

## Research Report

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# Concerns About Falling in Parkinson's Disease: Associations with Disabilities and Personal and Environmental Factors

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### Abstract.

**Background:** Fear of falling can be conceptualized in different ways, e.g., as concerns about falling or low fall-related self-efficacy. It is common in people with Parkinson's disease (PD), and there is growing knowledge about its contributing factors. However, previous multivariate studies have mainly focused on fear of falling in relation to PD-related disabilities, and less is known about the associations between fear of falling and personal and environmental factors.

**Objective:** To identify explanatory factors of concerns about falling in people with PD by focusing on personal and environmental factors as well as PD-related disabilities.

**Methods:** Data were collected from 241 persons with PD (39% women, median age 70 years, PD duration 8 years). Concerns about falling (assessed with the Falls Efficacy Scale-International, FES-I; categorized into low, moderate, or high concerns) were used as the dependent variable in a multivariate ordinal regression analysis. Personal factors, environmental factors and PD-related disabilities constituted independent variables.

**Results:** Low, moderate and high concerns about falling were reported by 29%, 24% and 47% of the participants, respectively. Walking difficulties, orthostatism, motor symptoms, age, and fatigue (presented in order of importance) were significant ( $p < 0.05$ ) explanatory factors of concerns about falling.

**Conclusions:** Several factors significantly explained concerns about falling in people with PD. Walking difficulties was by far the strongest explanatory factor. This suggests that minimizing walking difficulties should be a primary target when aiming at reducing concerns about falling in people with PD.

Keywords: Accidental falls, fear, multivariate analysis, Parkinson disease, regression analysis, self efficacy

## INTRODUCTION

Fear of falling (FOF) has been defined as “a lasting concern about falling that leads to an individual avoiding activities that he/she remains capable of performing” [1]. It is a widely used umbrella term for

concerns about falling [1, 2], decreased balance confidence [3], low fall-related self-efficacy [4] and activity avoidance due to the risk of falling [5]. These conceptualizations of FOF are closely related but not interchangeable [6–9]. The explicit focus of the present study is FOF conceptualized as concerns about falling.

FOF is common in people with Parkinson's disease (PD), with prevalence estimates ranging from 37 to 59% [6, 10–14]. Although more prevalent among those reporting previous falls, FOF is experienced also among those without a history of falls [14]. In studies

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that have targeted people with PD, FOF has been identified as a predictor of recurrent falls [15] and walking in the community [16], a barrier to physical exercise [17] and expressed as restricting participation in meaningful activities [18]. Furthermore, FOF has been shown to be negatively associated with quality of life [19] and a more important determinant of health-related quality of life than balance impairments and actual falling [13].

There is growing knowledge about contributing factors to FOF in PD, which is crucial in order to provide optimal treatment and care for people with FOF. Several PD studies have investigated associated factors to FOF by using multivariate regression analyses [10, 12, 19–21]. However, two of these studies were based on data collected by means of postal surveys and therefore lacked clinical data [12, 19] and three studies included few ( $n = 4–6$ ) potential independent variables [19–21], resulting in non-comprehensive analyses of contributors to FOF.

Prior multivariate PD studies on FOF have mainly focused on disabilities related to PD (such as difficulties in walking and activities of daily living) [10, 12, 19–21]. Less is known about the associations between FOF and personal and environmental factors, as defined by the International Classification of Functioning, Disability and Health (ICF) [22]. According to the ICF, personal factors are defined as “the particular background of an individual’s life and living” and include e.g., general self-efficacy. Environmental factors are defined as “the physical, social and attitudinal environment in which people live and conduct their lives” and include e.g., social support and mobility devices. In the general older population, studies have shown conflicting results regarding the influence of environmental factors [23–27]. That is, informal/social support has been shown to be associated with increased as well as decreased activity avoidance due to FOF [23, 24], living in a rural area has been identified as a risk factor for FOF [25], and a review article underlined that the use of walking devices has been persistently associated with higher FOF [26]. However, another article showed that none out of several environmental factors studied were significantly related to FOF [27]. To the best of our knowledge, no previous multivariate PD study investigated possession of a security alarm and type of housing as potential explanatory factors of FOF. A security alarm might contribute to a feeling of security and thus reduce concerns about falling, and type of housing (apartment/single-family) as an environmental factor could potentially contribute to concerns about falling. Even though general self-efficacy is a

