Falls in Portuguese older people: procedures and preliminary results of the study Biomechanics of Locomotion in the Elderly

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ABSTRACT

Aim: The aims of this study were to: (1) present preliminary results about the evaluation of the procedures (physical activity and functional fitness tests) followed in the baseline period of our research program, (2) present a preliminary characterization of Portuguese older people regarding sociodemographic, health, physical activity (PA) and functional fitness (FF) variables (3) identify, within those parameters, the ones which are determinant to predict falls in Portuguese older adults.
Material and Methods: 647 subjects aged over 65 years were randomly recruited in Lisbon and Tagus Valley area. Trained interviewers administered: (1) a standardized questionnaire that included sociodemographic, health and falls parameters; (2) YPAS questionnaire for PA and (3) six FF tests (30sec Chair-Stand and 8 foot Up&Go from SFT battery and items 4-7 from FAB Scale).

Reproducibility and convergent validity of the FF and PA tests were determined by ICC and Pearson correlations. Logistic regression analysis was used to model fall occurrence considering three different fall groups (non-fallers (NF – 0 falls), fallers (F – 1 fall) and recurrent fallers (RF - >1 fall).
Results: FF and PA tests showed to have a good convergent validity and reproducibility, giving us confidence about the results obtained.

Approximately 37% of the elderly tested fell during the previous year. From these, 41% were RF. Our results showed that age is not a risk factor for falling and that health and FF variables are the most determinant factors to assess fall risk.
Conclusion: According to the results, falls might not be an inevitable consequence of age, but instead, mainly associated with poor health and functionality. Moreover, PA seems to play a key role in this process, not only because a higher level of PA will lead to a better functionality, but also because PA was found to be a protective factor for both episodic and recurrent falls.

Keywords: Elderly; Falls; Functional Fitness; Physical Activity; Health.

INTRODUCTION

The increase of life expectancy in the industrialized countries has raised new public health issues derived from the increment of the number of years lived by the elderly. Thus, improving elderly functional status and minimizing their disability burden, became a primary concern[1,2]. Among other things, elderly quality of life depends on their ability to perform activities of daily living (ADLs). In this sense, it is important to determine the mechanisms that can improve functionality and, consequently, quality of life in the elderly[3].

Inactivity is one of the factors that can lead to the decline in physical and psychological functions, therefore affecting the ability of people to perform ADLs. This potential impairment is especially critical for older adults[4], whose activity levels are sometimes extremely low. Many older adults who have become increasingly sedentary may be performing ADLs at their maximum capacity being, therefore, at risk of losing independence, becoming disabled and also, at risk of falling[5,6].

Fall-related morbidity and mortality rates are referred to as one of the most common and serious problems faced by the elderly[7,8]. About 40% of the community-living population aged over 65 years will fall at least once each year, and about 1 in 40 of them will be hospitalized[9]. Nevertheless, the problem of falls in the elderly is clearly more complex than a high incidence

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issue. Young children and athletes have higher fall rates than older adults[10] but, as older people have higher incidence of chronic diseases (CD), like osteoporosis, reduced bone density and age-related physiological changes, the likelihood of an injury increases, making even a relatively mild fall particularly dangerous[9].

Although most falls do not cause serious injury, 5% of older people suffer major injuries such as fractures, head trauma and other musculoskeletal and soft tissue injuries[11]. Moreover, fall rates and their associated complications are reported to rise steadily with age, being about two times higher for persons aged over 75 years[9,11].

Thus, identifying old people who are at risk of falling seems to be a key step to establish interventions aiming at the prevention or the delay of physical frailty of that population.

Many studies have been done[9,12-17] to identify the risk factors for falling. Among others, the most referenced risk factors for falling are: age, gender, specific chronic diseases, impaired mobility, balance and gait, muscle weakness, sedentary behaviour, cognitive impairment, fear of falling, visual impairment, medication intake, health perception and history of falling.

