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Predicting the Occurrence of Falls Among Portuguese Community-Dwelling Adults Aged 50 or Older Using the Timed up and Go Test

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Abstract: Falls are a major cause of morbidity and mortality among older adults. While the Timed Up and Go (TUG) test has recently been identified as the best predictor of falls, it should not be used in isolation to identify individuals at risk. This study aims to develop a predictive model by combining the TUG test with fall risk factors that involve intrinsic and extrinsic elements to predict future falls in Portuguese community-dwelling adults aged 50–60, 60–70, and 70 years or older. A total of 403 participants aged 50 or older completed a questionnaire on demographic information and fall risk factors, underwent the TUG test, and were monitored for 12 months to record falls. ROC curve analysis demonstrated that the TUG test alone effectively distinguished fallers from non-fallers exclusively among adults aged 50–60, with a cut-off time of 6.9 s. Multivariate logistic regression defined three predictive models based on age groups, with ROC curve results as follows: 50–60 (AUC = 0.825, cut-off = 18.1), 60–70 (AUC = 0.754, cut-off = 17.8), and 70 or older (AUC = 0.708, cut-off = 24.8). These findings are clinically significant, demonstrating that the TUG test combined with a few self-reported questions can efficiently identify individuals at risk of falling in just a few minutes, without requiring specialized equipment.

Keywords: unintentional falls; multifactorial risk factors; community-dwelling adults; timed up and go test; logistic regression model

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1. Introduction

Falls are a significant public health issue, as they greatly affect quality of life [1] and represent a leading cause of morbidity and mortality [2]. About 30% of adults aged 65 and over have been experiencing falls each year [3,4]. Between 2010 and 2018, Portugal reported 383,016 fall-related hospital admissions, accounting for 2.1% of total hospitalizations during that period [5].

Identifying individuals at risk requires a multifactorial assessment [1], with early intervention relying on brief fall risk screening to estimate an individual's likelihood of falling and to determine the need for a more comprehensive evaluation [3,6]. A thorough fall risk assessment should consider various factors, including fall history, fear of falling, medical conditions, medication use, environmental hazards, and functional abilities such as gait, lower limb muscle strength, balance, and mobility [4,7].

Tinetti et al. [8] highlighted that only a small proportion of falls result from a single, identifiable cause. Consequently, fall ethology is widely recognized as multifactorial, encompassing intrinsic (patient-related) and extrinsic (environmental) factors, as well as activity-related variables [9]. Previous research has shown that extrinsic precipitating factors account for approximately 41–55% of falls among community-dwelling older adults and around 16% among those residing in nursing homes. In contrast, intrinsic factors contribute to 39–53% of falls in community-dwelling older adults and up to 80% of falls in nursing home residents [10,11].

Intrinsic factors originate within the individual and include variables such as age, sex, and age-related physiological changes, including visual and auditory impairments, balance disorders, increased fat mass, decreased muscle mass, fear of falling, and a history of previous falls. Additionally, chronic conditions such as stroke, dementia, Parkinson's disease, and heart failure are significant intrinsic contributors. Conversely, extrinsic factors involve external elements, such as environmental hazards (e.g., slippery surfaces, inadequate lighting, or uneven flooring), which play a crucial role in fall incidents. Studies indicate that these extrinsic factors are responsible for 30% to 50% of falls among older adults [12]. A comprehensive understanding of both intrinsic and extrinsic risk factors underscores the complexity of falls in aging populations and highlights the need for targeted prevention strategies.

The history of falls is a significant risk factor, as older adults who have suffered one or more falls are three times more likely to fall again in the following year compared with those without a history of falls [13,14]. Additionally, fear of falling is a significant risk factor. Defined as concern about falls, it often causes individuals to avoid activities they are still able to perform [15] and is associated with an increased risk of functional decline [16]. This decline, particularly in lower limb muscle strength, can lead to dependence on the upper limbs for assistance when rising from a chair [17]. Among individuals who have suffered a recent fall, up to 70% report a fear of falling and of these, 50% may limit physical or social activity, further increasing the risk of falling [12]. Additionally, certain health conditions—such as hypertension, high cholesterol, osteoarthritis, osteoporosis, urinary incontinence, and visual impairment—also contribute to a significant increase in the risk of falling [18].

Medications are frequently linked to a higher likelihood of falls [19], and it is widely acknowledged that the risk of falling rises with the number of medications used, with individuals taking four or more medications (polypharmacy) being at a particularly elevated risk [20]. Moreover, significant associations have been identified between falls and the use of sedatives, hypnotics, antidepressants, and benzodiazepines [19,21,22].

