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Judgment Capacity, Fear of Falling and the Risk of Falls in Community-Dwelling Older Adults: The Pro.V.A. Longitudinal Study

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ABSTRACT

Background. Little is known of the factors that transform fear of falling (FOF) from a normal adaptive to a maladaptive response that could alter its impact on fall risk. Focusing on judgment capacity, we investigated whether it is associated with FOF and FOF-related activity restriction (AR), and whether it modifies the influence of FOF on fall risk.

Methods. Data came from 2625 community-dwelling older adults enrolled in the Progetto Veneto Anziani. Baseline FOF and AR were assessed through personal interviews, and judgment capacity − high, moderate or poor − through situational tests. At follow-up after 4.4 years, self-reported falls during the previous year prior were recorded. The associations between judgment and FOF/AR, and between FOF and the risk of at least one fall or recurrent falls (≥2 falls), stratified by judgment capacity, were evaluated using multinomial logistic regressions.

Results. Compared with high-judgment participants, lower judgment participants were 20% more likely to report FOF; moderate judgment participants were 55% more likely and poor judgment participants twice as likely to report AR. After adjusting for potential confounders, including physical activity and physical performance, FOF increased the reporting of at least one fall only in the poor judgment group. The association between FOF and recurrent falls was stronger in individuals with poor (OR=3.33, 95% CI:1.95-5.68) than with moderate (OR=2.71, 95% CI:2.14-3.42) or high (OR=1.64, 95% CI:1.48-1.83) judgment.

Conclusions. Poor judgment capacity increases the probability of FOF and AR in older adults, and may exacerbate the effect of FOF in increasing fall risk.

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INTRODUCTION

Fear of falling (FOF) is reported among older adults with a prevalence ranging from 21% to 85%[1], whether or not they have a history of previous falls[2]. FOF may be a normal adaptive, i.e. protective, response when it arises from a realistic awareness of an increased fall risk, preventing exposure to dangerous situations and lowering the probability of experiencing falls. However, FOF can also be maladaptive when it is excessive or incommensurate with the actual individual fall risk[3]. In this case it may impair balance and gait[4], and these effects could be explained partly by FOF-related activity restriction[5,6], and partly by psychological distress[7–9], which paradoxically increase the risk of new falls[10,11]. Various authors have identified the factors associated with FOF, such as older age, female gender, anxiety, depression and cognitive disorders[1]. FOF has also been associated with an increased risk of new falls, although reports are inconsistent[1,12]. However, little attention has been focused on the factors influencing FOF that may turn a protective response into a maladaptive response. Judgment, which is "the capacity to make decisions after careful consideration of the available information, contextual factors, possible solutions and probable outcomes", may play a role here[13]. Judgment is closely linked to executive functions, which can often be impaired in people with dementia, but also in people free from dementia[14]. Moreover, irrespective of cognitive performance, judgment can be strongly influenced by other factors, such as educational level, and emotional and social drivers[15,16]. As a fundamental factor in the decision-making process, judgment may play an important role in FOF and falls' occurrence. Firstly, it may influence the individual's perception of fall risk, and therefore, as suggested by studies on the judgment of reach, also the presence of FOF[17] and subsequent activity restriction. Secondly, judgment is involved in appraising potentially hazardous situations[18], and could therefore positively influence FOF, which could lead to the avoidance of falls[17], especially recurrent falls. In light of these considerations and because no overall measure of judgment has been established with regard to falls, the aim of this study was to investigate whether the capacity for judgment is associated with FOF and related activity restriction, and whether it could modify the influence of FOF on the risk of falls in older adults. Our hypothesis is that individuals with poor judgment capacity are more likely to exhibit FOF as a maladaptive response, which

will in turn be more likely associated with activity restriction and an increased risk of falls and recurrent falls.

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METHODS

Study population

The data for this study came from the Progetto Veneto Anziani (Pro.V.A.), an observational study of a cohort of Italian individuals aged 65 years or older, randomly selected using a multi-stage stratified sampling method[19]. Trained nurses and physicians assessed the study participants at baseline (between 1995 and 1997), and made follow-up assessments after about 4 years (mean follow-up period 4.4 years). Overall response rate to the baseline assessment was 77% for men and 64% for women, giving a sample of 3099 participants[19]. For the purpose of this study, we excluded 211 individuals from this sample due to incomplete judgment capacity test results, 118 due to missing data on the presence of FOF, 7 due to no information on the occurrence of falls at the second assessment, and 138 who did not attend the follow-up. Compared with the 2625 participants in the final sample, those who were excluded (n=474) were more likely to be older (81.6±8.3 *vs* 75.4±7.3 years, p<0.001), to be women (65.0% *vs* 58.9%, p=0.01), to have a lower level of education (39.9% *vs* 53.3% attended ≥5 years of schooling, p<0.001), to have a higher prevalence of cognitive impairment (78.5% *vs* 37.0% scored <24 in the Mini-Mental State Examination [MMSE], p<0.001), but to have a lower frequency of depressive symptoms (13.5% *vs* 39.5% scored >10 on the Geriatric Depression Scale [GDS], p<0.001).