Although there is a general agreement regarding what are the main risk factors for falling, the mentioned studies were done using different tools, procedures and variable definitions (e.g fall, level of physical activity or functional level definitions) that are not always well clarified, making therefore difficult the comparison between studies. Moreover, no study was done to verify these relations in Portuguese older adults.

Therefore, this paper aims to: (1) present preliminary results about the evaluation of the procedures (physical activity (PA) and functional fitness (FF) tests) followed during baseline period of the project Biomechanics of Locomotion in the Elderly: Determinants in Fracture Risk Reduction; (2) present a preliminary characterization of Portuguese older people regarding sociodemographic, health, PA and FF parameters and (3) identify, within the previous mentioned variables, the ones which are determinant to predict falls in Portuguese older adults.

POPULATION AND METHODS

SAMPLE RECRUITMENT

The first stage of this project has enrolled 647 from 870 subjects, aged 65 years or older, recruited in Lisbon and Tagus Valley area. The subjects were randomly selected from day care centres, senior schools, gyms and health promotion community events. To obtain a representative sample, a multistage stratified sampling design was used.

The institutions were selected within a 50km distance from Faculty of Human Kinetics, Technical University of Lisbon. The choice of this area for sample recruitment was done, not only due to geographic proximity, but also because the selected area allowed us to establish a cohort of representative elderly subjects from Lisbon region by encompassing people from both urban and country sides.

The mentioned institutions were selected randomly from a list available on the website of the General Directorate of Health (Ministry of Health).

The general inclusion criteria were: to have 65 or more years, to correctly understand the Portuguese language, to be autonomous, not have dementia, cognitive and cerebrovascular impairments and not be recovering from an acute illness. For Functional Fitness (FF) tests, the following inclusion criteria were added: to be able to walk independently and/or without assistance of a walking aid and not to have a hip or knee prosthesis.

Immediately prior to data collection, all participants were informed about the study, accepted to participate and signed the informed consent. The Ethics Committee of Faculty of Human Kinetics, Technical University of Lisbon, approved all the study protocols.

HEALTH AND FALLS INTERVIEW

Trained examiners administered a structured and standardized questionnaire, by interview, that included sociodemographic characteristics, health, vision and hearing perception status, medical history (medical visits, hospitalizations, surgeries), medication intake (total and number for each disease, with specification of the drug name) fear of falling (FOF), falls self-efficacy, fall prevalence (in the previous year) and falls characteristics (location, circumstances and consequences of, at most, 3 of the reported falls). A fall was defined as "an unexpected event in which the participant comes to rest on the ground, floor or lower level"[18]. The mean duration of the interview was 12 minutes.

PHYSICAL ACTIVITY INTERVIEW

PA was assessed by interview, following the health questionnaire, with Yale Physical Activity Questionnaire – YPAS[19]. This tool reports to a typical week during the month prior to evaluation and is divided in two parts:

1. *YPAS activity checklist* allows to obtain detailed information about the type, duration (Hrs/week) and intensity (Kcal/min[2]) of the typical activities carried out by the elderly (housework, exercise, caretaking, yard work and recreational activities).
2. *YPAS activity scores* allow to assess an index of intensity of five distinct PA dimensions: (a) the *vigorous index* (VI) combines the frequency and the duration engaged in activities that cause large increases in breathing rate and heart rate, sweating or leg fatigue; (b) the *walking index* (WI) reports the frequency and the duration of walking activities that last at least 10 minutes without stopping or making a vigorous effort; (c) the *moving index* (MI) comprehends the time spent daily in activities with movement while standing, including walking, (d) the *standing index* (SI) evaluates the daily time spent in activities while standing but without movement; and, (e) the *sitting index* (STI) assesses daily time spent in the seated position. Partial scores are multiplied by the specific weighting factor to calculate the individual indexes and then summed to determine the summary index of activity (SumI).

The mean duration of interview was 13 minutes.

The subjects who answered the interview and fulfilled the inclusion criteria were then invited to participate in the FF assessment.