The literature highlights the importance of identifying and mitigating environmental hazards [7,23]. Home environment screening has proven to be an effective intervention for individuals with a history of falls or other fall risk factors [7]. Additionally, it is well-documented that stairways are common locations for falls, representing a significant risk, especially for older adults, as these incidents are related to both the task and the environment, and are associated with severe injuries [4,24].

Several functional tests assess lower extremity muscle strength, including the 30 s sit-to-stand test [25] and gait speed measurements, such as the 10 m walking speed test [26]. However, recent literature identifies the Timed Up and Go (TUG) test as one of the best predictors of falls [27]. The TUG test evaluates dynamic balance, mobility, and lower extremity muscle strength [28]. This test involves performing basic motor tasks essential for independent living, such as standing up from and sitting down on a chair, walking a short distance, and changing direction while walking [29]. The TUG test is recommended as a routine screening tool to assess gait and balance in fall risk evaluations [2,7]. Nonetheless, it should not be used in isolation to identify individuals at high risk of falling; other risk factors must also be considered [3,30,31].

Given the diversity of risk factors to be evaluated, it is essential to establish a brief protocol that more effectively predicts the occurrence of falls. Although research on falls primarily focuses on adults aged 65 or older, individuals aged 50 or older often tend to underestimate their likelihood of experiencing a fall, where falls pose a risk of injury, potentially leading to related expenses and disruptions to life [32]. The objective of this study was to develop a predictive model combining the TUG test with intrinsic and extrinsic fall risk factors to predict future falls among community-dwelling Portuguese adults aged 50 years and older.

2. Materials and Methods

This study employed a prospective longitudinal design with a convenience sampling method. Ethical approval was obtained from the Research Ethics Committee of the Polytechnic University of Coimbra (Approval Number: 6/2017). All participants provided written informed consent prior to data collection, in accordance with the Declaration of Helsinki. The study was registered on ClinicalTrials.gov under the identifier NCT03619200. The anonymity and confidentiality of the collected data were ensured. The study was conducted exclusively for scientific purposes.

2.1. Participants

Portuguese community-dwelling adults aged 50 years or older were recruited from parish councils, physical therapy clinics, senior universities, and other community facilities. Participants were eligible for inclusion if they could stand and walk independently, with or without walking aids, and provided informed consent to participate in the study. Exclusion criteria comprised severe sensory impairments, such as deafness or blindness, as well as cognitive impairments. Anyone who was able to reach the screening site, regardless of their education level, could participate; however, those showing signs of cognitive impairment that prevented test completion or raised suspicion were assessed but later excluded from the study. The size and statistical power of the sample were calculated using the G*Power 3.1 software application. The following parameters were considered: logistic regression; two tails; odds ratio: 2.35; α-level: 0.05; statistical power: 0.93; proportion of events: 0.25. Therefore, the initial size of the total sample was estimated at 391 participants.

A total of 428 individuals met the eligibility criteria and consented to participate. After 25 participants dropped out during the 12-month follow-up period, the final study sample consisted of 403 individuals (mean age = 69.7 $\pm$ 10.3 years; 70.0% women).

2.2. Definition of Fall

In this study, a fall is defined as 'an unexpected event in which the participant comes to rest on the ground, floor, or a lower level', excluding cases where the participant comes to rest against furniture, a wall, or another structure [2,22].

2.3. Functional Ability Assessment

The TUG test measures the time, in seconds, required to stand up from a chair, walk straight for 3 m, turn around, return to the chair, and sit down. Participants are instructed to walk as quickly and safely as possible, using their walking aids if needed and wearing their regular footwear [29,33]. Assessments were conducted by two younger research physiotherapists involved in the project and who had received prior training in administering the TUG. The test is performed once, with timing starting at the instruction 'go' and stopping when the participant sits back on the chair. The person must stand up without help (cannot use the upper extremities for support); however, if a walking aid is needed, it should be placed next to the chair and can be used to perform the gait component of the test [34].

2.4. Assessment of Other Variables

Participants completed a structured questionnaire during initial data collection.

Independent variables identified as risk factors for falls in people aged 50 and over include (1) demographic characteristics comprised of age and sex, (2) intrinsic factors such as history of falls, fear of falling, and medical conditions (heart attack, stroke, osteoarthritis, diabetes, Parkinson's disease, osteoporosis, urinary incontinence, hypertension, high cholesterol, hearing loss), and (3) extrinsic factors including consumption of medications (number and pharmaceutical group) that cause drowsiness and reduce balance, dependence on upper extremities for assistance when getting up from a chair, assistive mobility, and the presence of stairs at home [34].

