletal disorders. Differently to younger people, the elderly have a reduced ankle range of movement (ROM) and strength, for which they exhibit more proximal—mainly hip—compensatory mechanisms, due to the decreased distal limbs proprioception [35,43]. Performing posture and gait analyses for the early screening of fall risk is well established in literature. However, recent research stated that a single test could not discriminate between fallers and non-fallers, but a comprehensive evaluation of physical performances could be predictive of fall risk [44]. Among these functional tests, the timed up and go (TUG) is frequently administered to assess the ability to stand from a chair in combination with 3 m walking and returning to sit again. Nevertheless, the supporting evidence for TUG's ability to predict falls still seems inconsistent [44,45]. Gait parameters, as gait speed, can be examined with the six-minute walking test (6 MWT) and the 10 m walking test (10 MWT) that verify the walking performance of the elderly. The completed distance and time of both tests respectively show the degree of functional disability, especially related to the lower extremities; of note, the detected walking speed, if reduced, is associated with increased mortality [45].

There are several evidence-based protocols aimed at preventing the risk of falling [46], by contrast, frailty is more difficult to diagnose [23,47]. Screening interventions mainly consist of self-reported questionnaires [48] by which lifestyles, the amount of physical activity, nutrition, psychological and social attitudes [49] are assessed and evaluated for early recognition of falling risk and/or frailty conditions. Exercise programmes improving balance and strength are also available as home-based interventions or in a clinical setting [50,51] as prevention protocols. This study aimed at programming a screening protocol for both fall risk and frailty in the elderly. The screening protocol is a mix of clinical and instrumental evaluation, because clinical assessment with standardized tests and wearable technology can be objectively predictive of frailty condition and fall risk. As a consequence, the screening protocol seeks the early detection of fall risk and frailty followed by a quick start of the specific prevention programme.

## 2. Materials and Methods

### *2.1. Participants*

Participants in this study were recruited in October 2017 and evaluation tests lasted until January 2019. The inclusion criteria were:

- subjects over 65 years old;
- non-institutionalized subjects;
- independent gait, except for walking stick or crutch (subjects with any other health equipment—rollator, wheelchair, or medical walkers—were excluded).

All participants were exhaustively informed about the study and its aims; they all read and signed a written informed consent afterwards. This study was approved by the Local Institutional Ethics Committee of Area Vasta Emilia Nord (AVEN, Emilia Romagna region; ID number 17262).

### *2.2. Procedures*

The study consisted of a clinical evaluation (at the Geriatric Unit of AOU Parma) in which all participants were screened for the presence/absence of visual or hearing impairment, health equipment use, drugs use, fall history; then, patients completed, as the clinical pathway requested, tests and a questionnaires battery composed of Mini Mental State Examination (MMSE), Geriatric Depression Scale (GDS), Short Physical Performance Battery (SPPB), Hand Grip Test, Physical Activity Scale for the Elderly (PASE), Fall Efficacy Scale (FES), Dual-TASK Gait performance, Mini Nutritional Assessment (MNA-SF).

On a different day, gait and balance performance were evaluated at the Movement Analysis Laboratory (Parma). Also performed was a bioelectrical impedance analysis (BIA) to obtain the body mass index (BMI), percentage of fat mass and fat free mass.

The static condition was evaluated with a stabilometric platform (PoDataTM 2.0). Participants stood on the platform barefoot, arm at their side, for about 30 s, with open eyes (OE), followed by the same analysis with closed eyes (CE). During the analyses, the Global Postural System (GPS) recorded the movement of the centre of pressure (CoP) and the related parameters: path length (mm), sway area (mm$^2$), and maximum path velocity (mm/s).

Gait performance was then evaluated with the G-Sensor (G-Sensor®, BTS Bioengineering s.p.a, Milan, Italy). Subjects wearing the wireless device at L5-S1 were asked to walk on a ten-metre-long path at a self-selected speed while performing the 10 m walking test (10 MWT), six-minute walking test (6 MWT), and the timed up and go (TUG) test [52,53]. During the tests the Ground Reaction Force (GRF) was recorded while participants walked on the force platforms (BTS-P6000). A rest period of 10 min among tests was considered. Data collected were analysed with the BTS G-Studio software (BTS Bioengineering G-Studio®, Milan, Italy).

