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Fear of falling in people with chronic obstructive pulmonary disease

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Summary
Background: Increased fear of falling (FOF) has been associated with impaired physical function, reduced physical activity and increased fall risk in older adults. Preliminary evidence suggests that individuals with chronic obstructive pulmonary disease (COPD) may have an increased FOF. This study aims to compare the level of FOF in people with COPD with healthy controls, and to determine the associations between FOF and measures of physical function, physical activity and fall risk in COPD.
Methods: FOF was assessed in 40 participants with COPD and 25 age- and gender-matched controls using the Falls Efficacy Scale—International (FES-I). Physical function was evaluated using quadriceps hand-held dynamometry, the Berg Balance Scale and the Six-minute Walk Test. Associations between FOF, physical activity and fall risk were evaluated using the Physical Activity Scale for the Elderly and the Falls Risk in Older People — Community Setting. Pearson's correlation coefficient and stepwise multivariate linear regression were used.
Results: Individuals with COPD (mean ± SD; age: 71 ± 8 years, FEV_1: 45 ± 16 %pred) had higher FOF compared to controls (FES-I: 25.0 ± 7.9 vs 20.2 ± 5.2, $p = 0.01$). Higher FOF was associated with lower quadriceps strength ($p = 0.02$) and an impaired balance ($p < 0.01$); these explained 26% of the FOF variance. Reduced levels of physical activity ($p = 0.01$) and a higher fall risk ($p < 0.01$) were associated with an increased FOF in COPD.

Abbreviations: BBS, Berg Balance Scale; FES-I, Falls-Efficacy Scale — International; FOF, fear of falling; FROP-Com, Fall Risk for Older People — Community setting; HHD, hand-held dynamometry; ICC, Intraclass Correlation Coefficient; MDD, Minimal detectable difference; PASE, Physical Activity Scale for the Elderly; 6MWT, six-minute walk test.

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Conclusion: People with COPD have a higher FOF compared to the healthy peers, which is related to lower quadriceps muscle strength, impaired balance, lower levels of physical activity and an increased fall risk.

Introduction

Falls in the elderly are a major health problem. One third of adults aged over 65 years and living in the community experience a fall annually [1], which can have significant physical consequences including injuries, hospitalization and increased mortality [2,3]. Falls may also have important psychological consequences leading to an increased fear of falling (FOF) in older adults [4]. While this fear is more prevalent among people with advanced age and a prior fall history, it also present in those who have not experienced prior falls [5]. Preliminary evidence suggests an increased FOF among people with chronic obstructive pulmonary disease (COPD) compared to those in the general elderly population [6,7].

Increased FOF in the elderly has been associated with impaired physical function, social isolation and decreased quality of life [8-11]. Lower muscle strength [12], impaired balance [13] and reduced exercise capacity [14] are physical function factors known to be associated with increased FOF in older adults, however, the relationship between FOF and these factors have not been studied in people with COPD. An increased FOF could also adversely influence the level of physical activity performed [15,16]. Importantly, a higher FOF is also a well-recognized predictor of future falls in older adults [4,17]. Although the importance of FOF assessment has been increasingly recognized in COPD [18], the relationship between FOF and its potential influence on activity levels and fall risk in this population are yet to be determined.

The primary aim of this study was to identify the proportion of people with COPD with a high FOF and the level of this fear compared to age- and gender-matched healthy controls. The secondary aim was to determine the relationship between FOF and physical functional measures including muscle strength, balance and exercise capacity and the associations between FOF, physical activity and fall risk in COPD.

Materials and methods

Study design

This is a controlled cross-sectional study. Assessments of all participants were completed in a single session in a hospital outpatient setting and university facilities. The protocol was approved by the Human Research Ethics Committee of the Royal Melbourne Hospital and The University of Melbourne with informed consent obtained from all participants. This study is reported following the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) recommendations [19].

Study population

A consecutive sample of 40 people with COPD who attended the respiratory outpatient clinic at the Royal Melbourne Hospital, Melbourne, Australia, was included in the study. Inclusion criteria were: diagnosis of COPD according to international criteria [20]; community-dwelling and clinically stable in the 30 days prior to assessments [20]. Exclusion criteria were 'severely frail' to 'terminally ill individuals' [21], diagnosis of neurological or musculoskeletal conditions known to affect balance, untreated visual abnormality, impaired peripheral sensation or inability to understand spoken English. Similar exclusion criteria were used for recruitment of a convenience sample of community-dwelling healthy controls. Twenty-five healthy age- and gender-matched community-dwelling people with normal lung function (forced expiratory volume in one second (FEV_1) $\geq$ 80% predicted and FEV_1/forced vital capacity (FVC) $\geq$ 0.7) and smoking history of $<$10 pack-years were included. All participants were recruited and assessed during February 2011 to August 2012.