The ethics committees of the University of Padova and Local Health Units (USSL) nos.15 and 18 of the Veneto Region approved the study protocol, and all participants gave written informed consent.

General data on participants

Participants were assessed by trained physicians and nurses at clinics or, where they were unable to attend a clinic, at home. Data were collected from face-to-face interviews, standardized questionnaires, medical records and physical examinations. The participants' vital status was obtained from regional official registers over the study period.

Baseline characteristics. Data were collected on each participants' *sociodemographic characteristics* (age, sex, level of education, monthly income, and cohabitation status), *risk*

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behaviors (smoking habits, alcohol consumption, and level of physical activity), *body mass index*, *clinical status* (presence of diabetes mellitus, cardiovascular diseases, chronic obstructive pulmonary disease [COPD], cancer, lower limb osteoarthritis, and vision impairment), *physical performance* (assessed by the Short Physical Performance Battery (SPPB), a validated test covering gait speed, static balance and chair stand[20]), *previous falls* (the reporting of at least one fall in the year preceding the baseline evaluation), and whether they exhibited *cognitive impairment* (a score of <24 on the 30-item MMSE[21]) or *depressive symptoms* (a score >10 on the 30-item GDS[22]). For further details on data collection see **Supplementary Material, Appendix 1**.

Fear of falling and related activity restriction. FOF was evaluated in face-to-face interviews by trained nurses who asked participants whether they were afraid of falling (yes *vs* no)[8,11]. Participants who reported being afraid of falling were asked whether their fear had led them to reduce their activities (yes *vs* no).

Judgment capacity. Skilled neuropsychologists (blind to the participants' fall history) administered three situational tests to candidates to evaluate their judgment capacities[23]. Candidates were asked how they would respond in three problematic situations (seeing a neighbor's house on fire; finding a stamped and addressed letter on the ground; losing an umbrella they had borrowed) by choosing from a short list of possible actions. In each situation, the investigator recorded whether the participant answered appropriately or inappropriately. For the purposes of our study and in light of the distribution of the test results, judgment capacity was classified as high (no inappropriate answers), moderate (one inappropriate answer) or poor (more than one inappropriate answer). When, in a sensitivity analysis, the sample was stratified by the reporting of previous falls and the presence of cognitive impairment, the small number of individuals in each category required that we use instead two classes of judgment capacity, high (no inappropriate answers) and low (at least one inappropriate answer).

Incident falls. At the follow-up assessments, trained nurses recorded the number of accidental falls in the previous year in face-to-face interviews with participants or with their caregivers. In line with international guidelines, we defined a fall as "an unexpected event where a person falls to the ground from an upper level or the same level"[24]. The

reporting of *at least one fall* or at least two falls (*recurrent falls*) in the year prior to the follow-up assessment were considered separate study outcomes.

Statistical analysis

The Pro.V.A. sample was generalized to the population living in two geographical areas using a set of weights based on the gender and age distribution of the reference population (Italy, Census 1991) and on the sample fraction. We compared participants' baseline characteristics by reported fear of falling or by judgment using the Student t-test or an ANOVA for the normally distributed continuous variables, and the Chi-squared test for the categorical variables. The associations between the baseline judgment capacity and fear of falling on the one hand and FOF-related activity restriction on the other (only for the 1204 individuals reporting FOF and for whom data on activity restriction were available) were analyzed using binary logistic regression. The associations between FOF and the risk of reporting at least one fall/recurrent falls at follow-up were examined using multinomial logistic regressions. In these models, not having had a fall in the year prior to the follow-up was taken as the reference, having reported at least one fall/recurrent falls at follow-up was considered the primary outcome, and death before the follow-up assessment was the alternative outcome. All the analyses were adjusted for age, sex, educational level and previous falls (Model 1), and additionally for other factors that differed according to whether participants were with or without FOF or that could be confounders in the associations between FOF and the risk of falls (living alone, physical activity level, vision impairment, diabetes, lower limb osteoarthritis, BMI, GDS, and MMSE; Model 2). To evaluate the potential effect of physical performance in mediating this association, we developed a third model (Model 3) that also included the SPPB score among the covariates. The strength of the associations was estimated by adjusted odds ratios (OR) and 95% confidence intervals (95%CI), and the presence of potential interactions (by age, sex, and judgment capacity) was tested by including the multiplicative interaction term in the models. Since a significant interaction was found between FOF and judgment capacity for the risk of at least one fall ($p_{interaction}$=0.02) and the risk of recurrent falls ($p_{interaction}$=0.005), analyses of the associations between FOF and the risk of falls were performed for both the sample as a whole and the sample stratified by judgment capacity. Sensitivity analyses explored the above associations in individuals by presence of cognitive

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impairment and by report of previous falls at baseline. We decided to focus on these characteristics since the history of previous falls could influence the association between FOF and fall risk, and the presence of cognitive impairment could influence the impact of judgment on this association. A supplementary multinomial logistic model was also performed to evaluate the impact of FOF with and without activity restriction on the risk of falls in the sample as a whole and by judgment capacity. As an analysis for missing values revealed a frequency of <5% for the covariates, a single imputation using an expectation maximization algorithm was performed for continuous variables, and dummy variables were used for the categorical variables. All statistical tests were two-tailed and statistical significance was assumed at $p<0.05$. The analyses in this study were performed using SPSS 21.0 for Windows (SPSS Inc., Chicago, Illinois).