FUNCTIONAL FITNESS ASSESSMENT

Several FF tests for older adults have been developed and reported[20-24]. Among these, we selected 6 for this study (30sec Chair-Stand (CS) and 8 foot Up and Go (UG) from Senior Fitness test[22] and items 4 to 7 from Fullerton Advance Balance Scale[23]), based on their reported ability to discriminate fallers and detect age functional decline in community-dwelling older adults[22-23,25], as well as their feasibility in clinical and exercise field. The first two tests (CS and UG) assess lower limb strength, power and mobility, while the last four measure static (FAB6 – stand on one leg – and FAB7 – stand on a foam with eyes closed) and dynamic (FAB4 – step up and over a bench – and FAB5 – tandem walk along a line) balance.

Besides the referred tests, during FF assessment, height and weight were also measured for Body Mass Index (BMI) calculation.

Before testing, a demonstration was performed by the examiner and the subjects completed one or two practice trials.

At the end of the each session, participants received feedback, through a written report, concerning their test results.

The duration of FF assessment was on average approximately 12 minutes.

EXAMINERS TRAINING

For all the tests, forty examiners were trained by the research team over a total period of 51 hours (33 hours of theoretical and practical training and 18 hours of field assessments).

The examiners received an instruction manual for field data collection containing: (1) a script with the questions included in both questionnaires and the most common difficulties of the subject when responding to the questionnaires; (2) basic instructions on conducting the interview; (3) basic FF test instructions, according to the respective author's method[22,23].

All examiners were supervised while interviewing and applying FF test to older subjects, who kindly offered to be tested, by at least two members of the research team. At the end of the work sessions, a verbal feedback was given to each examiner.

Examiners were also asked to classify the performance of the same older subject in all FF tests, presented through video recording during one of the classes. These results were compared between examiners, in order to perform an inter-observer analysis, and with the assessment made by two research team members, experts in Health & Exercise, to assess the convergent validity of these tests. For the UG and the CS tests the convergent validity was also assessed by comparing examiners assessment with accelerometer data (xyzPlux triaxial accelerometer sensor, with a dynamic range of ±3g) that was collected from 33 elderly subjects during the field assessments.

Besides answering the PA questionnaire, 98 of the subjects worn uniaxial accelerometers (Actigraph Model 7194) and the results were compared to assess the convergent validity of the questionnaire. Furthermore, the reproducibility of this test was assessed using the test-retest results of 31 subjects.

STATISTICAL ANALYSIS

Reproducibility and convergent validity for PA and FF field tests were determined respectively by Intra-class correlation (ICC-parallel; one-way random effect model; 95%CI) and Pearson's correlation coefficient.

A cross-sectional study was designed and the subjects were divided in three different groups according to fall prevalence: non-fallers (NF), subjects who did

not report any falls during the previous year; fallers (F), those who reported to have fallen only once during the previous year; and recurrent fallers (RF), the ones that fell twice or more times during the previous year. Statistical analysis was done according to these groups.

The characterization of Portuguese older adults in matters of sociodemographic, health, PA and FF variables was performed through basic descriptive statistics.

The identification of main factors for falling in Portuguese older adults was evaluated via Mantel–Haenszel chi-square, t-Student or Mann-Whitney tests, with the significance of the results set at $p \leq 0.05$. The Spearman correlation coefficient was also used to investigate associations among quantitative independent variables. Finally, binary logistic regression analysis was used to model fall occurrence (NFvsF, FvsRF and FvsRF). Because, in clinical/exercise settings, risk factors must be easily and quicly measured, independent variables were dichotomized throughout their median value, as normality could not be assumed by Kolmogorov--Smirnov test for continuous variables. BMI was the only exception, being classified as good between 22.0 and 26.9Kg/m^2 and poor for results ≥27,00 Kg/m^2[22,27]. Values below its median were classified as "poor level", and values equal or greater than the median were classified as "good level", with the exceptions of the number of medications and the sitting index.

All the analyses were performed using PASW 18.0.