After 12 months, participants were interviewed by phone in order to check for fall events (number of falls with fractures or other consequences, hospitalization). Thus, patients were classified into 4 groups: the Fall group included subjects who experienced at least one fall event in the last year, in contrast with the No Fall group in which subjects did not experience fall events in the past twelve months; frail people were included in the Frail group for subjects who met the criteria to identify frailty according to Fried et al. [22]—at least three criteria satisfied among involuntary weight loss in the last year, muscular strength decrease (evaluated with the hand grip test), weakness, physical inactivity (low PASE score)—in contrast with the Able group that identified participants with higher scores and an overall better performance.

### *2.3. Statistical Analysis*

The statistical analysis was performed using jamovi (jamovi v2.3, Sydney, NSW, Australia) [54]. To verify the differences in the characteristics of gait, balance, and body composition in frail/able and fallers/non-fallers groups, a non-parametric statistical analysis has been performed (Mann Whitney U test). A Receiver Operating Characteristic (ROC) curve investigation has been made to identify cut-off levels on tests.

## 3. Results

Fifty subjects (17 males and 33 females, mean age 76.9 ± 3.69 years) were enrolled as participants into the study (Table 1). Patients were classified into Fall group (Fall, n = 13), No Fall group (NFall, n = 37), Able group (Ab, n = 37), Frail group (Fr, n = 13). Contingency table among groups is reported in Table 2.

**Table 1.** Demographic data of participants included in the study.

| | **Mean (SD)** |
|---|---|
| Age (years) | 77.1 (3.6) |
| Gender (M/F) | 50 (17/33) |
| Height (m) | 1.59 (0.1) |
| Weight (kg) [a] | 73.1 (13.6) |
| BMI (kg/m$^2$) [a] | 28.7 (4.7) |
| PBF (%) [a] | 35.6 (11.7) |

SD = standard deviation; M = male; F = female; BMI = body mass index; PBF = percentage of body fat; [a] n = 47.

**Table 2.** Contingency table of subjects included in the study.

| | **Groups** | | |
|---|---|---|---|
| | **Able** | **Frail** | **Total** |
| Fall | 7 | 6 | 13 |
| No Fall | 30 | 7 | 37 |
| Total | 37 | 13 | 50 |

### 3.1. Fall vs. NFall Groups

No differences were observed regarding the bioimpedance analysis (BIA) between fallers and non-fallers. Data from the stabilometric test showed a significant difference between Fall and NFall groups regarding the sway area with the open eyes (OE) condition and the maximum speed of oscillation (or sway speed) at OE (respectively $p = 0.016$ and $p = 0.003$). No difference was found in path length for OE ($p = 0.06$) or CE conditions in any group comparison. Fall and NFall groups did not differ in the six-minute walking test (6 MWT) nor in the 10 m walking test (10 MWT). Statistical significance has been detected in the left propulsion at 10 MWT only ($p = 0.03$). As for the timed up and go (TUG) test, significant differences were found between Fall and NFall groups in the (i) duration of initial rotation (IR) during TUG test ($p = 0.038$), (ii) duration of final rotation (FR) during TUG test ($p = 0.015$), (iii) speed of initial rotation during TUG test ($p = 0.019$), and (iv) speed of final rotation during TUG test ($p = 0.048$) (Table 3).

**Table 3.** Comparison between Fall and NFall groups.

| Tests | Parameters | Statistic [a] | *p*-Value |
|---|---|---|---|
| Stabilometry | Sway Area OE | 132 | 0.016 |
| | Max Speed_Oscillation OE | 107 | 0.003 |
| 10 MWT | 10 MWT_Left Propulsion | 144 | 0.033 |
| TUG | TUG_IR_Duration | 147 | 0.038 |
| | TUG_FR_Duration | 131 | 0.015 |
| | TUG_IR_Speed | 134 | 0.019 |
| | TUG_FR_Speed | 151 | 0.048 |

10 MWT = 10-m walking test; IR = initial rotation; FR = final rotation; Max_Speed_Oscillation OE = maximum speed of oscillation at OE; OE = open eyes; TUG = timed up and go. [a] *U* values of Mann-Whitney test.