personal factor that may potentially influence FOF and some of the commonly used FOF rating scales are based on Bandura’s theory of self-efficacy [3, 4], to the best of our knowledge no previous multivariate PD study included general self-efficacy as an independent variable.

As yet, no study has explicitly targeted concerns about falling when investigating contributing factors to FOF in people with PD. Accordingly, the aim of this study was to identify explanatory factors of concerns about falling in people with PD by focusing on both personal and environmental factors, as well as PD-related disabilities.

## MATERIALS AND METHODS

The present study was based on data collected within the project “Home and Health in People Ageing with PD”. The project design and methods have been described in detail elsewhere [28].

The project was conducted in accordance with the Helsinki Declaration and was approved by the Regional Ethical Review Board in Lund, Sweden (No. 2012/558). All participants gave their written informed consent.

### *Participants and recruitment*

Participants were recruited from three hospitals in the region of Skåne in southern Sweden; 653 individuals fulfilled the inclusion criterion of being diagnosed with PD (G20.9) since at least one year. A total of 158 individuals were not eligible due to the following exclusion criteria: difficulties in understanding/speaking Swedish and/or pronounced cognitive difficulties/other reasons that made the individual unable to give informed consent or take part in the majority of the data collection (e.g., hallucinations or a recent stroke). Based on an additional exclusion criterion used only for the part of the sample recruited from the largest hospital, another 58 individuals were excluded since they lived outside the region of Skåne. The remaining 437 individuals were invited to participate. Of these 157 declined to participate, 22 were unreachable, two had their PD diagnosis changed and one was excluded due to extensive missing data. This rendered a sample of 255 participants.

For the present study, participants were included if they had responded to all items of the Falls Efficacy Scale-International (FES-I; the dependent variable in the present study) within two months from the home visit (part of the data collection). The study sample

consisted of 241 individuals (39% women). The median (first-third quartile; min-max) age was 70 (64–77; 45–93) years and PD duration was 8 (5–13; 1–43) years. PD severity according to the Hoehn and Yahr staging ranged from I–V (stage I: 50 persons, II: 70 persons, III: 66 persons, IV: 54 persons, V: 1 person). See Table 1 for further descriptive data.

### Procedure

The data collection was accomplished by means of a self-administered postal survey and a subsequent home visit that contained both structured interviews and clinical assessments. The data collection was administered and performed by two project administrators

(experienced reg. occupational therapists) that underwent project-specific training. Further details regarding the procedure have been described in the study protocol [28].

### Instruments

Details regarding self-administered questionnaires, interview questions and clinical assessments are presented as footnotes in Table 1 and in the study protocol [28].

### Concerns about falling

Concerns about falling were assessed with the self-administered questionnaire FES-I, which constituted

Table 1  
Participants' characteristics and distribution of dependent and independent variables,  $n = 241$