RESULTS

REPRODUCIBILITY AND CONVERGENT VALIDITY OF FUNCTIONAL FITNESS AND PHYSICAL ACTIVITY TESTS

The reproducibility results indicate significantly high inter-examiners correlations for all FF tests. The inter-observer ICC for each item ranged from 0.588 to 0.965 while the ICC for average measures ranged from 0.938 to 0.998. According to the literature[27,28], our results show a very good reproducibility for most of FF testes. The exceptions were observed for CS and FAB5 tests, which had a satisfactory level of reproducibility.

The Pearson correlation coefficients associating both CS and U&G tests and accelerometry were strong and highly significant (CS: 0.83, U&G: 0.92, $p < 0.00$), confirming the good results for convergent validity of these tests.

The test-retest results for YPAS questionnaire were very good for SI (ICC=0.76) and MI (ICC=0.79). For other indexes the results were satisfactory with ICC ranging from 0.620 to 0.73[27,28]. The results of the validation criteria by accelerometry[29] showed a positive correlation among active indexes ($0.307 < rho < 0.373$; $0.004 < p < 0.000$) and a negative correlation with the SIT (rho=-0.469; $p < 0.000$).

SOCIODEMOGRAPHIC PARAMETERS

Eight hundred and seventy older subjects over 65 years accepted to participate in the field assessments over one year testing period. From those, 647 subjects met all the inclusion criteria, being therefore included in the study analysis. The recruitment results were very satisfactory; the sample represents 0.05% of the elderly population in Portugal and ~7.1% of the elderly living in Lisbon and Tagus Valley region. Besides, the sample size highly exceeds the minimum number needed (379 elderly, for EES=0.5, power=80%, =0.05 and considering a annual prevalence of falls of about 40% in national population[30]) to ensure a representative sample of Lisbon population.

As only a few determinant factors were found to distinguish fallers from recurrent fallers, the respective results are not presented in the tables. However, when these differences were found, a reference is done in the text.

Participants' sociodemographic characteristics are summarized on Table I.

From the total sample, 405(63.1%) of subjects didn't' fall during the previous year, 140(21.8%) reported one fall and 97(15.1%) reported to have fallen twice or more throughout the same period. Five participants did not report their fall status.

Their mean age was 74.48±6.41 years and about 10% were older than 85 years. No differences were found for age between fall groups.

The majority of the participants were female (69.9%). Near half of the sample was married (58%) and about 84.3% lived in their own home. More than 60% of participants had only the basic education level and the mean age for retirement was approximately 60 years. The results also showed that women, when compared to men, presented a risk of falling about 40% higher and that to be married is a protective condition for falling. Moreover, subjects who had only the basic education level had also a higher probability to be recurrent fallers.

FALLS AND HEALTH PARAMETERS

Falls occurred mainly in outdoor settings for both F (59.8%) and RF (59.3%). Most of the falls occurred

TABLE I. SAMPLE CHARACTERIZATION: MAIN DEMOGRAPHIC PARAMETERS AND THEIR ASSOCIATIONS AMONG GROUPS NON-FALLERS (NF), FALLERS (F) AND RECURRENT FALLERS (RF)

	NF n=405	F n=140	RF n=97	NF *vs* F	NF *vs* RF
	n (%)	n (%)	n (%)	OR (95%CI)	OR (95%CI)
Female	268 (66.2)	107 (76.4)	73 (75.3)	1.47 (1.04-2.08)§	1.44 (0.85-1.00)
Marital status (married)	221 (55.1)	55 (23.6)	44 (46.8)	0.63 (0.47-0.85)§	0.74 (0.52-1.06)
Living alone	104 (26.0)	46 (33.6	38 (40.5)	1.30 (0.97-1.76)	1.63 (1.13-2.34)§
Living in own home	331 (81.7)	119 (87.5)	80 (85.1)	0.80 (0.47-1.36)	0.97 (0.54-1.73)
Basic education level	247 (65.5)	80 (63.0)	59 (60.8)	1.48 (0.88-2.47)	1.93 (1.04-3.72)¥
	X±sd (Me)	X±sd (Me)	X±sd (Me)	OR (95%CI)	OR (95%CI)
Age	74.25±6.45 (73.00)	74.99±6.27 (74.00)	74.78±6.58 (73.00)	1.35 (0.92-1.99)	1.05 (0.73-1.50)
Retirement age	60.53±6.88 (62.00)	59.36±7.83 (61.00)	59.04±7.41 (60.50)	1.26 (0.83-1.90)	1.36 (0.84-2.19)

