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Activity Restriction Induced by Fear of Falling and Objective and Subjective Measures of Physical Function: A Prospective Cohort Study

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Abstract

Objectives—To examine whether activity restriction specifically induced by fear of falling (FF) contributes to greater risk of disability and decline in physical function.

Design—Prospective cohort study.

Setting—Population-based older cohort.

Participants—Six hundred seventy-three community-living elderly (≥ 65) participants in the Invecchiare in Chianti Study who reported FF.

Measurements—FF, fear-induced activity restriction, cognition, depressive symptoms, comorbidities, smoking history, and demographic factors were assessed at baseline. Disability in activities of daily living (ADLs) and instrumental activities of daily living (IADLs) and performance on the Short Performance Physical Battery (SPPB) were evaluated at baseline and at the 3-year follow-up.

Results—One-quarter (25.5%) of participants did not report any activity restriction, 59.6% reported moderate activity restriction (restriction or avoidance of <3 activities), and 14.9% reported severe activity restriction (restriction or avoidance of ≥ 3 activities). The severe restriction group reported significantly higher IADL disability and worse SPPB scores than the no restriction and moderate restriction groups. Severe activity restriction was a significant independent predictor of worsening ADL disability and accelerated decline in lower extremity performance on SPPB over the 3-year follow-up. Severe and moderate activity restriction were independent predictors of worsening IADL disability. Results were consistent even after adjusting for multiple potential confounders.

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Conclusion—In an elderly population, activity restriction associated with FF is an independent predictor of decline in physical function. Future intervention studies in geriatric preventive care should directly address risk factors associated with FF and activity restriction to substantiate long-term effects on physical abilities and autonomy of older persons.

Keywords

fear of falling; activity restriction; aging; disability; physical function

Fear of falling (FF) has been recognized as a serious and common problem in older persons^{1,2} that may not necessarily be preceded by an actual fall.³ In an attempt to avoid fall-related morbidity and social embarrassment,⁴ many fearful older persons resort to activity restriction. Although in the short term curtailment of activities or avoidance may protect against falls, in the long term, activity restriction can diminish the physical and mental health of an older person and may further increase risk of future falls.^{5,6}

Two cross-sectional studies have reported poorer balance and lower muscle strength in older persons who restrict their activities as a consequence of FF than in those who do not.^{5,7} These initial findings have led researchers to suggest that fear-induced activity restriction could be an important psychological factor in decline in physical function and increase in disability, although it is possible that only fearful older individuals who have poor balance and lower muscle strength resort to activity restriction. The cross-sectional design of these studies does not allow temporal sequence, which may suggest the existence of a causal pathway between fear-induced activity restriction and accelerated decline in physical function, to be established. Therefore, prospective evidence is needed to substantiate predictive significance of fear-associated activity restriction in accelerated increase in disability and decline in physical function. The first objective of this study was to examine the differences in self-reported disability and physical function of elderly people who do not restrict their activities, those who moderately restrict their activities, and those who severely restrict their activities because of FF. The second objective was to determine whether fear-induced activity restriction can contribute to increase in disability and decline in physical function over time, independent of baseline physical function.

Methods

Participants

The Invecchiare in Chianti (aging in the Chianti area; InCHIANTI) Study is an epidemiological study conducted to understand factors contributing to decline in mobility in late life. The study population is a representative sample of the population living in two towns of the Chianti countryside of Tuscany, Italy. The study design and data collection have been described previously elsewhere.⁸ Briefly, in 1998, 1,270 older persons (aged ≥ 65) were randomly selected from the population registry of the two sites. Of these, 1,155 agreed to participate and were interviewed in their homes, and 1,026 participated in a comprehensive medical examination and mobility evaluation at the local clinical center. Follow-up data were collected after 3 and 6 years. The ethical committee of the Italian National Institute of Research and Care of Aging approved the study protocol, which complies with the Declaration of Helsinki. All participants received a detailed description of the study purpose and procedures, and all signed an informed consent.