RESULTS

The characteristics of the total sample and by presence of FOF are reported in Table 1 (cancer and COPD prevalence did not differ between groups, data not shown). Of the 2625 individuals included in the study, 1210 (46.1%) were afraid of falling, with a prevalence that ranged from 40.8% among those who did not report previous falls, to 59.0% among those reporting previous falls. Out of the total sample, 2003 participants (76.3%) had high judgment, 486 (18.5%) moderate, and 136 (5.2%) poor. Compared with the individuals with moderate or poor judgment, those with high judgment were more likely to be younger (74.6±7.1[high] *vs* 77.5±7.7[moderate] and 79.5±7.3 years[poor], $p<0.001$) and to be men (43.4%[high] vs 36.2%[moderate] and 24.3%[poor], $p<0.001$). They also exhibited better cognitive performance, although there were cognitively intact individuals in all judgment groups (median MMSE[min-max]: 26[5-30] for the high, 22[10-30] for the moderate, and 20[6-29] for the poor judgment groups, $p<0.001$).

Looking at the association between judgment capacity and FOF (**Table 2**), we found that individuals with moderate and poor judgment had around a 20% increased probability of reporting FOF. Among the participants who reported FOF, 669 (55.6%) had limited their activities. Compared with the high-judgment group, those with moderate judgment were 54% more likely to report activity restriction, and those with poor judgment were more than twice as likely. Sensitivity analyses revealed that these associations were stronger

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among the cognitively intact participants ($p_{judgment*cognitive\ impairment}$ <0.001 for both FOF and activity restriction) and those with previous falls ($p_{judgment*previous\ falls}$=0.57 for FOF; $p_{judgment*previous\ falls}$=0.001 for activity restriction) (**Supplementary Table 1**).

After an average of 4.4 years, 2097 participants attended the follow-up assessment, and 528 participants (20.1%) had died. Of those who took part, 774 individuals (36.9%) reported at least one fall in the previous year, and almost half of these (n=310) had experienced ≥2 falls. Participants who at baseline reported FOF with or without activity restriction had higher incidence of falls than those who did not report FOF (at least one fall 44.5% *vs* 41.2% *vs* 32.2%; recurrent falls 25.1% *vs* 19.6% *vs* 8.8%; p<0.001 for both comparisons; **Figure 1**). Similar results were found when individuals were compared by judgment (at least one fall 35.7%[high] *vs* 39.3%[moderate] *vs* 47.6%[poor], p=0.03; recurrent falls 13.6%[high] *vs* 17.9%[moderate] *vs* 22.9%[poor], p=0.02; **Figure 1**). However, the risk of one fall and recurrent falls evaluated as a function of judgment by multinomial logistic regression produced no significant results (data not shown). **Table 3** shows the results of a multinomial logistic regression on the association between FOF and the risk of falls (statistics for all variables included in Model 3 are reported in **Supplementary Table 2**). In the sample as a whole, after adjustment for potential confounders and for SPPB, the presence of FOF increased only the risk of experiencing recurrent falls. When the sample was stratified by judgment ability, we found that where FOF was present at baseline, the probability of reporting at least one fall at follow-up increased by 93% (95%CI 1.34-2.79) in the poor judgment group. The direct association between FOF and recurrent falls became gradually stronger from individuals with high judgment (OR=1.65, 95%CI 1.48-1.83) to those with moderate (OR=2.81, 95%CI 2.22-3.55) or poor judgment (OR=3.66, 95%CI 2.10-6.36). These results for recurrent falls were confirmed in individuals with and without cognitive impairment, but those with cognitive impairment who reported FOF and had high judgment ability had a lower risk of experiencing at least one fall (OR=0.69, 95%CI 0.60-0.80; $p_{judgment*FOF*cognitive\ impairment}$=0.06, **Supplementary Table 3**). As for previous falls, those who had fallen in the year prior to the baseline assessment and had low judgment ability had a greater risk of at least one fall and of recurrent falls associated with the presence of FOF ($p_{judgment*FOF*previous\ falls}$ <0.001 for the

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risk of at least one fall, and $p_{judgment*FOF*previous\ falls}$=0.10 for the risk of recurrent falls). Evaluation of the risk of falls as a function of FOF and of FOF-related activity restriction (**Supplementary Table 4**) showed a high risk of falls among those with moderate judgment capacity and FOF but no activity restriction, and an even greater risk among those with poor judgment and FOF-related activity restriction.

DISCUSSION

Our results suggest that in community-dwelling older adults, lower judgment abilities are associated with higher probabilities of FOF and subsequent activity restriction. Judgment capacity may also modify the influence of FOF on the risk of falls. In particular, the poorer the judgment capacity, the stronger the association between FOF and the risk of experiencing falls.