Measurements

Fear of falling

The Falls Efficacy Scale—International (FES-I) was used to assess FOF [22]. The FES-I is a 16-item self-reported questionnaire that evaluates concern about falling in a range of daily life and social activities, including going up and down stairs, cleaning the house and community walking with crowds. The level of concern is scored using a 4-point scale (1 = not at all, 2 = somewhat, 3 = fairly, 4 = very concerned). The 16-item FES-I is a reliable measure of FOF (Intraclass Correlation Coefficient (ICC) $>$ 0.90) and has demonstrated validity [23] and internal consistency (Cronbach's alpha $>$0.90) in clinical populations with balance disturbances [24,25]. The FES-I is the recommended FOF assessment tool in community-dwelling older adults [26], and its cut-off of 23 points discriminates between low and high fall concern [23]. A change of 3.5 points has been estimated as the minimal detectable difference based on published data (MDD 95% CI) [23,27].

Physical function

Physical function measures included quadriceps muscle strength, balance, and functional exercise capacity. A hand held dynamometry (HHD) (Nicholas, model 01163, Lafayette Instruments, IN, USA) was used to assess quadriceps muscle strength on the dominant leg following a

standardized measurement protocol in older adults [28]. The HHD is a suitable measure in clinical settings and has demonstrated good reliability in people with COPD [29]. The Berg Balance Scale (BBS) was used as a clinical balance assessment [30]. The BBS is a summative ordinal scale evaluating postural changes during 14 tasks including standing unsupported, sitting to stand and transfers. Each item is scored from 0 to 4, where a score of 4 implies the best performance. The BBS is a valid and reliable measure of balance in community-dwelling older adults [31] and has demonstrated relationships with COPD-specific outcome measures [18] In addition, exercise capacity was measured using the 6-min walking test (6MWT) following international recommendations [32]. The 6MWT normative data from a comparable population were derived from Australian prediction equations [33].

Physical activity and fall risk

The Physical Activity Scale for the Elderly (PASE) assessed the self-reported level of physical activity [34]. The PASE questionnaire estimates physical activity based on a broad range of tasks including leisure-time, household and occupational physical activity performed in the previous week. The total score ranges from 0 to 400. The PASE has demonstrated test-retest reliability [35], convergent validity with data obtained from objective physical activity measures [36] and is able predict severe physical inactivity in people with COPD [35]. Higher scores indicate higher levels of physical activity.

Self-reported multifactorial fall risk assessment was performed using the Falls Risk for Older People in the Community (FROP-Com) questionnaire [37]. The FROP-Com rates the importance of fall risk factors in a 0 to 3 scale and scores fall risk from 0 to 60, with higher scores representing higher fall risk. The FROP-Com has demonstrated intra- (ICC = 0.93), inter-rater reliability (ICC = 0.81) and predictive validity for falls in community-dwelling older adults [37].

Statistical analysis

All statistical analyses were performed using PASW Statistics, version 21.0 (SPSS Inc., Chicago, IL, USA). A sample size of 25 subjects in each group was required to provide a power of 0.80 (alpha = 0.05) in detecting an MDD of 3.5 points on the FES-I between people with COPD and the healthy older adults. Independent t-tests and Chi Square were used to determine between group differences. Pearson's correlation coefficient determined associations between FOF, physical function measures, physical activity, and fall risk in people with COPD. A stepwise multivariate linear regression analysed the influence of physical function measures (muscle strength, balance and exercise capacity) on FES-I score variance. The complete-cases analysis was used for missing data. A two-sided level of significance was considered when alpha (p) $\leq$ 0.05.

Results

Characteristics of the COPD and control groups are reported in Table 1. The healthy older adults were anthropometrically well matched with the COPD peers. People with COPD showed moderate-to-severe airflow limitation according to Global Initiative for Chronic Obstructive Lung Disease (GOLD) classification [20].

Table 1 Demographics of COPD and healthy controls.