§ p<0.05; ¥ p<0.001
*Reference category "good level", defined by value higher than median parameter; OR (95%CI) - Odds Ratio (95% Confidence Intervals)

while walking (F = 50%, RF = 60.8%) and climbing stairs (F = 13.6%, RF = 21.6%) and the more prevalent perceived causes were to stumble (F = 28%, RF = 25%) and to slip (F = 23.6%, RF = 42.3%). Among fallers, 57% had an injury as a result of the fall, and 14.4% resulted in fractures. The percentage of injuries as a result of falls was higher among RF (F=57.3%; RF=68.6%), although the frequency of fractures was slightly higher in the F group (F=17.4%; RF=13.7%). Logistic regression analysis showed no statistically significant associations between fall prevalence and the circumstances and consequences of the falls.

Health parameters results are presented on Table II. The most determinant risk factors for falling were health perception (HP), visual HP and Fear-of-falling (FOF).

Non-fallers (NF) have better health perception (HP) and visual HP than F and RF, and both of the factors increase the risk of falling by approximately 50% and the risk of recurrent falling by ~140%. FOF showed be determinant only for F, when compared with NF. However it is interesting to note that the falls self-efficacy manifest only as determinant for RF, when compared with fallers.

Regarding the prevalence of chronic diseases (CD), more than 60% of the subjects had cardiovascular disease (64.5%), followed by psychiatric disorders (28.4%) and high cholesterol (21.4%). However, no statistical differences were found between fall groups. The same was observed for the number of medical visits during the previous month.

For Medication intake, differences were found between F and RF, with the RF having about 80% more risk of falling than F (OR=1.80; 95%CI 1.02-3.15).

PHYSICAL ACTIVITY PARAMETERS

Table III shows the main results obtained for PA variables.

In general, NF presented higher partial activity scores than F and RF and the differences between groups were statistically significant. Moreover, all poor activity scores were correlated and risk factors for falling and/or recurrent falling. Specifically, having a poor VI (i.e. 0 min) showed to be a determinant factor for falling, while having a poor WI (walking less than 30 min per day), MI (moving less than 3-5 hr/day) and/or SI (standing less than 3-5 hr/day) is a risk factor for both F and RF.

On the other hand, it is also important to highlight that RF had the highest inactivity score (SIT index) and that these differences were significant when compared to NF, showing that with the increase of the number of hours of inactivity (>6 hours/day), the risk of falling recurrently doubles.

FUNCTIONAL FITNESS PARAMETERS

The results of FF tests are presented on Table IV.

The risk of falling recurrently, when compared to not falling, doubles for subjects who have a poor FF level, independently of the test chosen. And, for some of the

TABLE II. HEALTH PARAMETERS AND ITS ASSOCIATION AMONG GROUPS OF NON-FALLERS(NF), FALLERS (F) AND RECURRENT FALLERS (RF)