All participants who at baseline completed the Survey of Activities and Fear of Falling in the Elderly (SAFE) questionnaire,⁹ aimed at quantifying FF and activity restriction, were initially included ($n = 1,155$). Seventy-eight participants with severe cognitive impairment (Mini-Mental State Examination (MMSE) score < 15)^{10,11} and another 10 participants who used a

proxy for the interview were excluded. Of 1,067 eligible participants, the final study population consisted of 673 participants who reported some FF (SAFE score >0).

Outcome Measures

Fear-Induced Activity Restriction—Fear-induced activity restriction was quantified using the SAFE questionnaire.⁹ This scale inquires about FF for an array of 11 common activities performed inside and outside the home environment without help (shopping, cooking, bathing or showering, getting out of bed, walking outside the home, walking on a slippery surface, visiting relatives or friends, reaching up, going to a crowded place, going for long walks, and bending down to pick up objects). For each activity, participants were asked to report whether they usually performed that activity. If the response to this first question was affirmative, they were asked whether they were afraid of falling while performing that activity and whether they were performing that activity less often than 3 years before exclusively because of FF. If the response to the first question was negative, they were asked whether they usually did not perform that activity because of FF. Restriction of the activity due to any reasons other than FF was exempted. For those who reported some FF, a “total activity restriction” score was calculated by adding the number of activities that were performed less often than 3 years before or were not performed because of FF (range 0–11). After visually inspecting frequency distribution of total activity restriction (Figure 1), participants were stratified into three groups: no activity restriction, moderate activity restriction (1–2), and severe activity restriction (>2).

Self-Reported Disability—Participants were asked to report the number of activities of daily living (ADLs: bathing, dressing, eating, getting into and out of bed or chair, walking across a room, and using the toilet) for which they required help, and an ADL disability score ranging from 0 to 6 was calculated. Analogously, the disability score for instrumental activities of daily living (IADLs: preparing meals, shopping for groceries, managing money, making phone calls, performing light housework, performing heavy housework, getting to places outside of walking distance, and managing medications) was computed (range 0–8).¹²

Measure of Physical Performance—The Short Physical Performance Battery (SPPB), which incorporates static balance, walking, and time for repeated chair rise, was used as an objective assessment of mobility function. This test has been shown to have an excellent test–retest reliability¹³ and is known to predict nursing home admission, disability, and mortality.^{14,15} For static standing balance, participants were asked to place their feet sequentially in side-by-side, semitandem, and full tandem positions and maintain each position for 10 seconds. The performance was graded from 0 to 4, with grade 0 indicating inability to stand in the initial side-by-side-feet position and grade 4 indicating the ability to hold all three stands. For the walking component, participants were asked to walk a 4-m distance at their usual pace. The time for the faster of two trials was used. Finally, for the repeated chair rise, participants were asked to fold their arms across their chest and stand up from a sitting position five times consecutively as quickly as possible. The performance was graded from 1 to 4 according to the quartile cutoff points from the normative data.¹⁴ A grade of 0 was given when the participant was unable to perform the task. A summary SPPB score was computed by summing the grades of balance, walking, and chair rise components (range 0–12).

Covariates—Comorbidity index at baseline was assessed as the total number of prevalent comorbidities (Parkinson's disease; stroke; angina pectoris; myocardial infarction; congestive heart failure; asthma; chronic obstructive pulmonary disease; hip fracture; hip or knee replacement surgery; symptomatic knee osteoarthritis; severe hip, knee, or back pain; peripheral vascular disease, and diabetes mellitus) determined from a self-reported questionnaire, medical examination, and laboratory tests.¹⁶ Cognitive function was evaluated

using the MMSE (range 0–30, higher scores indicating better cognitive functioning).¹¹ The Center for Epidemiologic Studies Depression Scale (CES-D), a 20-item self-report questionnaire, was used to assess depressive symptoms¹⁷ (range 0–60, higher scores indicating more-severe symptomatic depression). Smoking status was assessed according to self-reported data. Pack-years, which is a measure of smoking exposure that combines intensity and duration, was calculated as (number of packs per day) $\times$ (years of smoking).¹⁸ Demographic factors included participant's age, sex, and body mass index (BMI, weight in kg/height in m²).