History of falls (HoF) within the previous 12 months was assessed through self-report with the question: 'Did you fall in the past 12 months? Yes/No'. Fear of falling (FoF) was evaluated with the question: 'Are you afraid of falling? Yes/No'. Upper Extremities to stand up from a chair (UpExt) was determined by asking: 'Do you need assistance from your upper extremities to stand up from a chair? Yes/No'. The presence of stairs at home was assessed through self-report with the question: 'Do you have stairs in your house? Yes/No'. The number of medications was assessed with the question: 'Do you take four or more different medications per day?' Additionally, participants' daily medications were classified by pharmaceutical group [34].

2.5. History of Falls After 12 Months

Participants were prospectively followed for 12 months through monthly phone calls to document fall occurrences. The calls were conducted by the two youngest physiotherapist researchers in the project, who were responsible for systematically documenting the events. Fall rates were recorded from the date of inclusion until voluntary withdrawal, loss of phone contact, or the end of the follow-up period (365 days). Participants who reported at least one fall during the 12-month follow-up were classified as fallers, while those who reported no falls were classified as non-fallers [13,14,34].

2.6. Statistics

Statistical analyses were performed using IBM SPSS software (version 28) for Windows. Descriptive statistics included mean and standard deviation for quantitative variables and frequency distributions for qualitative variables. Differences between fallers and non-fallers were analyzed using Student's *t*-test for independent samples or the Chi-square test. Logistic regression analysis was conducted to develop a predictive model for falls based on functional tests and other variables.

Receiver Operating Characteristic (ROC) curve analysis was used to differentiate fallers from non-fallers. Sensitivity (the percentage of fallers correctly identified), specificity (the percentage of non-fallers correctly identified), and the area under the curve (AUC) of the model were calculated to predict falls during the follow-up period. A significance level of 0.05 was applied to all comparisons, except for the goodness of fit of the regression models, assessed using the Hosmer–Lemeshow test, where significance was defined as $p > 0.05$.

3. Results

Of the 428 individuals who met the inclusion criteria, 25 (6%) dropped out during the one-year follow-up period. The final sample consisted of 403 participants aged 50 to 95 years, with the following age distribution: 83 participants (21%) aged 50–60 years, 106 (26%) aged 60–70 years, and 214 (53%) aged 70 years or older. The most prevalent self-reported health conditions were hypertension (60%), high cholesterol (48%), osteoarthritis (47%), and urinary incontinence (31%). The characteristics of the participants are presented in Table 1.

Table 1. Characteristics of individuals by fall occurrence during follow-up for all adults aged 50 and older.

Factors	Total (n = 403)	Fallers (n = 97)	Non-Fallers (n = 306)	*p*
Intrinsic				
Gender				0.039
Male	121 (30)	21 (17)	100 (83)	
Female	282 (70)	76 (27)	206 (73)	
History of Fall				<0.001
Yes	127 (32)	47 (37)	80 (63)	
No	276 (69)	50 (18)	226 (82)	
Fear of Fall				0.113
Yes	192 (48)	53 (28)	139 (72)	
No	211 (52)	44 (21)	167 (79)	
Extrinsic				
Medication				
Benzodiazepines				0.002
Yes	106 (26)	37 (35)	69 (65)	
No	297 (74)	60 (20)	237 (80)	
Antidepressants				0.010
Yes	94 (23)	32 (34)	62 (66)	
No	309 (77)	65 (21)	244 (79)	
Antihypertensive				0.048
Yes	257 (64)	70 (27)	187 (73)	
No	146 (36)	27 (19)	119 (82)	
Polypharmacy				0.009
Yes	232 (58)	67 (29)	165 (71)	
No	171 (42)	30 (18)	141 (82)	
Upper Extremities				0.026
Yes	132 (33)	41 (31)	91 (69)	
No	271 (67)	56 (21)	215 (79)	
Mobility assistive				0.800
Yes	51 (13)	13 (26)	38 (74)	
No	352 (87)	84 (24)	268 (76)	
Stairs				0.978
Yes	312 (77)	75 (24)	237 (76)	
No	91 (23)	22 (24)	69 (76)	

Values were expressed as frequency (percentage). Significant result: $p \leq 0.05$.

3.1. Univariate Analysis

During the one-year follow-up, 97 participants (24%) reported falls. The incidence of falls was 19% among adults aged 50–60 years (16 fallers out of 83 participants), 21% among adults aged 60–70 years (22 fallers out of 106 participants), and 28% among adults aged 70 years or older (59 fallers out of 214 participants).