	NF n=405	F n=140	RF n=97	NF *vs* F	NF *vs* RF
	n (%)	n (%)	n (%)	OR (95%CI)	OR (95%CI)
Health Perception Status (HPS)	172 (43.7)	42 (30.4)	20 (20.6)	1.54 (1.12-2.12)§	2.47 (1.57-3.91)¥
Visual Health Perception (VHP)	255 (65.4)	70 (51.9)	38 (39.2)	1.51 (1.31-2.01)§	2.35 (1.63-3.38)¥
Hearing Health Perception (HHP)	64 (48.0)	17 (44.7)	14 (60.7)	1.15 (0.55-2.36)	1.56 (0.716-3.38)
Chronic diseases					
Psychiatric	98 (25.7)	41 (32.3)	30 (65.9)	1.38 (0.90-2.13)	1.49 (0.91-2.46)
Cardiovascular	242 (63.5)	86 (67.7)	57 (64.8)	1.09 (0.61-1.93)	1.21 (0.79-1.85)
Allergies	7 (1.8)	4 (3.1)	3 (3.4)	1.74 (0.50-6.04)	1.89 (0.49-7.44)
Musculoskeletal	47 (12.3)	16 (12.6)	17 (19.3)	1.02 (0.56-1.88)	1.70 (0.92-3.74)
Diabetes	42 (11.0)	22 (17.3)	10 (11.4)	1.69 (0.97-2.96)	1.035 (0.50-2.15)
Colesterol	78 (19.3)	29 (22.8)	21 (21.6)	1.15 (0.71-1.87)	1.22 (0.71-2.11)
FOF	62 (44.3)	27 (69.2)	13 (56.5)	2.83 (1.33-6.04)§	1.64 (0.67-3.98)
Impairment to daily activities	21 (17.1)	11 (30.6)	8 (42.1)	2.14 (0.91-5.00)	3.53 (1.29-9.84)§
	X±sd (Me)	X±sd (Me)	X±sd (Me)	OR (95%CI)	OR (95%CI)
Medical consultation (previous months)	0.71±0.90 (1.00)	0.67±0.80 (1.00)	0.77±0.99 (1.00)	1.17 (0.76-1.86)	1.28 (0.76-2.18)
Medication (more than 6 months)	3.10±2.41 (3.00)	3.32±2.40 (3.00)	3.54±1.92 (3.00)	1.25 (0.84-1.85)	2.24 (1.37-3.67)

§ p<0.05; ¥ p<0.001
*Reference category "good level", defined by value higher than median parameter; OR (95%CI)- Odds Ratio (95% Confidence Intervals)

tests (CS, FAB4 and FAB7), this risk is even higher.

The risk of falling, when compared to non-falling, also increases, although with less extent, for those who have poor results in almost all of the FF tests, with the exception of FAB7 and BMI tests.

DISCUSSION

As far as we know, this is the first population-based study that has characterized a cohort of Portuguese older subjects and identified fall risk factors in this population using in situ methods that were not exclusively questionnaires.

The identification of the referred variables requires validated instruments for the elderly population, as those that were used in this study, without implying a burden to the examiners. The low burden was expressed by the mean time of 35min for the application of the 3 batteries per subject.

The assessment of a sample with this dimension is only possible with a large team available on the field. As so, we trained 40 examiners and the results obtained for the validation process were rated as very good for most of the FF and PA parameters. The reproducibility of these tools showed also good results for field application. These results give us high confidence in the collected data that is discussed on the following paragraphs.

Our results showed that approximately 37% of the elderly tested fell during the previous year. From these, 41% were RF. These results were similar to the ones reported in the literature[31].

On the contrary of what has been reported[16], in our study, age was not a risk factor for falling or recurrent falling. Interestingly, the same result was obtained using a different cut off value (≥80 years old), instead of the median, to dichotomize this variable (OR F=1.05; 95% CI 0.661-1.657; OR RF=1.041 (0.612--1.769). Thus, falling seems not to be an inevitable

TABLE III. PHYSICAL ACTIVITY PARAMETERS AND THEIR ASSOCIATION AMONG BETWEEN GROUPS NON-FALLERS (NF), FALLERS (F) AND RECURRENT FALLERS (RF)