Descriptive data	Median (first-third quartile) unless otherwise stated	Missing, $n$
PD duration (years)	8 (5–13)	
PD severity (Hoehn & Yahr) <sup>a</sup>	3 (2–3)	
Fear of falling (yes), $n$ (%)	112 (46%)	
<i>Dependent variable</i>		
Concerns about falling (Falls Efficacy Scale-International) <sup>b</sup>	26 (19–39)	
<i>Independent variables: personal factors</i>		
Age (years)	70 (64–77)	
Gender (women), $n$ (%)	93 (39%)	
General self-efficacy (General Self-Efficacy Scale) <sup>c</sup>	29 (24–34)	7
<i>Independent variables: environmental factors</i>		
Use of any mobility device outdoors (yes), $n$ (%)	123 (51%)	
Social support (from partner / other than partner / none), $n$ (%) <sup>1</sup>	152 (63%) / 86 (36%) / 2 (1%)	1
Living alone (yes), $n$ (%)	61 (25%)	
Security alarm connected to social services (yes), $n$ (%)	50 (21%)	
Housing type (apartment / single-family), $n$ (%)	104 (43%) / 137 (57%)	
Residential area (rural / urban / metropolitan), $n$ (%)	79 (33%) / 65 (27%) / 97 (40%)	
<i>Independent variables: PD-related disabilities</i>		
Motor symptoms (UPDRS III) <sup>d</sup>	30 (22–39)	3
Walking difficulties (Generic Walk-12) <sup>e</sup>	14 (7–24)	4
Turning hesitations (FOGQsa item 6, dichotomized, yes), $n$ (%) <sup>2</sup>	116 (48%)	
Balance problems while dual tasking (yes), $n$ (%)	152 (63%)	
Falls and/or near falls past 6 months (yes), $n$ (%)	155 (65%)	1
Lower extremity function (Chair-Stand Test, sec) <sup>3</sup>	16 (13–20)	29
Need help from others in daily activities (PADLS, dichotomized, yes), $n$ (%) <sup>4</sup>	60 (25%)	
Fluctuations with increasing PD symptoms (yes), $n$ (%)	153 (64%)	2
Cognitive function (Montreal Cognitive Assessment) <sup>f</sup>	26 (22–28)	5
Depression (Geriatric Depression Scale) <sup>g</sup>	2 (1–4)	5
Fatigue (NHP-EN, dichotomized, yes), $n$ (%) <sup>5</sup>	136 (56%)	
Anxiety (NMSQuest item 17, yes), $n$ (%)	65 (27%)	2
Orthostatism (NMSQuest item 20, yes), $n$ (%)	129 (54%)	

PD = Parkinson's disease; UPDRS III = Unified Parkinson's Disease Rating Scale, motor examination; PADLS = Parkinson's Disease Activities of Daily Living Scale; NHP-EN = Energy subscale of the Nottingham Health Profile; FOGQsa = self-administered version of the Freezing of Gait Questionnaire; NMSQuest = Nonmotor Symptoms Questionnaire. Possible scoring range, scoring direction: <sup>a</sup>1–5, higher = worse; <sup>b</sup>16–64, higher = worse; <sup>c</sup>10–40, higher = better; <sup>d</sup>0–108, higher = worse; <sup>e</sup>0–42, higher = worse; <sup>f</sup>0–30, higher = better; <sup>g</sup>0–15, higher = worse. <sup>1</sup>Not included in the multivariate regression model due to skewed data and signs of multicollinearity with the variable 'living alone'. <sup>2</sup>Those who scored  $\geq 1$  were classified as having turning hesitations. <sup>3</sup>In the regression model categorized into: unable to perform ( $n = 29$ ) / slow performer / fast performer, based on median. <sup>4</sup>Those who scored  $\geq 3$  were classified as needing help from others. <sup>5</sup>Those who affirmed at least one out of three dichotomous questions were classified as having fatigue.

the dependent variable in this study. In FES-I, the respondents answer how concerned they are about the possibility of falling in relation to 16 different activities. The response options are: not at all, somewhat, fairly, or very concerned (scored 1–4, respectively). The total score ranges from 16 to 64 (higher = worse) [2]. In the present study, FES-I total scores were categorized into three groups: low (16–19 points), moderate (20–27), and high concerns about falling (28–64), according to previous work by Delbaere et al. [29].

#### *Personal and environmental factors*

Data on personal factors were collected in terms of age, gender and general self-efficacy. The latter was assessed with the self-administered General Self-Efficacy Scale (GSE) [30].

Data on environmental factors included several aspects. Structured questions targeted use of mobility devices outdoors and social support. Dichotomous questions targeted the living situation (living alone/not alone) and possession of a security alarm connected to social services (yes/no). Type of housing was categorized into apartments (included owned and rented apartments as well as apartments in special housing) or single-family housings. Residential area was categorized into rural, urban or metropolitan based on postal code.