Significant differences were observed in fall occurrences during the 12-month follow-up period between genders (27% in women vs. 17% in men; p = 0.039). Persons on multiple medications showed a significantly higher likelihood of falling compared with non-polymedicated individuals (29% vs. 18%; p = 0.009), particularly those taking benzodiazepines (35% vs. 20%; p = 0.002), antidepressants (34% vs. 21%; p = 0.008), and antihypertensives (27% vs. 17%; p = 0.031). Additionally, individuals who fell during the follow-up period reported taking, on average, more medications per day (5.20 ± 3.2 vs. 4.15 ± 3.1; p = 0.002). A significantly higher probability of falling was also identified in participants who reported a history of falls (HoF) in the 12 months prior to the baseline assessment (37% vs. 18%; p < 0.001) and in those requiring upper limb assistance to rise from a chair (UpExt) (31% vs. 21%; p = 0.026) (Table 1).

The factors significantly influencing fall events varied across different age groups (Table 2). Among adults aged 70 years or older, falls were significantly associated only with HoF (p = 0.004). In adults aged 60–70 years, significant associations were observed with benzodiazepine use (p = 0.029), polypharmacy (p = 0.045), number of medications per day (5.64 ± 3.2 vs. 3.69 ± 2.7, mean ± standard deviation for fallers and non-fallers, respectively; p = 0.005), and UpExt (p = 0.021). Among adults aged 50–60 years, significant associations were identified between falls and the number of medications per day (3.81 ± 3.4 vs. 1.85 ± 2.2, mean ± standard deviation for fallers and non-fallers, respectively; p = 0.041), as well as all other factors presented in Table 1, except for the use of antihypertensive medications.

Table 2. Characteristics of individuals by fall occurrence during follow-up, stratified by age groups.

Factors	50–60 Years (n = 83)			60–70 Years (n = 106)			≥70 Years (n = 214)		
	Fallers (n = 16)	Non-Fallers (n = 67)	p	Fallers (n = 22)	Non-Fallers (n = 84)	p	Fallers (n = 59)	Non-Fallers (n = 155)	p
Intrinsic									
Gender			0.064			0.776			0.054
Male	0 (0)	13 (100)		4 (17)	20 (83)		17 (20)	67 (80)	
Female	16 (23)	54 (77)		18 (22)	64 (78)		42 (32)	88 (68)	
History of Fall			0.003			0.346			0.004
Yes	9 (43)	12 (57)		8 (27)	22 (73)		30 (40)	46 (60)	
No	7 (11)	55 (89)		14 (18)	62 (82)		29 (21)	109 (79)	
Fear of Fall			0.016			0.842			0.754
Yes	9 (36)	16 (64)		11 (22)	40 (78)		33 (28)	83 (72)	
No	7 (12)	51 (88)		11 (20)	44 (80)		26 (27)	72 (73)	
Extrinsic									
Medication									
Benzodiazepines			0.012			0.038			0.330
Yes	7 (44)	9 (56)		8 (38)	13 (62)		22 (32)	47 (68)	
No	9 (13)	58 (87)		14 (17)	71 (83)		37 (25)	108 (75)	
Antidepressants			0.037			0.562			0.120
Yes	7 (39)	11 (61)		6 (26)	17 (74)		19 (36)	34 (64)	
No	9 (14)	56 (86)		16 (19)	67 (81)		40 (25)	121 (75)	
Antihypertensive			0.553			0.084			0.651
Yes	6 (23)	20 (77)		17 (26)	47 (74)		47 (28)	119 (72)	
No	10 (18)	47 (82)		5 (12)	36 (88)		12 (25)	36 (75)	
Polypharmacy			0.003			0.045			0.876
Yes	9 (43)	12 (57)		16 (28)	41 (72)		42 (27)	112 (73)	
No	7 (11)	55 (89)		6 (12)	43 (88)		17 (28)	43 (72)	
Upper Extremities			0.017			0.021			0.910
Yes	7 (41)	10 (59)		9 (39)	14(61)		25 (27)	67 (73)	
No	9 (14)	57(86)		13 (16)	70 (84)		34 (28)	88 (72)	
Mobility assistive			0.035			1.00			0.531
Yes	2 (100)	0 (0)		0 (0)	3 (100)		11 (24)	35 (76)	
No	14 (17)	67 (83)		22 (21)	81 (79)		48 (29)	120 (71)	
Stairs			1.000			0.730			0.692
Yes	14 (20)	57 (80)		19 (20)	74 (80)		42 (28)	106 (72)	
No	2 (17)	10 (83)		3 (23)	10 (77)		17 (26)	49 (74)	

Values were expressed as frequency (percentage). Significant result: $p \leq 0.05$.