	Stable COPD (n = 40)	Healthy controls (n = 25)	p value
Age	71 ± 8	69 ± 8	NS
Female, n	21 (52%)	13 (52%)	NS
BMI (kgm^2)	25.0 ± 4.8	24.6 ± 3.4	NS
FEV_1 (%pred)	45.1 ± 16.2	102.1 ± 12.8	<0.001
FVC (%pred)	97.6 ± 19.3	108.1 ± 13.7	0.01
FEV_1/FVC	37.9 ± 9.7	98.6 ± 11.0	<0.001
Pack-years	49 ± 25	–	–
Use of oxygen, n	18 (45%)	–	–
MRC	3 (2–4)	–	–

Data presented as n (%), mean ± SD or median (IQR). NS: not significant. BMI: body mass index; FEV_1: forced expiratory volume in 1 s; FVC: forced vital capacity; MRC: Medical -Research Council dyspnoea scale; -: not applicable.

The proportion of people with a high FOF (FES-I score >23) was 58% among people with COPD compared to only 16% in the healthy group (p = 0.001). Table 2 shows the results of FES-I scores, physical function measures, physical activity and fall risk for both groups. Compared to healthy older adults, people with COPD reported higher FOF with a mean difference of 4.8 (95%CI: 1.5–8.0) FES-I score. In addition, people with COPD presented with lower quadriceps muscle strength, impaired balance performance on the BBS and a 53% reduced exercise capacity on the 6MWT compared to normative values [33] (p $\leq$ 0.001). Reduced

Table 2 Fear of falling, physical function, physical activity and fall risk in people with COPD and healthy controls.

	Stable COPD (n = 40)	Healthy controls (n = 25)	p value
Fear of falling			
FES-I	25.0 ± 7.9	20.2 ± 5.2	0.004
Physical function			
Quadriceps strength, kg	20.1 ± 6.0	25.4 ± 5.2	0.001
BBS	51.6 ± 4.2	55.2 ± 1.4	<0.001
6MWT, m†	327 ± 112	612 ± 46†	<0.001
Physical activity			
PASE	99.5 ± 69.7	160.7 ± 64.3	0.001
Fall risk			
FROP-Com	12.2 ± 5.2	6.1 ± 3.4	<0.001
Falls in previous year, n	13 (33%)	7 (28%)	0.78

Data presented as mean ± SD and n (%). †data derived from predictive normative values. FES-I: Falls efficacy scale – international; BBS: Berg balance scale; 6MWD: six-minute walk distance; PASE: Physical Activity Scale in the Elderly; FROP-Com: Falls Risk for Older People – Community setting; -: not applicable.

levels of self-reported physical activity and higher fall risk were also found in those with COPD compared to the healthy older adults ($p \leq 0.001$).

In people with COPD, increased FOF was associated with lower quadriceps strength and impaired balance (Fig. 1); a trend towards an association with reduced exercise capacity was also observed ($r = -0.31$, $p = 0.06$). Using age as a covariate, balance and muscle strength explained 26% of FES-I variance ($p = 0.001$), however, only balance performance was independently associated with FOF ($r = -0.51$; $p = 0.001$). Higher FOF was also associated with lower levels of physical activity and an increased fall risk (Fig. 2).

Discussion

This is the first study to demonstrate an increased proportion of people with a higher FOF in people with COPD compared to age- and gender-matched healthy older adults. The main findings of this study are: people with COPD have an increased FOF compared to healthy peers; this increased FOF was associated with an impaired physical function as measured by reduced muscle strength and impaired postural balance performance; and an increased FOF was associated with decreased physical activity and higher fall risk, as evidenced by a higher score on the FROP-Com questionnaire. These findings suggest that assessment of FOF should be considered in people with COPD.

In this study, the average score on the FES-I in people with COPD was 4.8 points higher compared with the control group. This finding is difficult to interpret in the absence of published score for this measure established as a minimal clinically important difference. However, the difference in FOF observed between the two groups is greater than the FES-I MDD derived from a previous study in older adults of 3.5 points [23]. The MDD is the amount of change in a