Judgment is a stage in the decision-making process where the consequences of an action are appraised and inferred in consideration of contextual factors. Despite its fundamental role in everyday activities, a lack of uniformity in the methods used to assess judgment has thwarted attempts to investigate how it might change at an advanced age and in relation to cognitive decline[14]. Although the individuals in our sample with lower judgment abilities had poorer cognitive performance, some of those with poor judgment were cognitively intact at MMSE, and, vice versa, high judgment scores were also obtained by individuals with impaired cognition. These data suggest that the common screening tools for assessing overall cognitive performance, such as the MMSE, may not be suitable for comprehensively evaluating the judgment capacity of older individuals.

The primary aim of our study was to investigate the association between judgment and FOF and related activity restriction. Consistent with the findings of previous studies[1], 46.1% of our cohort of community-dwelling older adults reported FOF, and more than half of these reported having limited their daily activities as a result[25–27]. FOF has been associated with a variety of factors that include female gender, older age, and poor physical performance[1,28]. However, few studies have investigated neuropsychological and behavioral factors, which have been found to be more strongly associated with activity restriction than with FOF alone[28]. Our results corroborate these findings with respect to judgment capacity. Compared with FOF, we found a stronger stimulus-response

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relationship between judgment and activity restriction, where individuals with poor judgement were twice as likely to limit their daily activities as those with high judgment. Interestingly, these relationships were more marked in people with no cognitive impairment and in those who had already experienced falls.

There are several possible reasons why judgment is linked with FOF and related activity restriction. Judgment impairment may lead to inappropriate perception of fall risk, either overestimating or underestimating it. As we adjusted our analyses for an objective measure of physical performance, our results suggest that where judgment is poor, there is a particular tendency for adults without cognitive impairment to overestimate fall risk, prompting them to report FOF. These people may also have greater anxiety levels, leading them to feel they do not have the situation under control, and diminishing their capacity to rationally appraise individual and environmental fall risks[3]. These factors may increase the psychological burden of FOF and lead to a reduction in daily activities. In contrast, poor judgment was not significantly associated with FOF in people with cognitive impairment, suggesting that these individuals are less likely to overestimate fall risk, or that other neuropsychological dysfunctions may influence the relationship between judgment and FOF. A further hypothesis concerns the influence of relatives or caregivers. Among individuals with, in particular, a history of falls, and irrespective of the presence of cognitive impairment, caregivers of those with poor judgment may, being aware of this deficiency, indirectly keep them from carrying out certain daily tasks in an attempt to prevent mishaps or injury.

Although a higher incidence of falls was observed where judgment was impaired, judgment did not emerge from the multinomial logistic analyses as an independent predictor of falls; instead, it seemed to modify the association between FOF and incident falls. This was particularly evident for recurrent falls, whose risk in relation to the presence of FOF increased by around 100% for each lower level of judgment. These findings support our hypothesis, namely that poor judgment makes it more likely that FOF is a maladaptive rather than a protective response. Where there have been previous falls, in particular, poor judgment may lower the possibility that FOF is a result of learning from experience, which should help prevent, rather than increase, the occurrence of falls. One of the

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features characterizing FOF as a maladaptive response is restriction in the performance of daily tasks[8]. If older adults limit their activities, their physical and cognitive functions may steeply decline with detrimental social and psychological effects that increase the risk of falls[7,8,28–31]. As our results suggest, this mechanism may be particularly marked in individuals with poor judgment, and we indeed found that these participants were more likely to limit their daily activities due to FOF, and the impact on them of FOF-related activity restriction in increasing fall risk was stronger. In addition to limiting the number of daily tasks, which we accounted for in our analyses by adjusting for physical activity level, judgment capacity could also influence the types of activity undertaken. Hence, people with poor judgment may inappropriately evaluate the tasks to be avoided, and, despite an overall reduction of their daily activities, may continue to be exposed to hazardous situations. Finally, FOF has been largely associated with the adoption of stiffening strategies, which can cause changes to balance and gait[4,32,33]. Although these strategies appear to prevent the loss of postural control while performing simple tasks, recent studies suggest that they may be detrimental in multi-task scenarios due to inadequate allocation of attentional resources and poor sensory acquisition[33–35]. Neuropsychological factors may play an important role in these changes in physical functions. Anxiety, for example, seems to significantly affect attentional processes[33], while impaired executive functions have been associated with gait abnormalities and gait speed decline[36]. As for judgment capacity, this has so far not received much attention. Taylor et al. found that inaccurate judgment of reach was associated not only with FOF and incident falls, but also with reduced cognitive performance, executive function, balance and reaction time[17]. Although we used a different measure of judgment capacity, we found that including SPPB in the model weakened the association between FOF and fall risk, suggesting that it could be modified by judgment as a result of alterations in gait and postural control.

The limitations of our work include, firstly, the fact that the information on falls was obtained from participants' self-reports and concerned only the year prior to the follow-up assessment. This may have led to underestimation of the number of incident falls and the strength of the association between FOF and fall risk, especially among those with poor judgment, although the presence and involvement of caregivers, especially with

cognitively-impaired individuals, may have mitigated this recall bias. Secondly, the participants excluded from our sample were older and had lower educational levels and cognitive performance, which may also have caused further underestimation of the number of falls and the associations examined. Thirdly, without a comprehensive physiological measurement of fall risk we were unable to evaluate how FOF and judgment could *per se* influence the risk of falling. Finally, the first assessments in the Pro.V.A. study were made between 1995 and 1997 and involved participants with relatively low educational and socio-economic levels, which may limit the generalizability of our results to higher-income countries and to the current generation of older adults. On the other hand, our study is strengthened by its prospective design, the large sample size and the number of covariates adjusted for in our analyses.