3.2. ROC Curves for TUG

ROC curve analysis was conducted to assess the ability of the TUG test to predict falls during the 12-month follow-up period. When analyzing the overall sample without age stratification, the TUG test did not demonstrate significant discriminatory ability (p = 0.136). However, when applying the ROC curve to the three previously defined age groups, distinct results were observed. For the 50–60 years age group, a cut-off point of 6.9 s was identified, yielding a sensitivity of 86.7%, specificity of 66.7%, and an AUC of 78.3%, indicating a good ability to distinguish between fallers and non-fallers (p = 0.001). In contrast, for the 60–70 years and 70 years or older age groups, the TUG test did not show significant discriminatory ability (p = 0.300 and p = 0.137, respectively).

3.3. Logistic Regression

In the logistic regression analysis, the dependent variable was whether a participant experienced falls during the 12-month follow-up period (1: yes, 0: no). The independent variables included the TUG score (used for the aged 60–70 and 70 or older groups), TUG cut-off (0: TUG $\geq$ 6.9 s [risk of falling], 1: TUG < 6.9 s) for the aged 50–60 years group, and other variables that showed a statistically significant association with falls during the follow-up period. The outcome measures that demonstrated a statistically significant effect on the dependent variable (p < 0.05) were as follows: TUG (a), HoF (b), UpExt (c), and benzodiazepine use (d) in all participants; TUG cut-off (e) and HoF (b) in the aged 50–60 years group; TUG (a), UpExt (c), and number of medications per day (f) in the aged 60–70 years group; and TUG (a), HoF (b), and benzodiazepine use (d) in the aged 70 or older group (Table 3).

Table 3. Factors associated with falls among community-dwelling adults aged 50 and older, identified through logistic regression.

Models	β	SE	Wald	p	OR	95% CI
≥50 years						
(a) TUG	−0.185	0.022	67.424	<0.001	0.83	0.80–0.87
(b) HoF (1)	0.848	0.263	10.382	0.001	2.34	1.39–3.91
(c) UpExt (1)	0.585	0.285	4.212	0.040	1.79	1.11–21.4
(d) Benzodiazepines (1)	0.834	0.280	8.856	0.003	2.30	1.33–3.99
50–60 years						
(e) TUG cut-off (1)	−2.528	0.832	9.234	0.002	0.08	0.02–0.41
(b) HoF (1)	1.666	0.689	5.856	0.016	5.29	1.37–20.41
Constant	−1.136	0.448	6.443	0.011	0.32	-
60–70 years						
(a) TUG	−0.173	0.072	5.806	0.016	0.84	0.73–0.97
(c) UpExt (0)	−1.345	0.468	8.245	0.004	0.26	0.10–0.65
(f) Medications/day	0.215	0.086	6.214	0.013	1.24	1.05–1.47
≥70 years						
(a) TUG	−0.056	0.027	4.444	0.035	0.95	0.90–0.99
(b) HoF (1)	1.125	0.347	10.497	0.001	3.08	1.56–6.09
(d) Benzodiazepines (1)	0.797	0.362	4.836	0.028	2.22	1.09–4.51
Constant	−1.093	0.356	9.422	0.002	0.34	-

TUG cut-off (0: TUG ≥ 6.9 s (risk of falling), 1-TUG < 6.9 s), HoF (1: yes, 0: no), UpExt (1: yes, 0: no), Benzodiazepines (1: yes, 0: no).

The probability of suffering a fall, $pr(Fall)$, can then be calculated as:

$$\text{Adults aged 50 years or older } pr(Fall) = \frac{1}{1 + e^{0.185(a) - 0.848(b) - 0.585(c) - 0.834(d)}} \quad (1)$$

$$\text{Adults aged 50–60 years}: \ pr(Fall) = \frac{1}{1 + e^{1.136+2.528(e)-1.666(b)}} \quad (2)$$

$$\text{Adults aged 60–70 years}: \ pr(Fall) = \frac{1}{1 + e^{0.173(a)+1.345(c)-0.215(f)}} \quad (3)$$

$$\text{Adults aged 70 years or older}: \ pr(Fall) = \frac{1}{1 + e^{1.093+0.056(a)-1.125(b)-0.797(d)}} \quad (4)$$