Recording of demographic factors; evaluation of ADL and IADL disability and smoking history; and administration of SAFE, MMSE, and CES-D scores were completed in the interview session of InCHIANTI data collection. Assessment on SPPB was completed in the physical performance assessment session.

Descriptive Variables—Mobility-related parameters were evaluated for descriptive purposes. Usual walking speed (m/s) was measured over 7 m. Participants were asked whether they could climb a flight of stairs without support and whether they had difficulty walking 400 m.

Statistical Analyses

Variables with a skewed distribution were log transformed for the analysis and back-transformed for data presentation. General linear models were used to test for the differences in the three activity-restriction groups at baseline.

Bivariate correlations of fear-induced activity restriction, demographic variables, and covariate factors were assessed separately with each of the three outcome measures (ADL and IADL disability and SPPB scores) at the 3-year follow-up. Demographic variables were included in the separate multiple regression analyses to test the hypothesis that fear-induced activity restriction was an independent risk factor for increase in disability and accelerated decline in physical performance over the 3-year follow-up. There was no group-specific predisposition for attending the interview session or the physical performance assessment session at the 3-year follow-up (Interview: chi-square (χ^2) = 2.769, P = .60; Physical performance session: χ^2 = 0.445, P = .98; Table 1). Therefore, for longitudinal analyses, overall means were used to replace missing values for the follow-up. According to an autoregressive model, changes in ADL and IADL disability and SPPB scores were regressed on baseline activity restriction by adjusting for the respective baseline performance. Furthermore, covariates with correlational significance of P < .20 were included in the respective multiple linear regression analysis models to test robustness of this association. Dummy variables were created such that the “no activity restriction” group was used as a reference group. All statistical analyses were conducted using SPSS version 13.0 (SPSS, Inc., Chicago, IL). P < .05 was considered statistically significant.

Results

Of 1,067 eligible participants, the final study population consisted of 673 participants who reported some FF (SAFE score >0). Of these, 157 were aged 65 to 69, 324 were aged 71 to 79, 159 were aged 80 to 89, and 33 were aged 90 and older. A total of 172 (25.5%) participants did not report any activity restriction in spite of reporting some FF (Table 1), 401 (59.6%) participants reported restriction or avoidance of less than three activities (moderate activity restriction) of the 11 activities asked about, and 100 (14.9%) participants reported restriction or avoidance of three or more activities (severe activity restriction). Of 673 participants who were included at the baseline and completed the interview session, 584 (86.7%) were assessed for physical performance (Table 1). Those who attended the physical performance assessment session were more likely to report no activity restriction (P = .003).

Cross-Sectional Analysis at Baseline

Table 2 reports the characteristics of the overall study sample and according to activity restriction groups. Older age and female sex were associated with greater activity restriction ($F_{(2,670)} = 32.039$, $P < .001$ and $\chi^2_{(2)} = 12.296$, $P = .002$, respectively). When adjusted for age and sex, there were significant differences between the IADL disability and SPPB scores of the three activity-restriction groups. In contrast, ADL disability was not different between the groups. Post hoc analysis showed that the severe-restriction group reported significantly greater IADL disability and worse SPPB scores than the no-restriction and moderate-restriction groups (all four $P < .001$). Additionally, after adjusting for age and sex, higher BMI, poorer cognition, higher depressive symptoms, and worse mobility were associated with greater activity restriction (Table 2).

Longitudinal Analysis

Overall, ADL and IADL disability significantly increased (ADL: 0.12 ± 0.54 vs 0.47 ± 1.33 , $F = 52.528$, $P < .001$; IADL: 0.76 ± 1.55 vs 1.48 ± 2.53 , $F = 41.716$, $P < .001$) and SPPB performance declined over 3 years (9.83 ± 2.78 vs 8.57 ± 3.67 , $F = 68.030$, $P < .001$). Significance (P -values) of bivariate correlations between fear-induced activity restriction, demographic factors, and covariates and ADL and IADL disability and SPPB scores are reported in Table 3. Smoking was dropped from further analysis for SPPB scores because of poor correlation ($P > .20$).