In conclusion, our study found judgment capacity to be associated with FOF and, in particular, with FOF-related activity restriction. The impact of FOF in increasing the risk of falls, especially of recurrent falls, seems to be stronger for older adults with poor judgment compared with those with high judgment. These findings suggest that judgment capacity may be a useful measure in assessing fall risk and identifying those individuals who would benefit most from interventions aimed at preventing or reducing their FOF.

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Table 1. Characteristics of the 2625 participants by presence of fear of falling

Baseline characteristics		All (n=2625)	Fear of Falling	
			Yes (n=1210)	No (n=1415)
Age (years)		75.4±7.3	77.2±7.5	73.8±6.8***
Sex (female)		1547 (58.9)	869 (71.8)	678 (47.9)***
Education level (≥5 years)		1398 (53.3)	501 (41.4)	897 (63.4)***
Monthly income (>€500)		1012 (39.3)	379 (32.1)	633 (45.5)***
Living alone		479 (18.2)	264 (21.8)	215 (15.2)***
Physical activity >4h/w		658 (25.1)	232 (19.2)	426 (30.1)***
Smoking habits	*Never*	246 (9.4)	853 (70.5)	724 (51.2)***
	Former	802 (30.6)	282 (23.3)	520 (36.7)***
	Current	1577 (60.1)	75 (6.2)	171 (12.1)***
Alcohol consumption	*None*	1807 (68.8)	899 (74.3)	908 (64.2)***
	Light-to-moderate	485 (18.5)	207 (17.1)	278 (19.6)
	Heavy	333 (12.7)	104 (8.6)	229 (16.2)***
Body mass index (kg/m^2)		27.7±4.5	28.0±4.9	27.4±4.1***
Previous falls		759 (28.9)	448 (37.1)	311 (22.0)***
Diabetes		425 (16.2)	219 (18.1)	206 (14.6)*
Cardiovascular diseases		563 (21.4)	292 (24.1)	271 (19.2)**
Lower limb osteoarthritis		657 (25.0)	409 (33.8)	248 (17.5)***

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Vision impairment	1058 (40.3)	587 (48.5)	471 (33.3)***
Cognitive impairment	972 (37.0)	574 (47.4)	398 (28.1)***
Depressive symptoms	1037 (39.5)	711 (58.8)	326 (23.0)***
SPPB	8.2±3.3	6.9±3.5	9.4±2.7***

Figures are numbers with either (%) or mean±SD, as appropriate. *Abbreviations:* SPPB, Short Physical Performance Battery. *p<0.05, **p<0.01, ***p<0.001 for the between-group differences obtained with the Student t-test (quantitative variables) or the Chi-square test (qualitative variables)

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Table 2. Logistic regression on the association between judgment capacity, fear of falling and related activity restriction

		Odds ratio and 95% confidence intervals			
		FOF (n=2625)		FOF-related activity restriction (n=1206)†	
		Model 1	Model 2	Model 1	Model 2
Judgment capacity	High	[ref]	[ref]	[ref]	[ref]
	Moderate	1.44 (1.35-1.55)***	1.22 (1.13-1.32)***	1.62 (1.48-1.78)***	1.54 (1.40-1.71)***
	Poor	1.64 (1.44-1.87)***	1.18 (1.02-1.37)*	2.81 (2.37-3.34)***	2.33 (1.93-2.80)***

Model 1 is adjusted for age, sex, education, previous falls. Model 2 is also adjusted for living alone, vision impairment, body mass index, Geriatric Depression Scale, Mini-Mental State Examination, Short Physical Performance Battery. *Abbreviations:* FOF, Fear of Falling.
† Only participants who reported FOF at baseline and whose data on FOF-related activity restriction was available were analyzed. *p<0.05, **p<0.01, ***p<0.001.

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Table 3. Multinomial logistic regression on the associations between fear of falling and the risk of at least one fall and the risk of recurrent falls in the total sample (n=2625) stratified by judgment capacity

		Odds ratios of falls and 95% confidence intervals			
		All	Judgment capacity		
			High	Moderate	Poor
At least one fall					
	Model 1	1.25 (1.18-1.33)***	1.20 (1.13-1.29)***	1.28 (1.11-1.48)**	1.72 (1.26-2.35)**
Fear of falling (yes *vs* no)	**Model 2**	1.07 (1.004-1.14)*	1.02 (0.95-1.09)	1.13 (0.97-1.33)	2.09 (1.46-2.99)***
	Model 3	1.04 (0.97-1.11)	0.98 (0.91-1.06)	1.16 (0.98-1.36)	1.93 (1.34-2.79)***
Recurrent falls					
	Model 1	2.27 (2.08-2.47)***	2.05 (1.86-2.26)***	2.85 (2.30-3.54)***	3.57 (2.25-5.68)***
Fear of falling (yes *vs* no)	**Model 2**	1.99 (1.81-2.18)***	1.74 (1.56-1.93)***	2.94 (2.33-3.71)***	4.19 (2.52-6.98)***
	Model 3	1.87 (1.70-2.05)***	1.65 (1.48-1.83)***	2.81 (2.22-3.55)***	3.66 (2.10-6.36)***