3.4. Logistic Regression Models Validation—ROC Curves

After defining the various models presented in Table 2, the area under the ROC curve (AUC) was used to assess their ability to accurately predict fall occurrences. Table 4 and Figure 1 show the results of the ROC analyses and ROC curves for all individuals aged at least 50 years and for the different age groups, comparing the results between the TUG and the Logistic Regression models. In combination with the TUG cut-off, HoF emerged as the strongest self-reported question for distinguishing between fallers and non-fallers among adults aged 50–60 years (AUC = 82.5%; $p < 0.001$). For community-dwelling adults aged 60–70 years, the combination of UpExt and the number of medications per day with TUG proved to be the strongest (AUC = 75.4%; $p < 0.001$). Among adults aged 70 years or older, the model combining TUG, HoF, and benzodiazepine use demonstrated significant discriminatory ability (AUC = 70.8%; $p < 0.001$). However, when considering the entire group of individuals aged 50 years or older, the model combining TUG with HoF, UpExt, and benzodiazepine use exhibited only a weak ability to differentiate between fallers and non-fallers (AUC = 67.1%, $p < 0.001$).

Table 4. Comparison of the ROC analyses for TUG and Logistic Regression models.

	Cut-Off Scores	**Sensitivity (%Fallers)**	**Specificity (%Non-Fallers)**	**AUC**	**95% CI**	***p***
TUG						
≥50 years	-	-	-	54.7	48.5–60.9	0.136
50–60 years	6.9	86.7	66.7	77.7	0.66–0.91	0.001
60–70 years	-	-	-	56.8	43.9–69.8	0.300
≥70 years	-	-	-	43.4	34.6–52.1	0.137
Models						
≥50 years	26.5	69.7	61.0	67.1	60.5–73.7	<0.001
50–60 years	18.1	86.7	65.7	82.5	69.3–95.7	<0.001
60–70 years	17.8	77.3	65.1	75.4	64.7–86.1	<0.001
≥70 years	24.8	71.2	61.5	70.8	62.8–78.8	<0.001

TUG—Timed Up and Go test; AUC—Area Under the Curve; 95% CI—95% Confidence interval.