### 3.2. Able vs. Frail Groups

No differences were found among stabilometric parameters between Ab and Fr groups. The distance of 6 MWT was conversely influenced by frailty condition ($p < 0.001$). Cadence ($p = 0.036$), speed ($p < 0.001$) and left propulsion in 10 MWT ($p < 0.001$) were statistically different when comparing Ab and Fr groups (Table 4). Differences were also observed in the total duration of the TUG test ($p = 0.05$), the duration of the initial and final rotation ($p = 0.05$ and $p = 0.04$ respectively), and the speed of initial and final rotation during TUG test ($p < 0.001$ and $p = 0.02$) (Table 4).

**Table 4.** Comparison between Able and Frail groups.

| Tests | Parameters | Statistic [a] | *p*-Value |
|---|---|---|---|
| 10 MWT | 10 MWT_Cadence | 146 | 0.036 |
| | 10 MWT_Speed | 91 | <0.001 |
| | 10 MWT_Left_Propulsion | 85.5 | <0.001 |
| 6 MWT | 6 MWT_Distance | 65 | <0.001 |
| TUG | TUG_Duration | 151.5 | 0.050 |
| | TUG_IR_Duration | 115 | 0.005 |
| | TUG_FR_Duration | 110 | 0.004 |
| | TUG_IR_Speed | 82 | <0.001 |
| | TUG_FR_Speed | 103 | 0.002 |

10 MWT = 10-m walking test; 6 MWT = six-minute walking test; IR = initial rotation; FR = final rotation; TUG = timed up and go. [a] *U* values of Mann-Whitney test.

### 3.3. ROC Curves

To identify the predictive value of fall event and frailty in all subjects evaluated in the study, ROC curves were obtained (Figures 1 and 2).