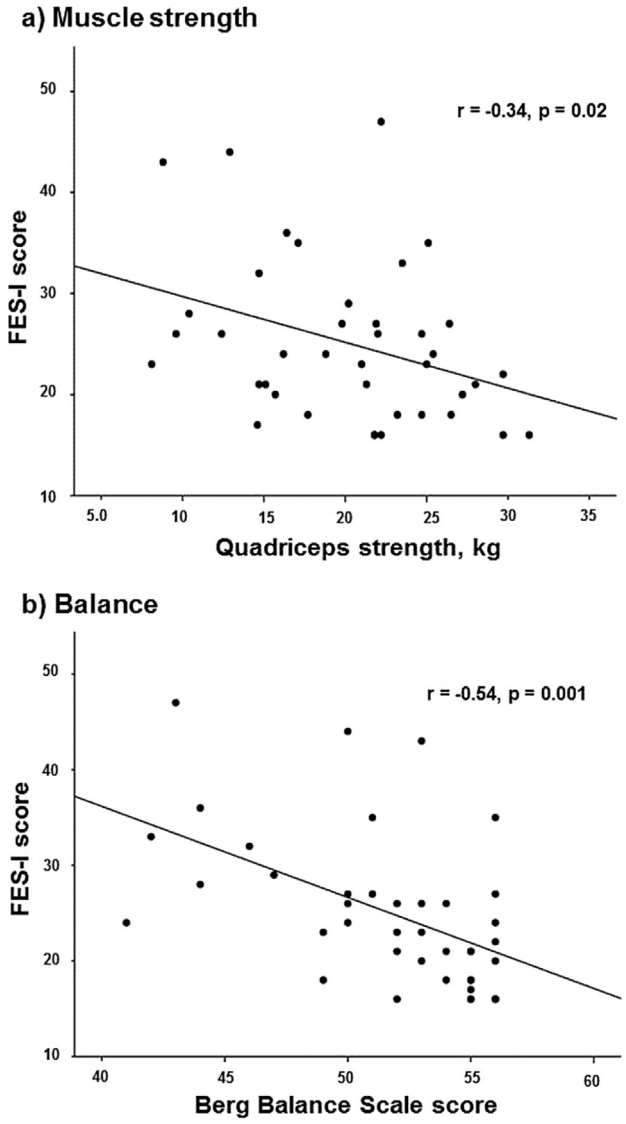

Figure 1 Association between FES-I score and a. quadriceps muscle strength and b. BBS score in people with COPD. FES-I: Falls Efficacy Scale — International.

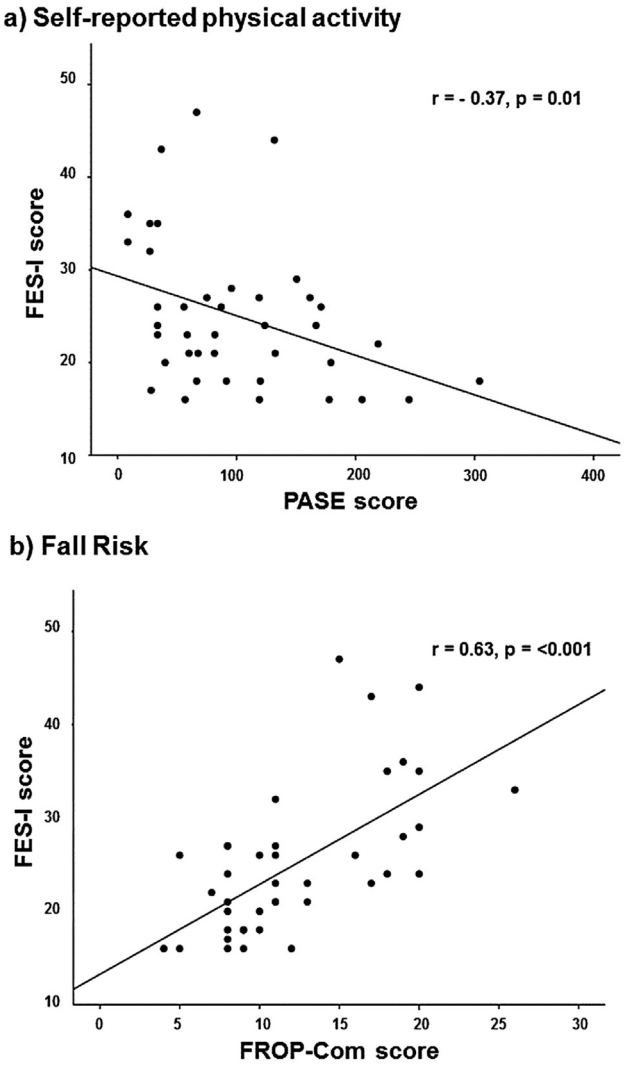

Figure 2 Association between FES-I score and a) PASE score and b) FROP-Com score in people with COPD. FES-I: Falls Efficacy Scale — International; PASE: Physical Activity Scale for the Elderly; FROP-Com: Falls Risk for Older People — Community setting.