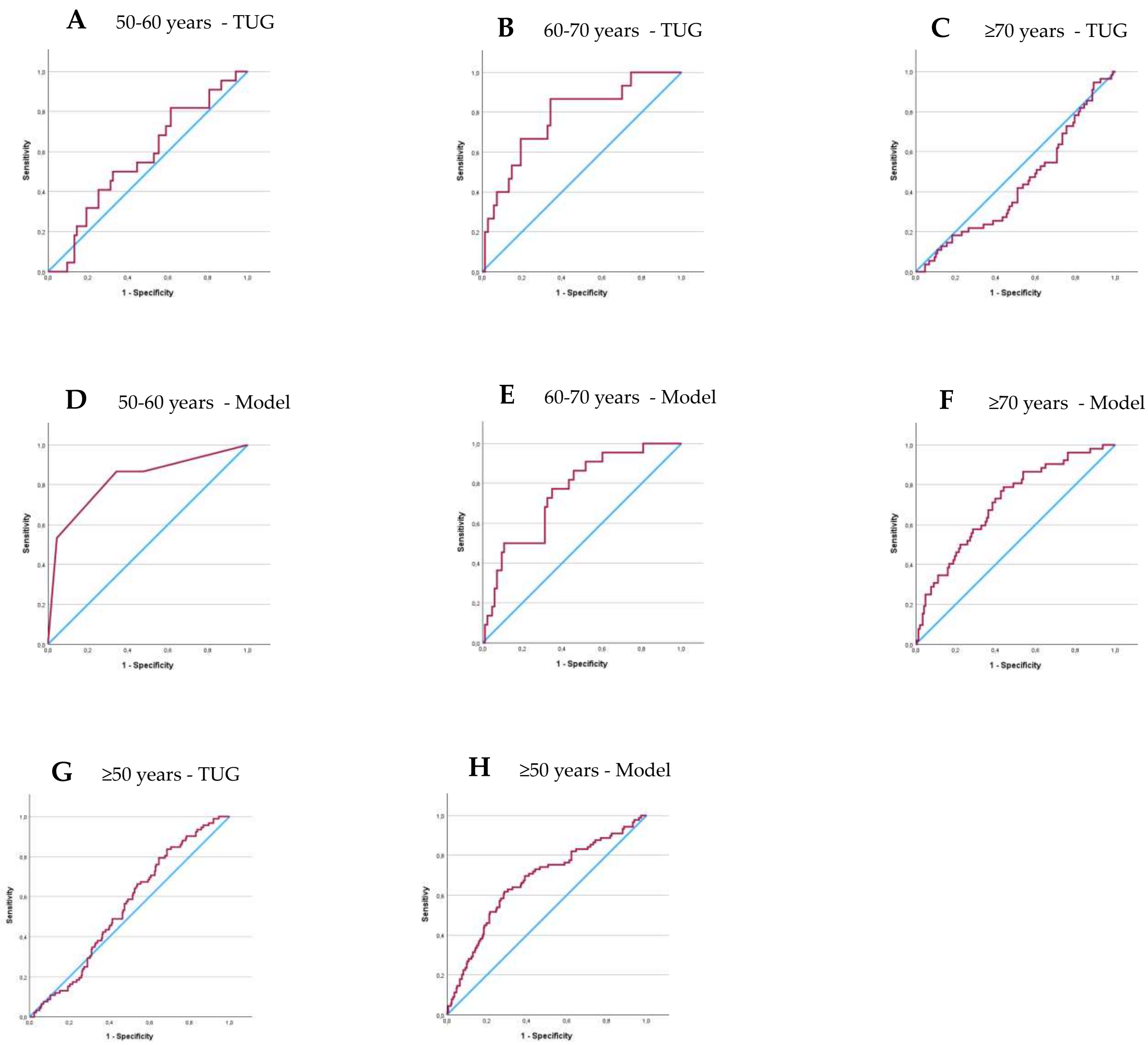

Figure 1. (**A**–**H**) Predictive Receiver Operating Characteristic (ROC) curves for Fall and Non-Fall subjects. (**A**–**C**) TUG duration for 50–60 years, 60–70 years, and 70 or older, respectively; (**D**–**F**) Logistic Regression models for 50–60 years, 60–70 years, and 70 or older, respectively; (**G**) TUG duration for 50 or older; (**H**) Regression models for 50 or older. TUG = Timed Up and Go test.

4. Discussion

The aim of this study was to develop a predictive model combining the TUG test with intrinsic and extrinsic fall risk factors to predict future falls among community-dwelling Portuguese adults aged 50 years and older. Given the need for fall risk screening tools to be brief, efficient, robust, and practical, this study also aimed to identify risk factors that can be easily self-reported during fall risk screenings carried out in public spaces.

The TUG test is strongly associated with measurements of dynamic balance, mobility, and lower extremity muscle strength [28], encompassing basic motor tasks essential for independent living, such as standing up from and sitting down on a chair, walking briskly, and changing direction while walking [4,29].

Our choice of the TUG test as a predictor of fall risk is related to the fact that this test is recommended by respected organizations, such as the Center for Disease Control and Prevention (CDC) [35], the American Geriatrics Society, and the British Geriatrics Society [7], as a routine screening tool to assess gait and balance in fall risk assessments.

This recommendation is based on the minimum testing requirements in terms of time, space, and material resources, as well as its ease of integration into regular clinical practice [3].

Although the TUG test is increasingly recognized as a significant predictor of falls [22,27], several studies emphasize that it should not be used as a standalone tool for identifying individuals at high risk of falling [30,31]. In fact, the ROC curve analysis showed that the TUG test did not present significant discriminatory capacity when analysing the general sample (AUC = 54.7%), improving this capacity when we combine the TUG with intrinsic and extrinsic risk factors (AUC = 67.1%). In our analysis, we reached the same conclusion when evaluating the ability of the TUG test to predict falls during the 12-month follow-up period. Similar results were obtained when we analysed the groups aged 60–70 years and 70 or more years, which improved the results from 56.8% to 75.4% and 43.4% to 70.8%, respectively. The group that had the best results was 50–60 years old but this group still managed to improve when combining the TUG test with risk factors, going from AUC = 77.7% to AUC = 82.5%.

The National Institute for Health and Care Excellence (NICE) [2], alongside recent literature [3,4], advocates for a multifactorial approach to fall risk assessment and prevention. This approach encompasses factors such as HoF, self-assessment of functional ability, FoF, medication usage, home hazards, and comprehensive evaluations of gait, balance, mobility, and muscle strength. Holistic strategies incorporating these elements enable more accurate and effective fall prevention and management in older adults [3,4,22].

In our study, we distinguished between falls with an intrinsic precipitating cause (gender, HoF, FoF, UpExt) and those triggered by an extrinsic circumstance (assisted mobility, presence of stairs at home, ingestion of benzodiazipines, antidepressants and antihypertensives, polypharmacy). Distinguishing between extrinsic and intrinsic factors can enhance our understanding of falls among community-dwelling individuals, enabling healthcare professionals to develop more targeted and effective prevention strategies, as demonstrated by Rubenstein et al. [10]. According to these authors, distinguishing those factors is relevant because institutionalized older adults tend to fall due to intrinsic precipitating factors, whereas community-dwelling older adults are more likely to fall due to extrinsic factors.