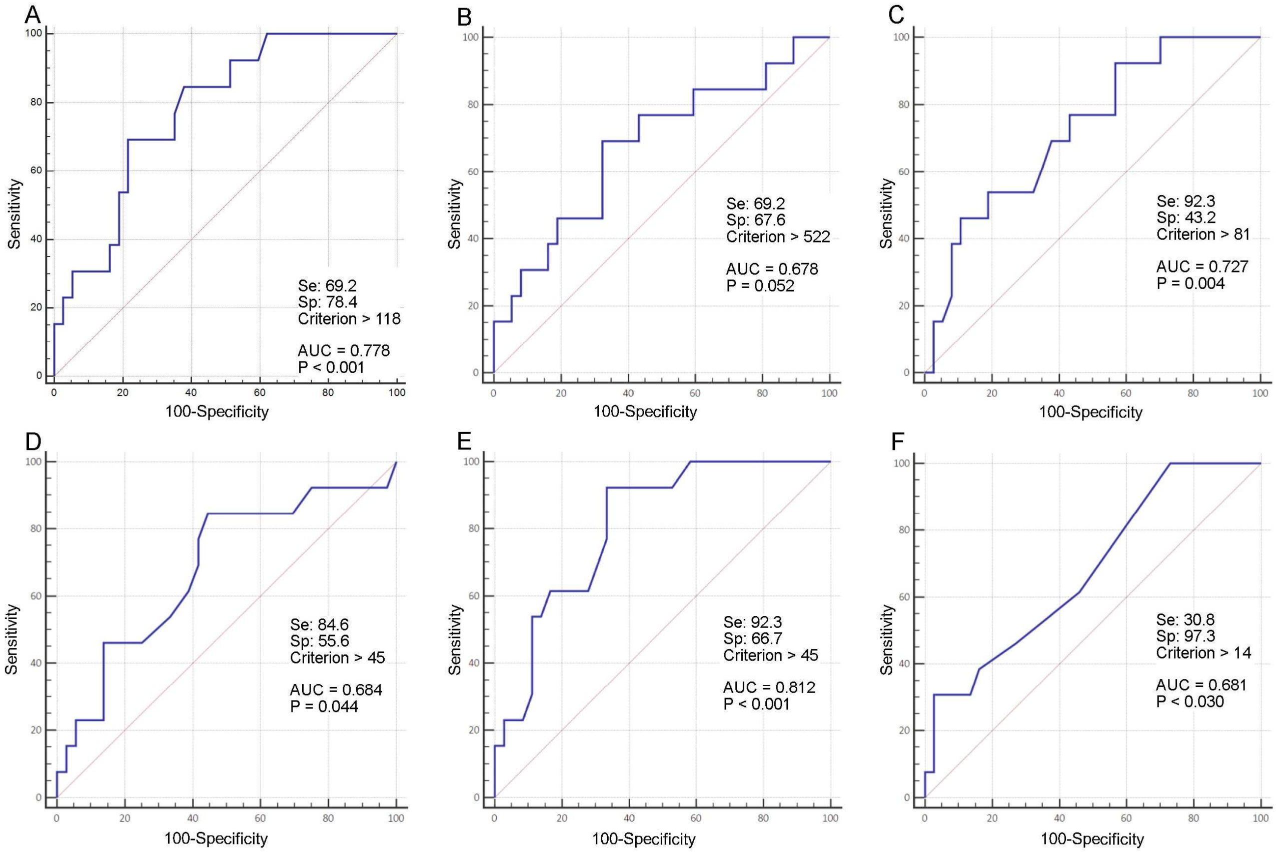


**Figure 1.** Predictive ROC curves for Fall (1) and NFall (0) subjects. (**A**) Max_Speed_Oscillation OE; (**B**) Path length at OE; (**C**) Sway area at OE; Right (**D**) and left (**E**) anterior-posterior (AP) ground reaction force (GRF); (**F**) TUG duration. AUC = Area Under the Curve; Criterion = Youden's Index; OE = open eyes; SE = sensitivity; SP = Specificity; TUG = timed up and go test.

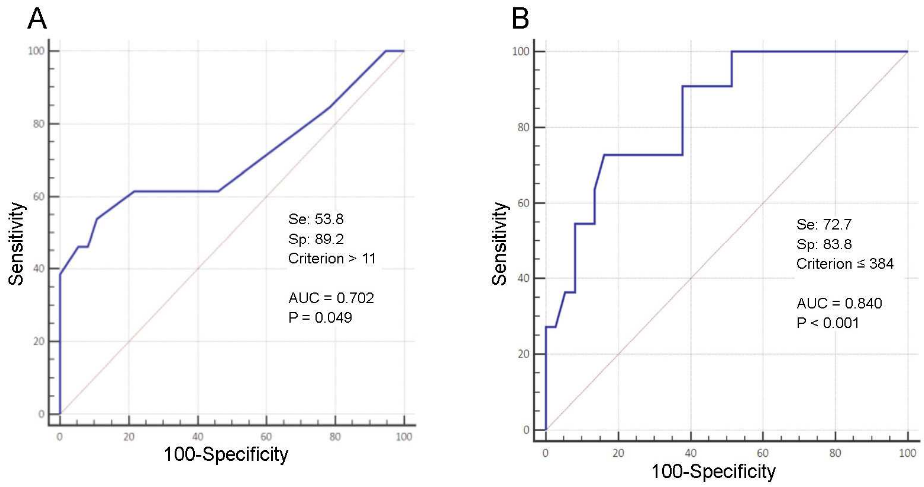


**Figure 2.** Predictive ROC curves for Able (1) and Frail (0) subjects. (**A**) TUG duration; (**B**) 6 MWT distance. AUC = Area Under the Curve; Criterion = Youden's Index; SE = sensitivity; SP = Specificity; 6 MWT = six-minute walking test; TUG = Timed Up and Go test.

Related to falls, the maximum speed of oscillation at OE in the stabilometric test is considered as a predictive threshold value of fall event (Figure 1, panel A, $p < 0.001$; criterion > 118). The path length at OE (Figure 1, panel B) could also identify the predictive threshold value of fall event ($p = 0.052$; criterion > 522). The sway area at OE is a predictor of fall event with criterion > 81 ($p = 0.004$) (Figure 1, panel C). The anterior-posterior (AP) ground reaction force (GRF) is a predictor of fall event for both limbs, with a criterion > 45 ($p_{right}$ = 0.044, $p_{left}$ < 0.001, Figure 1, panels D–E). The duration of the TUG (Figure 1, panel F) can predict the fall event with a criterion > 14 ($p$ = 0.030).