	NF n=405	F n=140	RF n=97	NF *vs* F	NF *vs* RF
Index	**X±sd (Me)**	**X±sd (Me)**	**X±sd (Me)**	**OR (95%CI)***	**OR (95%CI)***
Vigorous	13.13±16.93 (0.00)	9.31±13.67 (0.00)	9.79±14.40 (0.00)	1.51 (1.02-2.25)§	1.45 (0.94-2.31)
Walking	19.63±14.99 (16.00)	16.09±15.32 (16.00)	13.02±15.36 (8.00)	1.59 (1.07-2.36)§	2.59 (1.64-4.11)¥
Moving	9.15±3.42 (9.00)	8.15±3.66 (9.00)	8.03±4.06 (6.00)	1.45 (0.97-2.16)§	2.17 (1.37-3.43)¥
Standing	6.42±2.28 (6.00)	5.66±2.53 (6.00)	5.72±2.81 (6.00)	1.83 (1.21-2.76)§	2.37 (1.49-3.78)¥
Sitting	2.31±0.93 (2.00)	2.55±1.01 (2.00)	2.69±0.95 (3.00)	1.21 (0.80-1.83)	2.07 (1.05-4.10)§
Total	50.77±27.54 (46.00)	42.19±25.84 (36.50)	39.29±26.63 (34.00)	1.33 (0.90-1.96)	1.56 (0.96-2.43)

§ p<0.05; ¥ p<0.001
*Reference category "good level", defined by value higher than median parameter; OR (95%CI)- Odds Ratio (95% Confidence Intervals)

TABLE IV. FUNCTIONAL FITNESS PARAMETERS AND THEIR ASSOCIATION AMONG GROUPS NON-FALLERS (NF), FALLERS (F) AND RECURRENT FALLERS (RF)

	NF n=405	F n=140	RF n=97	NF *vs* F	NF *vs* RF
	X±sd(Me)	**X±sd(Me)**	**X±sd(Me)**	**OR (95%CI)**	**OR (95%CI)**
CS (x/30s)	15.55±5.35 (16.00)	13.69±5.67 (14.00)	12.57±6.01 (13.00)	1.67 (1.14-2.51)§	2.51 (1.57-4.00)¥
U&G (sec)	6.22±3.06 (5.39)	6.97±3.73 (6.14)	7.56±4.59 (6.00)	2.23 (1.48-3.36)¥	1.85 (1.16-2.95)§
FAB4	3.58±1.37 (4.00)	3.21±1.36 (4.00)	2.97±1.48 (4.00)	2.34 (1.38-3.97)§	3.10 (1.76-5.46)¥
FAB5	2.73±1.33 (3.00)	2.15±1.45 (2.00)	2.03±1.58 (2.00)	1.87 (1.26-2.77)§	1.84 (1.17-2.90)§
FAB6	2.59±1.35 (3.00)	1.96±1.40 (2.00)	1.80±1.39 (2.00)	2.29 (1.52-3.43)¥	2.28 (1.39-3.57)¥
FAB7	3.06±1.23 (4.00)	2.77±1.39 (3.00)	2.49±1.61 (3.00)	1.39 (0.91-2.11)	1.96 (1.23-3.13)§
BMI (kg/m^2)	27.67±4.35 (27.33)	28.80±5.33 (28.05)	29.52±5.15 (28.90)	1.15 (0.78-1.70)	2.01 (1.25-3.23)§

§ p<0.05; ¥ p<0.001; *Reference category "good level", defined by value higher than median parameter
OR (95%CI) – Odds Ratio (95% Confidence Intervals); CS – Chair-stand test; U&G- 8 foot Up and Go; FAB4 – step up and over a bench; FAB5 – tandem walk along a line; FAB6 – stand on one leg; FAB7 – stand on a foam with eyes closed; BMI- Body mass index.

consequence of ageing.

Old age is sometimes called a women's problem, based on the increasing ratio of women to men on old age groups and on their greater vulnerability for disability[16,32]. This fact was verified in our results, in which the percentage of women is ~70% and women have 40% more probability to suffer an episodic fall than men.

Being married was identified as protective factor for episodic falls, while living alone as a risk factor for recurrent falling, which also has been reported in the literature[35]. Furthermore, being married remains a protective factor for falling even when comparing NF with those who have fallen one or more times during the previous year (OR 0.597, 95% CI 0.432-0.826).

Poor educational level was identified as a risk factor for recurrent falls. These results can be supported by the growing evidence that persons with lower levels of education (as indicator for socioeconomic status) are much more likely to have lower levels of functionality, increased number of CD, and decreased health related quality of life, tendency for isolation and weak self-esteem[4,34].