#### *PD-related disabilities*

Data on PD-related disabilities were collected through self-reports and clinical assessments. Dichotomous (yes/no) questions targeted falls and/or near falls during the past six months, perceived balance problems while dual tasking, and fluctuations with increasing PD symptoms.

Several self-administered questionnaires were included. The Generic Walk-12 (Walk-12G) [31] targets walking difficulties in everyday life. The Parkinson's Disease Activities of Daily Living Scale (PADLS) [32] targets difficulties in activities of daily living: those who scored  $\geq 3$  were classified as needing help from others in daily activities [6]. The Energy subscale of the Nottingham Health Profile (NHP-EN) [33] targets fatigue: those who affirmed at least one of its three dichotomous questions were classified as having fatigue [34].

Individual items from two self-administered rating scales were included. Item 6 (i.e., turning hesitations) of the self-administered version of the Freezing of Gait Questionnaire (FOGQsa) [35] was dichotomized: those who scored  $\geq 1$  were classified as having turning

hesitations [12]. Two dichotomous items on anxiety and orthostatism (no. 17 and 20) of the Nonmotor Symptoms Questionnaire (NMSQuest) [36] were also included. In addition, the Geriatric Depression Scale (GDS-15) [37] was administered as an interview.

Clinical assessments included part three (severity of motor symptoms) of the Unified Parkinson's Disease Rating Scale (UPDRS III) [38], the Montreal Cognitive Assessment (MoCA) [39], and the timed Chair-Stand Test [40, 41] that targets lower-extremity function.

#### *Descriptive data*

Descriptive data included PD duration, PD severity according to the Hoehn and Yahr staging ("on-state") [42] and a question on FOF (are you afraid of falling; yes/no).

#### *Statistical analyses*

The Spearman's correlation coefficient ( $r_s$ ) was used to study relationships among independent variables (i.e., personal factors, environmental factors and PD-related disabilities) in order to detect any multicollinearity. Due to a skewed distribution of data in the variable 'Social support' (only two persons did not receive any social support) and signs of multicollinearity between the variables 'Social support' and 'Living alone' ( $r_s > 0.7$ ), 'Social support' was omitted from further analyses.

Associations between the dependent variable (categorized FES-I) and the remaining independent variables were then analysed in a series of univariate ordinal regression models (data not shown). In order to avoid leaving out a confounding variable, we decided to include all variables with a  $p$ -value below 0.3. All associations fulfilled this criterion and the variables were thus entered into a multivariate ordinal regression model (cumulative odds model, link function: logit) with the categorized FES-I as the dependent variable.

Ordinal regression analysis is suitable when the dependent variable is of ordinal nature. It estimates the average odds ratios of all possible dichotomizations of the response variable, which are assumed to be equal [43]. That is, the odds ratio for having low or moderate compared to high concerns about falling were assumed to be equal to the odds ratio of having low compared to moderate or high concerns. This assumption can be checked by using the test of parallel lines, where a non-significant  $\chi^2$  is desirable and indicates that the model is well fitted [43].

A total of 21 dichotomous, categorical or continuous/ordinal independent variables were included in

first step of the modelling. Dichotomous variables were: gender, use of mobility devices outdoors, living alone, security alarm, type of housing, falls and/or near falls, balance problems while dual tasking, fluctuations, needing help in daily activities, fatigue, turning hesitations, anxiety, and orthostatism. Categorical variables were: residential area (rural/urban/metropolitan) and lower-extremity function (Chair-Stand Test categorized into: unable to perform/slow performer/fast performer, based on median). Continuous/ordinal variables were: age, general self-efficacy (GSE), walking difficulties (Walk-12G), depressive symptoms (GDS-15), severity of motor symptoms (UPDRS III) and cognitive function (MoCA). The estimates and *p*-values for all independent variables in the multivariate model were inspected, and the variable with the highest *p*-value was manually removed from the model. This step continued until all independent variables in the model had *p*-values <0.1. Odds ratios with 95% confidence intervals for the independent variables that remained in the final model are reported. Nagelkerke's pseudo  $R^2$  for the final model is presented as a measure of the models' explanatory capacity [44]. The test of parallel lines revealed a highly insignificant  $\chi^2$  ( $p=0.811$ ) which indicated that the model was well fitted [43].