The results of the multivariate regression analyses are displayed in Table 4. Model 1, which adjusted for demographic factors (age, sex, and BMI) and baseline values of the respective dependent variables, showed that severe activity restriction was a significant independent predictor of increase in ADL disability and worse performance on SPPB after 3 years. In contrast, severe and moderate activity restriction were independent predictors of worsening IADL disability. The results were consistent even after adjusting for the multiple potential confounders (Model 2).

Discussion

Using a population-based sample of older adults, this study investigated whether activity restriction that is exclusively associated with FF predicts increase in self-reported disability and decline in measured physical function after 3 years, independent of baseline functional status. The cross-sectional results demonstrated higher severity of disability in IADLs and worse performance on the SPPB in older individuals with severe fear-induced activity restriction. Even after adjusting for baseline IADL disability and multiple possible confounders, moderate and severe activity restriction were independent predictors of higher IADL disability after 3 years. Additionally, severe fear-induced activity restriction was a significant independent predictor of accelerated increase in ADL disability and decline in SPPB performance after 3 years.

Fear-Induced Activity Restriction and Self-Reported Disability

One of the major detrimental consequences of FF is fear-induced activity restriction and the tendency to adopt a more-sedentary lifestyles.¹⁹ The possible accompanying deconditioning effect on muscle strength and postural control may contribute to increase in disability. These cross-sectional results demonstrated that, independent of age, severity of IADL disability, but not ADL disability, was significantly higher in severe activity restriction group. A higher prevalence of self-reported ADL disability in those who restricted activities due to FF than in those who did not has been reported, but prevalence of ADL disability was defined in that study as disability in one or more ADLs, and a dichotomous variable was used rather than identifying

a total number of ADLs for which assistance was required.⁶ Detecting presence or absence of ADL disability as measured in that study⁶ is also important, for example, for determining any need of assistance in ADLs, although if a participant reports ADL disability even on one of the six items at baseline, the dichotomized measure will not detect further increase in ADL disability. Therefore, grading ADL disability is particularly important for a prospective cohort study. The cross-sectional results of the current study demonstrated that a total number of ADLs for which assistance is required is not significantly higher in older persons with severe fear-induced activity restriction, suggesting they may have similar physical ability to perform ADLs but not for more challenging IADLs.

To the authors' knowledge, this is the first study that provides clear evidence of the independent predictive role of activity restriction associated with FF with regard to the risk of disability. The pattern observed is particularly intriguing. Although cross-sectional analysis did not show differences between the three groups, over time even ADL disability could be predicted by severe activity restriction. Even moderate activity restriction was predictive of higher future ADL disability, although this trend did not reach statistical significance when adjusted for other factors. Similarly, moderate activity restriction that was not associated with higher IADL disability in the cross-sectional analysis was also a significant predictor of higher IADL disability over time, in addition to severe activity restriction. These results suggest possible cumulative effects of fear-induced activity restriction pattern in the long term. The findings also indicate the need for intervention to encourage older adults to continue to be physically active despite FF to counteract far-reaching effects of fear-induced activity restriction. In particular, the ability of moderate and severe activity restriction to independently predict IADL disability raises serious concerns about long-term effects. Because IADL disability is a marker of frailty in elderly people,²⁰ in this population, restriction of activities due to FF could be an important component in transition to frailty.

Fear-Induced Activity Restriction and Measured Physical Performance

The cross-sectional results of measured physical performance are consistent with those of previous studies,^{6,7} despite the differences in measurement techniques, although one of these studies⁷ targeted a limited sample of a selected group of only females who attended a fall prevention clinic. The current study extends their findings to the general population and provides supportive evidence that elderly people with severe fear-induced activity restriction may have associated poor physical function independent of age and sex.