The duration of the TUG (criterion > 11, $p$ = 0.049) and 6 MWT distance (criterion ≤ 384; $p$ < 0.001) are together parameters that could identify the predictive threshold value of the condition of frailty (Figure 2, panels A and B).

The body mass index (BMI) had a positive correlation with the duration of the TUG, and a negative correlation with the acceleration in lifting from the chair and final rotation during the TUG (Table 5).

**Table 5.** Correlation matrix.

| | | BMI | TUG_Duration | TUG_Lift_Acc | TUG_FR |
|---|---|---|---|---|---|
| BMI | Pearson's r | — | | | |
| | *p*-value | — | | | |
| | Spearman's rho | — | | | |
| | *p*-value | — | | | |
| TUG_Duration | Pearson's r | −0.057 | — | | |
| | *p*-value | 0.705 | — | | |
| | Spearman's rho | 0.299 | — | | |
| | *p*-value | 0.041 * | — | | |
| TUG_Lift_Acc | Pearson's r | −0.311 | −0.576 | — | |
| | *p*-value | 0.033 * | <0.001 * | — | |
| | Spearman's rho | −0.37 | −0.772 | — | |
| | *p*-value | 0.01 * | <0.001 * | — | |
| TUG_FR | Pearson's r | −0.15 | −0.679 | 0.582 | — |
| | *p*-value | 0.313 | <0.001 * | <0.001 * | — |
| | Spearman's rho | −0.257 | −0.651 | 0.501 | — |
| | *p*-value | 0.081 | <0.001 * | <0.001 * | — |

* $p < 0.05$; BMI = body mass index; FR = final rotation; TUG = timed up and go; TUG_Lift_Acc = acceleration in lifting from the chair during the timed up and go test.

## 4. Discussion

The aim of this study was to set a prevention and screening protocol predictive of fall risk and frailty condition in the elderly. Despite the preventable nature of fall events, falls are experienced by a growing number of older adults. Having a history of fall generates fear of a second fall, even if the first experience did not lead to fatal or serious injuries. Interventions directed to the improvement of physical aspects such as gait and balance can reduce the falling risk; however, a preliminary assessment is needed to quantify risk factors and screening of the targeted population with the highest falling risk. Based on recent research [55], screening tests alone can be predictive of falling risk with low-to-moderate ability and various degrees of sensitivity and specificity. Therefore, screening tools should be more accurate. On the other hand, frailty further increases the vulnerability of older adults and, as with fall events, this can be assessed and prevented. However, frailty remains an ambiguous concept and its testing in clinical practice is still limited [56]. In this context, the proposed model of screening for falls and frailty in the elderly is a multicomponent approach evaluating risk factors for both conditions through geriatric assessment and functional tests. The literature demonstrates the usefulness of wearable technologies to evaluate different aspects of elderly daily living. As for the risk of falling, previous research highlighted the accuracy of sensor-based assessment and related values in detecting an early risk [57]. However, sensor-based technology alone is not sufficient in order to prevent fall events and the frailty condition, which together could indeed be recognized with a combined methodology—or screening protocol—including functional tests and geriatric exams. According to the results of this study, posture and gait analysis highlighted significant differences among groups of our sample, identifying frail subjects and/or with high falling risk. Both stabilometric and gait parameters can be predictive of fall events, whereas TUG test and 6 MWT can in particular predict frailty.