The level of statistical significance was set to  $p<0.05$ . All statistical analyses were carried out in IBM SPSS Statistics, version 22.0.

## RESULTS

The distribution of the dependent variable (FES-I) was: 69 persons (29%) reported low concerns, 58 persons (24%) reported moderate concerns, and 114 persons (47%) reported high concerns about falling. The median FES-I total score was 26 points (first-third quartile 19–39; min-max 16–64).

The multivariate ordinal regression model revealed six independent variables with  $p<0.1$  that were associated with concerns about falling: walking difficulties in everyday life, orthostatism, motor symptoms, age, fatigue and depressive symptoms (presented in order of importance). All but depressive symptoms were significant explanatory factors of concerns about falling (see Table 2). Nagelkerke's pseudo  $R^2$  for the model was 0.734, which implies that the model's explanatory capacity was 73.4%.

Walking difficulties in daily life was the strongest individual explanatory factor (indicated by the high Wald). The obtained odds ratio of 1.27 means that

Table 2

Multivariate ordinal regression with concerns about falling (Falls Efficacy Scale-International) as the dependent variable,  $n=229$

Independent variable	OR (95% CI)	Wald	<i>p</i> -value
Walking difficulties (Generic Walk-12)	1.27 (1.19–1.35)	60.33	<0.001
Orthostatism (NMSQuest item 20, no = reference category)	2.57 (1.30–5.07)	7.40	0.007
Motor symptoms (UPDRS III)	1.04 (1.00–1.07)	6.27	0.012
Age (years)	1.05 (1.01–1.10)	6.21	0.013
Fatigue (dichotomized NHP-EN, no = reference category)	2.13 (1.02–4.41)	4.14	0.042
Depression (Geriatric Depression Scale)	1.18 (0.99–1.40)	3.68	0.055

OR = odds ratio; CI = confidence interval; NMSQuest = Nonmotor Symptoms Questionnaire; UPDRS III = Unified Parkinson's Disease Rating Scale, motor examination; NHP-EN = Energy subscale of the Nottingham Health Profile. Higher total score = worse for all independent variables that are not dichotomous. Test of parallel lines:  $\chi^2$   $p=0.811$ . Nagelkerke's pseudo  $R^2=0.734$ .

a one point higher Walk-12G total score (i.e., more walking difficulties) increases the odds of belonging to a higher concern category with 27%. If the Walk-12G would instead increase by three points, it would approximately double the odds of belonging to a higher concern category (odds ratio  $1.27^3=2.05$ ).

## DISCUSSION

To the best of our knowledge, this is the first study that targets explanatory factors in relation to concerns about falling in people with PD. The multivariate model was well fitted with a high explanatory capacity. Walking difficulties was by far the strongest explanatory factor, followed by orthostatism, motor symptoms, age and fatigue. It should be noted that none of the studied environmental factors and only age among the personal factors significantly explained concerns about falling. Our results suggest that minimizing walking difficulties should be a primary target when aiming at reducing concerns about falling in people with PD.

The importance of walking difficulties corroborates previous studies that targeted contributing factors to fall-related self-efficacy in people with PD [10, 12]; walking difficulties alone explained then 60–68% of the variation in scores. Another PD study that targeted balance confidence [21] also identified walking difficulties to be of importance. In our study, as well as in two of the previous studies [10, 12], walking difficulties were assessed with the self-rating scale Walk-12G that targets walking difficulties in daily life [31]. It consists of twelve questions that encompass a variety of walking aspects such as balancing while walking,

stair climbing, smoothness of walking and walking distance. One previous study [10] included both the Walk-12G and gait speed as independent variables. However, while the Walk-12G was an independent explanatory factor of FOF, gait speed was not. Taken together, our results and those from previous studies [10, 12, 21] suggest that intervention studies aiming at reducing FOF in people with PD might benefit from focusing on various gait aspects rather than focusing on speed or walking distance alone.