Although relations were found between the sociodemographic parameters mentioned above and fall risk, the parameters that were more strongly correlated with falls were health and FF.

The health impairments that occur during the aging process are often related to poor HP status[35]. In our study, HP showed a significant association with fall risk, being consistently higher for RF. Other interesting result was the association between VHP and fall groups, showing the same relation with fall risk that was obtained for HP (ORF= 1,51; ORRF= 2,35). Visual

age–related decline is a normal process in older people that is expressed by the decreasing of visual acuity, glare sensibility, dark adaptation, accommodation and depth perception. All these factors are reported to be associated with visual health and risk factors for falling[36,37]. While visual health limitations may be more directly associated by the elderly to difficulties in performing daily tasks, particularly the ones involving locomotion, the same might not be true for hearing health limitations, if they are not related to inner ear pathologies. This could be a possible explanation for the fact that no association was found between perceived hearing health status and falls in this study.

Other factor found to be determinant for falling was FOF, increasing the risk of falling episodically by~180%. Previous studies[38,39] have also reported this fact. Furthermore ~70% of the subjects who have reported FOF, had higher probability to avoid certain ADLs and a 3.5 times higher risk of falling recurrently.

Finally, the number of medications, independently of the chronic condition, showed a positive association with RF, having those who took more than 3 drugs per day, a two times higher risk for falling recurrently, when compared with NF. Effectively, advanced age can be associated with an increase in the number of diseases, which implies the increase of medication intake and a higher diversity of the prescribed drugs, factors that have been both reported as risk factors for falling, although with a different cut-off value for number of medications (> 4 drugs per day)[40,41]. Chronic diseases, namely musculoskeletal diseases, have not been identified as determinant for either episodic or recurrent falls. The fact that all the tested elderly were autonomous may explain this result, since the identified chronic diseases might not necessarily represent a limitation in daily tasks performance.

As mentioned, FF variables, together with the health variables, were highly correlated to fall risk. A bad performance, on any of the applied tests, highly increases recurrent falling risk. The same is verified for the risk of falling episodically, with the exception of FAB7 and BMI scores. These results are extremely relevant because they reinforce that falls may not be an inevitable consequence of ageing and that by improving functionality, we probably can prevent falls in older adults.

PA plays a key role on the improvement of functionality[10,37]. Nevertheless, the relation between PA and fall risk is not yet well clarified. Some studies state that the increase of PA levels decreases fall risk[10,37], while other studies showed that higher PA rates[12] and, specially, higher vigorous PA rates increase fall risk[42]. Our results showed that the increase of PA levels, independent of the intensity, decreases the risk of falling both episodically and recurrently. The only exception was VI, that was only a protective factor for falling. However, as the majority of our subjects (~70%) did not practise vigorous PA, more studies should be done to clarify this relation. Furthermore, being sedentary (number of hours seated/day) showed to highly increase the risk of falling recurrently (~110%), fact that reinforces the importance of PA for fall prevention.

CONCLUSION

To the extent of our knowledge, this is the first population-based study that has characterized a cohort of Portuguese older subjects and identified, within a wide variety of factors, the ones that can increase fall risk in this population.

Our results showed that age is not a risk factor for falling and that health and FF variables are the most determinant factors to assess fall risk in Portuguese older adults. This means that falls might not be an inevitable consequence of age and therefore, by improving functionality and health it is probably possible to prevent falls in older adults. PA seems to play a key role in this process, not only because a higher level of PA will lead to a better functionality, but also because PA, of light to moderate intensity, was found to be a protective factor for both episodic and recurrent falls. Moreover, sedentary behaviour was found to be a strong risk factor for falling recurrently, reinforcing PA role in fall prevention.

Considering these results, in the future it would be important to validate a tool for Portuguese older adults, based on the found risk factors for falling, that would be (1) feasible to apply in a clinical/exercise setting and (2) able to establish a link between the intervention process and the assessment.

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