Related to the stabilometry, path length, sway area, and the maximum path velocity are predictors of fall event when they are performed at OE (conversely, we found no differences at CE). Although sight generally contributes to maintaining stability, our sample of elderly had vision-independent behaviour to control their upright stability. This behavioural phenomenon often occurs with aging, maybe due to reductions in visual acuity, alterations in the perception of contrast, conditions like presbyopia, cataracts, and maculopathy, that are factors correlated with the increased risk of falling. Falling can be related to various and subjective factors, however, poor balance has been associated with the increased occurrence of falls in older people [58]. Previous studies [59] highlighted how the balance tests obtained with stabilometric platforms are sensitive in differentiating performance between young, adult, and elderly populations. The stabilometry is sensitive and useful in showing changes in balance in longitudinal studies, but the impact that these measures have in predicting fall events is not yet clear. It has been observed that some parameters, such as the postural sway and the amplitudes of medium-lateral oscillations of the CoP at OE can provide useful information in predicting future or recurrent fall events, even though great uncertainty persists. In another study [60] it has been remarked that stabilometry can discriminate faller and non-faller subjects through the study of medio-lateral oscillations. These oscillations could be indicators of a fall event. Little information has been investigated about the other parameters such as the sway area and the path length.

The TUG [61] as well as other performance tests (Performed Oriented Mobility Assessment, POMA, and St. Thomas's Risk Assessment Tool in Falling Elderly Inpatients, STRATIFY) appear to be correlated with fall events, but, at the same time, lack sensitivity and accuracy [62,63]. In fact, they do not seem able to follow changes in the balance over time. Some studies have highlighted the possible usefulness of the TUG as a predictor of fracture in the elderly related to fall events [64]. However, our results suggest that the duration of the TUG test can be considered as a predictor of fall events. In addition, the TUG can predict the performance threshold associated with the condition of frailty. Using the accelerometer, it is possible to calculate the speed and duration of rotation, considered indices of dynamic instability of subjects [65–67], which in our sample were statistically different in the able and frail groups and fall and no fall groups.

Together with the TUG, the 6 MWT distance could also be a predictor of the condition of frailty. In the literature it has been shown that the 10 MWT has a good correlation with disability [61,68] thus, a lower walking speed leads to a limitation of independence and could be predictor of fall events, even though, based on our data, it cannot be considered a valid predictor of fall events. Although the evidence shows that the spatio-temporal parameters of gait recorded by accelerometer can differentiate faller from non-faller subjects in the elderly [68], we did not observe such dependence probably due to the different range of cognitive and motor skills in our sample.

Regarding the bioimpedance analysis (BIA) data, no differences or predictive values were found among groups. This result disagrees with the literature; although no predictivity was demonstrated in the present study, the body mass index (BMI) should be correlated with falls [69,70]. Using the Spearman correlation index, a statistically significant relationship was found between the increase in BMI and body fat and a reduction in rotation speed at the TUG test. Furthermore, the BMI correlates directly with the duration of the TUG. Therefore, BMI indirectly impacts on the stability of subjects.

Our study has some limitations. The results that we found could be confirmed with a larger sample size. Moreover, we checked for fall events after a year from the tests and geriatric exams. Therefore, we lack a follow-up and instrumental parameters comparison before and after the fall event.

## 5. Conclusions

According to the results, this study highlights and proposes the stabilometry parameters as predictive of falls in the elderly. The ability to maintain a stable upright position mainly depends on the ability to integrate sensitive information in order to maintain posture and balance. Therefore, the stability of subjects can be depicted by the parameters obtained from the stabilometry.

The TUG test is a falling risk predictor. Of note, the TUG test can also predict frailty, together with the 6 MWT. The performance tests (6 MWT, 10 MWT) are poorly predictive of fall events; of note, they are indeed predictors of frailty. Reasonably, frailtyin the elderly is linked to many clinical aspects, to the ability to perform endurance tests, to be able to move independently and safely. The TUG can be considered a predictor of both fall events and the condition of frailty; in fact, walking speed, final rotation, and the ability to get up and sit down from the chair (included in the TUG test) are representative of the balance and strength of the lower limbs.

In conclusion, performing stabilometric and accelerometric analyses in old subjects, identifying the parameters with a high predictive value (speed oscillation, path length, sway area, TUG, 6 MWT), could be proposed as a screening protocol supporting clinical and anamnestic evaluation. It could be a model to identify subjects with risk of a first fall event and the condition of frailty, directing subjects to primary and/or secondary prevention programs, while reducing the possibility of hospitalization and disability.

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