variable that must be achieved to reflect a true difference not influenced by random error [27]. Importantly, the FOF scores found in COPD were comparable to those previously reported by older adults fallers [38]. The proportion of fallers in the prior year did not differ from healthy older adults in the present study. The fact that an increased FOF may be present among those without a prior history of fall [5] may explain the higher FOF found among those with COPD without a concurrent increase in falls frequency measured retrospectively. Conversely, a previous cross-sectional study higher FOF was found in COPD prior fallers compared to non-fallers [39]. These conflicting findings indicate that future prospective studies are required to investigate the influence of an increased FOF in anticipating falls in people with COPD.

This study also sought to investigate the associations between FOF and physical function outcomes. Impaired physical function was demonstrated in people with COPD compared to healthy older adults and increased FOF was particularly related to lower quadriceps muscle strength and impaired balance. Similar associations have also been demonstrated among older adults [40]. The identification of potentially modifiable physical function measures associated with higher fear in COPD is important and may guide the choice of appropriate interventions, as only targeted treatments were effective in reducing FOF among older adults [41]. These may include tai chi exercises, use of hip protectors, specific balance training, multifactorial preventive intervention for falls within the home environment [41] and multicomponent cognitive behavioural group intervention [42]. More importantly, results from a recent cost-effectiveness evaluation of an 8-week cognitive behavioural group intervention demonstrated no increased costs compared to standard care, and significantly reduced FOF and related activity avoidance in community-dwelling older adults [43].

Although two of the three physical function measures used in this study significantly correlated with FOF, only balance performance was independently associated with this fear in the regression analysis. This finding is consistent with previous observations that the use of resistance training in pulmonary rehabilitation alone had no effect on the level of FOF in people with COPD [44]; however, when specific balance training is included as part of the rehabilitation program, reductions in FOF levels can be achieved [45]. Moreover, other factors such as environmental hazards and cognition may contribute to the increased FOF observed in COPD. Additional treatments strategies with demonstrated benefits in the elderly population may be necessary to reduce FOF in the COPD population [41,43].

Higher FOF was also associated with lower physical activity levels. These results support previous findings in which people with COPD who were afraid of falling also expressed activity avoidance [6]. Similar associations have been demonstrated among healthy older adults [46], particularly females [47]. The possible influence of FOF in reducing physical activity is clinically relevant as it may adversely affect one of the main goals of the current rehabilitation management for COPD [48]. For instance, home exercise prescription may include walking outside as a feasible training modality [49,50]. If high levels of FOF in a person limit adherence, alternative activities such as a stationary bike may warrant consideration. Nonetheless, further studies examining the influence of FOF as a potential factor influencing compliance with home-based exercise intervention in COPD are needed to test this assumption.

Moreover, association between higher FOF and an increased fall risk was also found in COPD. Fear of falling is a modifiable risk factor for falls, and interventions such as counselling and education aimed to reduce FOF in older adults has shown to be effective in older adults [41]; the use of strategies to reduce FOF and consequently fall risk may be appropriate for those with COPD and a higher FOF.

This study has limitations that need to be addressed. Firstly, the cross-sectional study design used prevents the identification of clear causal relationships between FOF and the physical function factors analysed. Secondly, although the sample size was sufficient to detect differences in FOF levels between groups, larger prospective studies are recommended to confirm the associations studied. Particularly, studies investigating the effects of factors that could increase FOF, including medications or the number of associated comorbidities; as well as the influence of FOF on anxiety, depression and quality of life in COPD. Finally, the use of prospective studies including falls monitoring may also identify the predictive validity of FOF in predicting falls in people with COPD.

Conclusions

A higher proportion of people with an increased FOF and higher scores on the FES-I are evident in people with moderate-to-severe COPD compared to age- and gender-matched controls. The higher FOF is associated with lower quadriceps muscle strength and impaired balance in COPD. These findings may guide future therapeutic strategies aiming to reduce FOF in COPD. Given the association between an increased FOF and lower levels of physical activity, an evaluation of this fear is recommended to identify a potential cause of activity avoidance in the COPD population. Future research is required to evaluate the role of FOF assessment in predicting future falls in people with COPD.

Conflict of interest

None.

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