Model 1 is adjusted for age, sex, education, previous falls. Model 2 is also adjusted for living alone, physical activity, vision impairment, diabetes, lower limb osteoarthritis, body mass index, Geriatric Depression Scale, Mini-Mental State Examination. Model 3 is also adjusted for Short Physical Performance Battery. *Notes:* data were obtained from

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multinomial logistic regressions where death was considered the alternative outcome.

*p<0.05, **p<0.01, ***p<0.001.

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FIGURES' LEGEND

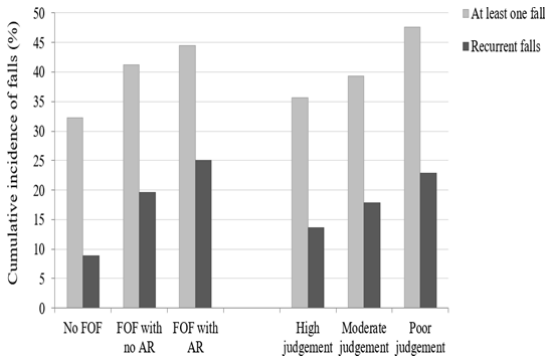

Figure 1. Self-reported incident falls in the year prior to the follow-up assessment by presence of fear of falling and related activity restriction, and by judgement capacity

Abbreviations: FOF, fear of falling; AR, activity restriction.

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SUPPLEMENTARY MATERIAL

Supplementary Table 1. Logistic regression on the association between baseline judgment capacity and fear of falling and related activity restriction by the presence of cognitive impairment and by previous falls

	Odds ratios and 95% confidence intervals			
	Cognitive impairment		Previous Falls	
	No	Yes	No	Yes
Fear of falling (n=2625)				
High judgment	[ref]	[ref]	[ref]	[ref]
Low judgment	1.55 (1.40-1.71)***	0.98 (0.88-1.09)	1.19 (1.09-1.30)***	1.31 (1.15-1.50)***
FOF-related activity restriction[†] (n=1206)				
High judgment	[ref]	[ref]	[ref]	[ref]
Low judgment	2.08 (1.82-2.39)***	1.38 (1.21-1.57)***	1.54 (1.37-1.73)***	1.93 (1.65-2.26)***

Model adjusted for age, sex, education, previous falls, whether living alone, physical activity, vision impairment, body mass index, Geriatric Depression Scale, Mini-Mental State Examination, Short Physical Performance Battery. *Abbreviations:* FOF, Fear of Falling. *p<0.05, **p<0.01, ***p<0.001. [†]Analysis performed only with participants who reported FOF at baseline and for whom we had data on FOF-related activity restriction.

Supplementary Table 2. Multinomial logistic regression on the associations between fear of falling and the risk of any fall or recurrent falls by judgment capacity

	Odds ratios of falls and 95% confidence intervals			
	All	Judgment capacity		
		High	Moderate	Poor
At least one fall				
Fear of falling (yes *vs* no)	1.04 (0.97-1.11)	0.98 (0.91-1.06)	1.16 (0.98-1.36)	1.93 (1.34-2.79)***
Age (years)	1.01 (1.003-1.01)**	1.01 (0.99-1.01)	1.02 (1.01-1.04)***	1.01 (0.99-1.04)
Sex (male *vs* female)	0.81 (0.76-0.86)***	0.81 (0.75-0.87)***	0.74 (0.62-0.87)***	1.07 (0.72-1.58)
Educational level (≥ *vs* < 5 years)	1.05 (0.99-1.12)	0.99 (0.92-1.07)	1.86 (1.58-2.19)***	0.46 (0.32-0.67)***
BMI (kg/m2)	1.00 (0.99-1.00)	1.00 (1.00-1.01)	0.98 (0.96-0.99)**	0.97 (0.94-1.00)
MMSE	0.99 (0.98-0.99)**	0.99 (0.98-0.996)**	0.97 (0.95-0.99)**	1.05 (1.01-1.09)*
GDS	1.04 (1.03-1.04)***	1.04 (1.03-1.04)***	1.03 (1.02-1.05)***	0.98 (0.95-1.01)
SPPB	0.96 (0.95-0.97)***	0.96 (0.94-0.97)***	1.02 (0.99-1.05)	0.83 (0.78-0.88)***