The longitudinal analysis demonstrated that severe fear-induced activity restriction predicts SPPB performance independent of baseline performance and other confounding factors. These findings are highly relevant, because this is the first study that clearly provides the evidence that activity restriction that is exclusively associated with FF is an independent risk factor for decline in physical function over time. In addition, poor performance on the SPPB is an indicator of many negative outcomes in elderly people, such as nursing home admission and even mortality. Therefore, future studies should specifically target older persons who report activity restriction due to FF to evaluate whether fear-induced activity restriction is directly associated with such drastic negative outcomes.

Moderate activity restriction was not associated with SPPB performance cross-sectionally or longitudinally. These findings should be interpreted taking into consideration the activities that were restricted or avoided. Participants in this group restricted or avoided less than three activities, and 96% of them reported restricting or avoiding "walking on slippery surface without help" or "reaching over their head." Considering the specific SPPB measurement procedures (refer to Methods), it is possible that this behavioral pattern might not have influenced their ability to perform the SPPB in a clinical environment.

A possible limitation of the study is that participants only with severe cognitive impairment were excluded from the study, and the validity of SAFE for lesser cognitive impairment is not clearly established. Furthermore, in the analysis, the missing values were replaced with overall means. When the analysis was performed by excluding those with missing data, this resulted in +5% to – 19% change in beta weight and similar change in *P* values although, the main findings of the study were not changed substantially.

Several cross-sectional studies have identified negative health characteristics and risk factors associated with FF and fear-induced activity restriction in various populations.^{5,7,21–24} In geriatric preventive care, these risk factors may be addressed proactively to prevent the possible long-term negative effects of fear-induced activity restriction on physical capabilities and consequent threat to autonomy of elderly people. Previous research indicates that various interventions such as home-based exercises, community-based tai chi, and home-based multifactorial interventions alleviate FF,²⁵ although there is sparse information as to whether reduction in FF after an intervention is also associated with resumption of physical activities that were completely discontinued or performed less because of FF. Additional research is warranted to understand the effects of teaching fearful older individuals how to perform activities safely to counteract fear-induced activity restriction.

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Figure 1.
Frequency distribution of total activity restriction at baseline (N = 673).

Table 1

Distribution of Participants in the Three Activity-Restriction Groups at the Baseline and at 3-Year Follow-Up

Session	Baseline	Follow-Up
	n (%)	
Interview		
No activity restriction	172 (25.5)	145 (27.0)
Moderate activity restriction	401 (59.6)	315 (58.7)
Severe activity restriction	100 (14.9)	77 (14.3)
Total	673 (100.0)	537 (100.0)
Physical performance assessment		
No activity restriction	155 (26.5)	131 (27.6)
Moderate activity restriction	348 (59.6)	278 (58.6)
Severe activity restriction	81 (13.9)	65 (13.7)
Total	584 (100.0)	474 (100.0)

Table 2
Baseline Characteristics of the Overall Study Sample and the Three Activity-Restriction Groups

Variable	Overall	No Activity Restriction	Moderate Activity Restriction	Severe Activity Restriction	P-Value
Age, mean $\pm$ SD	75.8 $\pm$ 7.2	73.4 $\pm$ 6.5	75.7 $\pm$ 6.9	80.4 $\pm$ 7.6	<.001
Male, %	30.9	41.3	28.2	24.0	.002
Body mass index, kg/m ² , mean $\pm$ SD	27.16 $\pm$ 4.18	27.22 $\pm$ 3.99	27.75 $\pm$ 4.12	28.12 $\pm$ 4.76	.04
Number of activity of daily living difficulties, mean $\pm$ SD	0.2 $\pm$ 0.6	0.2 $\pm$ 0.7	0.1 $\pm$ 0.6	0.2 $\pm$ 0.7	.22
Number of instrumental activity of daily living difficulties, mean $\pm$ SD	0.9 $\pm$ 1.7	0.5 $\pm$ 1.6	0.7 $\pm$ 1.5	2.3 $\pm$ 2.1	<.001
Short Performance Physical Battery score, mean $\pm$ SD	9.5 $\pm$ 3.0	10.5 $\pm$ 2.6	9.7 $\pm$ 2.7	6.4 $\pm$ 3.4	<.001
Mini-Mental State Examination score, mean $\pm$ SD	24.6 $\pm$ 3.4	25.6 $\pm$ 3.3	24.7 $\pm$ 3.2	22.7 $\pm$ 3.5	.001
Comorbidity index, mean $\pm$ SD	2.3 $\pm$ 1.3	2.2 $\pm$ 1.3	2.3 $\pm$ 1.3	2.6 $\pm$ 1.3	.07
Smoking, pack-years, mean $\pm$ SD	10.5 $\pm$ 20.1	13.3 $\pm$ 22.1	10.3 $\pm$ 19.9	6.6 $\pm$ 15.8	.72*
Center for Epidemiologic Studies Depression Scale score, mean $\pm$ SD	14.6 $\pm$ 8.9	11.5 $\pm$ 7.4	14.6 $\pm$ 8.7	20.1 $\pm$ 9.6	<.001*
Walking speed, m/s, mean $\pm$ SD	1.05 $\pm$ 0.30	1.18 $\pm$ 0.27	1.06 $\pm$ 0.26	0.79 $\pm$ 0.30	<.001*
Inability to climb a flight of stairs without support, %	64.9	48.3	64.6	95.0	<.001
Difficulty walking 400 m, %	27.3	21.3	20.6	55.2	<.001