Orthostatism is a common [45] and known risk factor for falls in people with PD [46]. Since it was the second most important explanatory factor in the present study, it might be an important aspect to consider also in relation to concerns about falling. Regular controls of blood pressure to evaluate and treat orthostatic hypotension could be recommended for people with PD who are concerned about falling. The significance of orthostatism is a novel finding; no prior PD study included orthostatism as an independent variable in multivariate analysis targeting FOF [10, 12, 19–21]. However, a previous study that used univariate analyses showed no difference in the proportion of PD patients who experienced FOF among those with and without orthostatic hypotension [47]. This discrepancy between studies might be explained by methodological differences. In the present study, orthostatism was self-rated in relation to the past month, whereas *Matinolli et al.* used an automated sphygmomanometer during three minutes on a single occasion and defined orthostatism as at least a 20 mm Hg fall in systolic or 10 mm Hg fall in diastolic blood pressure, with or without symptoms [47]. One could hypothesize that self-ratings of orthostatism capture persons who experience episodes of orthostatism that would not have been captured by the method used by *Matinolli et al.* If a person experiences symptoms of orthostatism, it is reasonable to assume that this could result in concerns about falling. If having a defined orthostatism but without experiencing any discomfort, the association with concerns about falling would possibly be weaker. Further studies are needed to clarify the relationship between FOF and orthostatism.

Severity of motor symptoms and age also significantly explained concerns about falling, but previous PD studies targeting various aspects of FOF showed inconsistencies regarding the impact of these factors [10, 12, 20, 21]. One study that found a non-significant association between motor symptoms and FOF (conceptualized as low fall-related self-efficacy) was based on a sample with relatively mild PD [10] in comparison to the present sample. Their mean PD duration

was 5 years compared to 8 years (median) in the present study, and their median UPDRS III score was 13 compared to 30 points. We did not find any patterns explaining the inconclusive results regarding age when comparing the age in our study (median 70 years) with previous studies (mean 64–70 years) [10, 12, 21]. The discrepancies may originate from using different FOF measures as the dependent variable. That is, age might explain balance confidence [21] and concerns about falling, but not fall-related self-efficacy [10, 12].

The finding that fatigue significantly explained concerns about falling is in line with previous PD studies that targeted fall-related self-efficacy [10, 12]. Impaired walking economy may cause fatigue in people with PD [48], which might potentially explain the association between fatigue and FOF since walking and FOF are closely related.

Previous PD studies have expressed a need to explore FOF in relation to environmental factors [10, 12]. In the present study, none of the environmental factors studied significantly explained concerns about falling in people with PD. Although no prior PD study addressing FOF included mobility devices as an independent variable, mobility devices have been shown to be persistently associated with higher FOF in the general older population [26]. It needs to be acknowledged that there could be other environmental factors of importance for concerns about falling in people with PD, such as physical environmental barriers, which are not addressed in the present study. Walking on slippery surfaces was in fact ranked as the most difficult FES-I item in a previous PD study [6], and difficulties climbing stairs have been shown to be of importance for fall-related self-efficacy [12]. Accordingly, further research on the possible impact of physical environmental factors on FOF in people with PD by using more detailed data on housing and close exterior surroundings is motivated, but due to the methodological complexity of such issues specific studies are required. As to personal factors, our non-significant results on gender corroborates previous PD studies [10, 12], which is in contrast to FOF studies targeting the general older population [26]. Taken together, it seems like PD imposes specific challenges that impact on FOF.