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Physical activity (< *vs* ≥ 4 h/week)	1.08 (1.01-1.15)*	1.04 (0.97-1.12)	1.52 (1.27-1.82)***	0.88 (0.58-1.34)
Previous falls (yes *vs* no)	1.61 (1.51-1.71)***	1.49 (1.39-1.6)	2.34 (2.00-2.74)***	1.87 (1.36-2.57)***
Living alone (yes *vs* no)	1.17 (1.08-1.25)***	1.22 (1.13-1.33)	1.15 (0.96-1.37)	0.51 (0.33-0.77)**
Vision impairment (yes *vs* no)	1.02 (0.96-1.08)	0.99 (0.93-1.06)	1.1 (0.94-1.29)	1.38 (1.00-1.92)
Diabetes (yes *vs* no)	1.06 (0.98-1.15)	0.99 (0.91-1.09)	1.26 (1.04-1.52)*	2.62 (1.6-4.29)***
Lower limb osteoarthritis (yes *vs* no)	1.08 (1.01-1.16)*	1.08 (1.004-1.17)*	1.26 (1.06-1.49)**	0.36 (0.25-0.53)***
Recurrent falls				
Fear of falling (yes *vs* no)	1.87 (1.70-2.05)***	1.65 (1.48-1.83)***	2.81 (2.22-3.55)***	3.66 (2.10-6.36)***
Age (years)	1.02 (1.02-1.03)***	1.04 (1.03-1.04)***	1 (0.98-1.02)	0.98 (0.94-1.02)
Sex (male *vs* female)	0.82 (0.74-0.91)***	0.76 (0.68-0.85)***	0.89 (0.70-1.14)	0.37 (0.20-0.68)**
Educational level (≥ *vs* < 5 years)	1.16 (1.05-1.27)**	1.2 (1.08-1.33)**	1.52 (1.21-1.91)***	0.46 (0.26-0.81)**

BMI (kg/m2)	1.00 (0.99-1.01)	1.01 (1.00-1.02)	0.96 (0.94-0.98)***	0.95 (0.91-1.00)*
MMSE	0.98 (0.97-0.99)***	0.99 (0.97-1.00)	0.94 (0.91-0.96)***	0.99 (0.94-1.04)
GDS	1.02 (1.01-1.03)***	1.03 (1.02-1.04)***	0.99 (0.97-1.01)	0.88 (0.84-0.92)***
SPPB	0.92 (0.9-0.93)***	0.93 (0.91-0.94)***	0.92 (0.89-0.96)***	0.65 (0.59-0.7)***
Physical activity (< *vs* ≥ 4 h/week)	1.18 (1.07-1.3)**	1.08 (0.97-1.21)	1.56 (1.22-2)***	2.89 (1.65-5.06)***
Previous falls (yes *vs* no)	2.48 (2.28-2.7)***	2.31 (2.1-2.54)***	3.88 (3.18-4.74)***	1.94 (1.27-2.94)**
Living alone (yes *vs* no)	1.01 (0.91-1.12)	0.99 (0.88-1.12)	1.28 (1.01-1.61)*	0.72 (0.41-1.28)
Vision impairment (yes *vs* no)	0.98 (0.89-1.06)	1.04 (0.94-1.15)	0.77 (0.62-0.96)*	0.77 (0.49-1.22)
Diabetes (yes *vs* no)	1.18 (1.06-1.32)**	1.03 (0.9-1.17)	1.45 (1.14-1.86)**	4.54 (2.47-8.35)***
Lower limb osteoarthritis (yes *vs* no)	1.05 (0.96-1.16)	1.08 (0.97-1.2)	0.93 (0.74-1.16)	0.29 (0.18-0.47)***

Abbreviations: BMI, body mass index; MMSE, Mini-Mental State Examination; GDS, Geriatric Depression Scale; SPPB, Short Physical Performance Battery.

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Supplementary Table 3. Multinomial logistic regression on the aassociations between fear of falling and the risk of any fall or recurrent falls by judgment capacity in participants with/without cognitive impairment and previous falls

		Odds ratios of falls and 95% confidence intervals			
		No cognitive impairment		Cognitive impairment	
Exposure	**Outcome**	**High judgment**	**Low judgment**	**High judgment**	**Low judgment**
Fear of falling (yes *vs* no)	***At least one fall***	1.10 (1.01-1.20)*	0.91 (0.74-1.14)	0.69 (0.60-0.80)***	1.53 (1.25-1.86)***
	Recurrent falls	1.65 (1.46-1.87)***	3.02 (2.07-4.39)***	1.53 (1.24-1.89)***	2.91 (2.22-3.81)***
		No previous falls		**Previous falls**	
		High judgment	**Low judgment**	**High judgment**	**Low judgment**
Fear of falling (yes *vs* no)	***At least one fall***	0.93 (0.85-1.01)	1.02 (0.85-1.22)	1.08 (0.94-1.23)	1.71 (1.30-2.25)***
	Recurrent falls	1.75 (1.53-2.01)***	2.66 (1.98-3.58)***	1.46 (1.24-1.73)***	3.25 (2.32-4.57)***

Model adjusted for age, sex, education, previous falls, whether living alone, physical activity, vision impairment, diabetes, lower limb osteoarthritis, body mass index, Geriatric Depression Scale, Mini-Mental State Examination, Short Physical Performance Battery.
Note: Data were obtained from multinomial logistic regressions where death was considered the alternative outcome. *p<0.05, **p<0.01, ***p<0.001.