Note: The analysis for the trend was adjusted for age and sex.

* Age-significant covariate.

SD = standard deviation.

Table 3

Significance of Bivariate Correlation Between Fear-Induced Activity Restriction, Demographic Factors, and Covariates at Baseline and Activity of Daily Living (ADL) and Instrumental Activity of Daily Living (IADL) Disability and Short Performance Physical Battery (SPPB) Scores at 3-Year Follow-Up

Variable	ADL Disability	IADL Disability	SPPB Score
	<i>P-Value</i>		
Activity restriction	.001	<.001	<.001
Age	.008	<.001	<.001
Sex	.23	.14	.17
Body mass index	.23	.85	.38
Cognition	<.001	<.001	<.001
Depressive symptoms	.002	<.001	<.001
Comorbidity index	.08	.01	.006
Smoking	.20	.02	.30

Table 4

Multiple Linear Regression Models Relating Activity Restriction Groups at Baseline with Activity of Daily Living (ADL) Disability (n = 673), Instrumental Activity of Daily Living (IADL) Disability (n = 673) and Short Performance Physical Battery (SPPB) Performance (n = 584) After 3 Years

Dependent Variable and Activity Restriction Group	$\beta \pm \text{Standard Error}$	T	P-Value
ADL disability			
Model 1 [*]			
No restriction		Reference	
Moderate restriction	0.028 $\pm$ 0.016	1.789	.07
Severe restriction	0.097 $\pm$ 0.022	4.419	<.001
Model 2 [†]			
No restriction		Reference	
Moderate restriction	0.026 $\pm$ 0.016	1.656	.10
Severe restriction	0.092 $\pm$ 0.023	4.085	<.001
IADL disability			
Model 1 [*]			
No restriction		Reference	
Moderate restriction	0.054 $\pm$ 0.022	2.492	.01
Severe restriction	0.145 $\pm$ 0.032	4.582	<.001
Model 2 [†]			
No restriction		Reference	
Moderate restriction	0.047 $\pm$ 0.022	2.183	.03
Severe restriction	0.130 $\pm$ 0.032	4.067	<.001
SPPB score			
Model 1 [*]			
No restriction		Reference	
Moderate restriction	− 0.026 $\pm$.021	− 0.976	.329
Severe restriction	− 0.143 $\pm$.032	− 4.502	<.001
Model 2 [†]			
No restriction		Reference	
Moderate restriction	− 0.014 $\pm$ 0.021	− 0.661	.509
Severe restriction	− 0.129 $\pm$ 0.032	− 3.981	<.001

* Adjusted for age, sex, body mass index (BMI), and baseline performance on the respective dependent variable.

† Adjusted for age, sex, BMI, baseline performance on the respective dependent variable, comorbidity index, Mini-Mental State Examination score, Center for Epidemiologic Studies Depression Scale score, and smoking (pack-years), although smoking was dropped in model 2 for SPPB score.