In line with those conclusions, our findings in adults aged 50 years and older living in the community reveal distinct patterns across age groups. Individuals aged 50–60 years exhibited both significant intrinsic and extrinsic fall risk factors. In contrast, those aged 60–70 years were primarily affected by extrinsic factors, including antidepressant use, polypharmacy, and UpExt. Meanwhile, individuals aged 70 years and older showed only significant intrinsic factors, specifically an HoF. The findings have significant practical implications, emphasizing the need for nuanced approaches to predict fall risk accurately across different age groups.

The multivariate analysis did not maintain all associations of fall risk factors when combined with the TUG test predictor. Therefore, we obtained more practical, efficient, and accessible predictive models, allowing us to implement preventive fall risk strategies in community environments. We also concluded when we applied logistic regression that the best predictive models are those adjusted to three specific age groups: 50–60 years, 60–70 years, and 70 years or more.

For adults aged 50–60 years, the combination of the TUG test with self-reported HoF demonstrated excellent predictive accuracy, reinforcing the importance of prioritizing fall histories in younger adults. This simple self-reported question significantly enhances the identification of individuals at risk, enabling timely preventative measures.

For adults aged 60–70 years, the inclusion of assistance need of upper extremities to stand up from a chair and the number of daily medications alongside the TUG test proved particularly effective. This finding highlights the interplay between functional ability and polypharmacy in fall risk, as stated in previous studies [36,37], indicating that clinicians should focus on medication reviews and functional assessments in this age group.

For adults aged 70 and older, HoF and benzodiazepine use were associated with fall risk. The incorporation of the benzodiazepine use in the model highlights the aggravated risk represented by sedative medications, as reported in other studies [15,19,21,22], and highlights the need for a multidisciplinary approach that encompasses medication management, history of falls, and interventions focused on mobility, adapted to the elderly.

When evaluating the entire population aged 50 years or older, the model's weaker discriminatory ability reinforces the importance of age-specific stratification for effective fall risk assessment. As noted in previous studies, a one-size-fits-all approach may dilute predictive accuracy [38,39]. It is therefore essential for healthcare providers to adopt tailored models that account for age-related differences in risk factors [40].

These findings offer a practical framework for stratifying fall risk and adapting interventions to the unique needs of different age groups. Furthermore, they highlight the importance of incorporating this knowledge into patient-focused materials, such as leaflets and brochures, as these are effective mediums [2] for raising self-awareness about modifiable risk factors that emerge throughout the lifespan, and they are relevant to providing guidance and to improving educational fall-prevention interventions in contexts such as primary health care or social health settings (day centers or others).

Based on the study's findings, the authors wish to highlight several practical implications: Primary healthcare providers and social health programs should regularly administer the TUG test, along with questionnaires assessing risk factors, to effectively identify older adults at increased risk of falling and facilitate timely, targeted interventions. Early identification of risk factors is crucial, as these risks differ across the life cycle and can change over time. Fall prevention efforts should address both intrinsic and extrinsic factors, incorporating physical activity (such as balance and strength training) and education. These programs should be customized according to individual fall risk assessments, such as those derived from the TUG test.

A limitation of this study is that it did not consider potential factors such as the insufficiency of postural subsystems, including the visual, vestibular, cerebellar, somatosensory and nigrostriatal systems, which are crucial for maintaining balance and preventing falls. These systems play a significant role in overall postural control and may contribute to the risk of falls [41], but they were not assessed in this study.

Other potential ideas for future research include investigating the long-term effectiveness of the predictive models in diverse populations with varying health conditions, socioeconomic backgrounds, or access to healthcare resources; exploring whether adding cognitive assessments to the predictive model improves fall prediction accuracy over time; and examining the potential of wearable devices or smartphone apps to continuously monitor and update fall risk assessments, enabling real-time interventions and personalized prevention strategies.

5. Conclusions

The TUG test alone is insufficient for individuals over 60 years old and especially for those over 70 years old. Only the combination of HoF and benzodiazepines leads to satisfactory performance.

Integrating the TUG test with a few self-reported questions offers a robust and feasible method for fall risk assessment. This approach not only facilitates risk identification but also provides an opportunity to educate adults aged 50 and older about their fall risk and the factors contributing to it across the lifespan. Consequently, the findings of this study can support the implementation of efficient, community-based fall prevention programs.

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