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Supplementary Table 4. Multinomial logistic regression on the associations between fear of falling with or without activity restriction and the risk of falls in the total sample (n=2625) stratified by judgment capacity

			Odds ratios of falls and 95% confidence intervals					
			At least one fall			Reccurrent falls		
			Model 1	Model 2	Model 3	Model 1	Model 2	Model 3
		All	1.23 (1.14-1.32)***	1.11 (1.03-1.19)**	1.10 (1.02-1.19)**	2.08 (1.87-2.30)***	1.94 (1.74-2.15)***	1.93 (1.74-2.15)***
FOF no ART	Judgment capacity	High	1.16 (1.07-1.25)**	1.03 (0.95-1.12)	1.02 (0.94-1.11)	1.86 (1.65-2.09)***	1.67 (1.49-1.89)***	1.66 (1.47-1.87)***
		Moderate	1.64 (0.37-1.97)	1.54 (1.27-1.87)***	1.55 (1.28-1.88)***	3.42 (2.64-4.43)***	3.62 (2.77-4.73)***	3.73 (2.86-4.88)***
		Poor	0.89 (0.57-1.38)	1.05 (0.64-1.73)	0.90 (0.54-1.50)	1.90 (1.05-3.44)*	2.11 (1.11-4.04)*	1.41 (0.69-2.87)
FOF with ART		All	1.30 (1.21-1.39)***	1.04 (0.96-1.13)	0.98 (0.90-1.06)	2.47 (1.23-2.72)***	2.07 (1.85-2.30)***	1.82 (1.63-2.04)***
	Judgment capacity	High	1.28 (1.17-1.39)*	1.01 (0.93-1.11)	0.95 (0.86-1.04)	2.29 (2.04-2.57)*	1.84 (1.62-2.09)*	1.65 (1.45-1.88)*

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		**			**	**	**
	Moderate	1.09 (0.92-1.28)	0.87 (0.72-1.04)	0.87 (0.72-1.05)	2.55 (2.02-3.22)**	2.46 (1.90-3.19)**	2.16 (1.66-2.82)**
	Poor	2.06 (1.50-2.84)**	2.54 (1.75-3.68)**	2.35 (1.61-3.44)**	4.25 (2.65-6.81)**	5.13 (3.05-8.65)**	4.80 (2.72-8.48)**

Model 1 is adjusted for age, sex, education, previous falls. Model 2 is additionally adjusted for living alone, vision impairment, diabetes, lower limb osteoarthritis, body mass index, Geriatric Depression Scale, Mini-Mental State Examination. Model 3 is additionally adjusted for Short Physical Performance Battery. *Notes:* Data were obtained from multinomial logistic regressions where death was considered the alternative outcome. *Abbreviations*: FOF, fear of falling; AR, activity restriction. [†]"no FOF" was the reference exposure category; *p<0.05, **p<0.01, ***p<0.001.

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Judgment Capacity, Fear of Falling and the Risk of Falls in Community-Dwelling Older Adults: the Pro.V.A. Longitudinal Study (DOI: 10.1089/rej.2019.2197)
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Appendix 1. Collection of data on the baseline characteristics of the study participants

Sociodemographic data referred to the participants' age, sex, level of education categorized as <5 or ≥5 years (5 being the number years of primary school in Italy), monthly income (≤ or > 500 euro), and whether they were living alone (yes or no). *Risk behaviors* referred to smoking habits (classified as never, former [for at least one year in their lifetime], or current), alcohol consumption (classified as none, light-to-moderate (<7 units of alcohol [UA]/week for women and <14 UA/week for men), or heavy (≥7 UA/week for women and ≥14 UA/week for men), and level of physical activity (classified as ≥ or < 4 h/week of at least moderate physical activity over the previous month). Body weight and height were also measured during clinical visits, and body mass index (BMI) was calculated as the ratio of body weight (kg) to height squared (m^2). *Clinical status* was evaluated through standardized questionnaires, medical and hospital data, self-reported symptoms, blood tests and physical examinations. For the purposes of our study, we took into account the presence of diabetes mellitus [1], cardiovascular diseases (CVD), chronic obstructive pulmonary disease, cancer, lower limb osteoarthritis, vision impairment, cognitive impairment and depressive symptoms. The presence of CVD was defined as the presence of at least one of the following: congestive heart failure, angina requiring a stent, angioplasty or hospitalization, myocardial infarction, and stroke. Lower limb osteoarthritis (OA) was evaluated on the basis of medical records, previous X-ray examinations, the use of analgesics and physical evaluation of the hip and knee region by a rheumatologist on the basis of a standardized algorithm [2]. The presence of any impairment in vision that was not appropriately corrected (*vision impairment*) was assessed by clinical examination by a physician and from medical and hospital records. *Cognitive performance* was assessed using the 30-item MMSE, and participants with a score of <24 were considered cognitively impaired[3]. A score of >10 on the 30-item GDS[4] was taken as indicating the presence of *depressive symptoms*. To test *physical performance*, participants underwent the Short Physical Performance Battery (SPPB), a validated test that examines gait speed, static balance and chair stand. Total SPPB score ranges from 0 (worse) to 12 (better physical performance)[5]. *Previous falls* referred to the reporting of at least one fall in the year preceding the baseline evaluation.

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