A surprising finding was that general self-efficacy did not significantly explain concerns about falling. The FES-I (i.e., our dependent variable) was developed by combining and modifying three other FOF scales [2], of which two are based on Bandura's theory of self-efficacy [3, 4]. Although FES-I scores have been shown to correlate ( $r > 0.80$ ) with self-efficacy based

FOF measures [6], the findings in the present study suggest that concerns about falling are not strongly connected to general self-efficacy in people with PD.

We used the FES-I as the dependent variable as we were interested in FOF conceptualized as concerns about falling. Previous multivariate PD studies that have investigated associated factors to FOF have focused on FOF conceptualized as fall-related self-efficacy [10, 12, 19, 20] or balance confidence [21]. Furthermore, a recent head-to-head comparison of four commonly used FOF rating scales showed that the FES-I and the modified Survey of Activities and Fear of Falling in the Elderly were the most favourable in terms of psychometric properties in people with PD [6].

An alternative to the ordinal regression analysis applied in the present study would be to use FES-I total scores as the dependent variable in a linear regression analysis. This was our initial strategy, but the FES-I showed a floor effect (14% of the participants scored lowest, i.e., best possible score) and the residuals of the model were heteroscedastic (data available on request). These problems could not be solved by applying common transformations. Thus, FES-I total scores were categorized into low, moderate and high concerns about falling [29] and a well fitted multivariate ordinal regression model was computed.

#### *Strengths and limitations*

To the best of our knowledge, the present study is so far the largest multivariate study targeting factors associated with FOF in people with PD. The number of independent variables included in the first step of modelling ( $n=21$ ) was slightly above the recommended number of variables for our sample size [49]. However, the independent variables that were excluded first had very high  $p$ -values and it was thus evident that they should not be part of the final model.

Although the present study considered a broad variety of aspects associated with concerns about falling in people with PD, we do acknowledge that there may still be other influential factors that deserve consideration, such as level of physical activity and physical environmental barriers. Another limitation is that we, due to the cross-sectional design, were only able to identify factors associated with concerns about falling and not predictive factors. Moreover, people were excluded from the study if they were unable to give informed consent or take part in the majority of the data collection, e.g., due to pronounced cognitive difficulties and/or hallucinations. While we did not find any significant association between cognitive func-

tion and concerns about falling in our study, previous PD studies have shown conflicting results regarding the association between fall-related self-efficacy and cognitive decline [10, 20]. Further studies are needed to more specifically address various types of cognitive impairment in relation to FOF in people with PD.

#### *Clinical implications and future perspectives*

Our results suggest that multiple factors could be targeted in order to reduce concerns about falling in people with PD: walking difficulties, orthostatism, motor symptoms and fatigue. However, walking difficulties was by far the strongest explanatory factor, suggesting that minimizing walking difficulties should be a primary target for interventions. It should be kept in mind that since age impacts on concerns about falling, rehabilitation efforts aiming to reduce concerns about falling might be even more essential as a person ages.

Longitudinal studies are needed to shed light on the cause and effect of FOF and its associated factors [10, 21]. In addition, little is known about fall-related activity avoidance [19], emphasizing the need for future studies that explicitly address such dynamics. To the best of our knowledge, no qualitative study has focused on FOF in people with PD. Thus, knowledge is lacking regarding how people with PD perceive FOF, highlighting the need for qualitative studies [12]. Furthermore, intervention studies in people with PD with FOF as the primary outcome are highly needed [12, 21]. A recent intervention study that targeted balance confidence by providing balance and gait training during twelve weeks showed a statistically significant improvement in balance confidence at three and twelve months follow-ups [50]. Further randomized controlled studies are needed, preferably targeting both motor and non-motor symptoms, such as walking difficulties, orthostatism and fatigue.

## **CONCLUSIONS**

While several factors explain concerns about falling in people with PD, walking difficulties in daily life is the strongest individual explanatory factor and orthostatism the second strongest. General self-efficacy and the studied environmental factors do not significantly explain concerns about falling. The present study suggests that minimizing walking difficulties should be a primary target when aiming at reducing concerns about falling in people with PD.

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## CONFLICT OF INTEREST

The authors have no conflict of interest to report.

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