Fear-related avoidance of activities, falls and physical frailty. A prospective community-based cohort study

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Abstract

\textbf{Objective}: to investigate the relationship between fear-related avoidance of activities and physical frailty.

\textbf{Subjects and methods}: fear-related avoidance of activities, physical performance, maximal isometric muscle strength and postural control were assessed in 225 community-living elderly (94 men and 131 women), aged between 61 and 92 years of age.

\textbf{Results}: bivariate analyses revealed significant correlations between avoidance of activities on the one hand, and physical performance, muscle strength, forward endpoint excursion of the centre of gravity, and previous falls on the other hand. Logistic regression analysis revealed that fear of falling and avoidance of activities in daily life were predictive of falls within a 1-year follow-up, together with general fear of falling, old age and being female.

\textbf{Conclusions}: fear-related avoidance of activities may have negative effects on physical abilities and may also be predictive for future falls. Avoidance of activities is therefore an important additional psychological variable in the development of physical frailty and falling in community-living elderly.

Keywords: avoidance of activities, fear of falling, elderly, physical frailty

Introduction

Fear of falling and poor physical performance are prominent symptoms in many older people [1, 2]. The prevalence of fear of falling in community-living elderly ranges between 12\% and 65\%, and is higher in women than men [3]. It commonly occurs after falls [1], but it also occurs without a previous fall history [4]. One of the major consequences of fear of falling is the restriction and avoidance of activities. However, not all elderly with fear of falling avoid activities in daily life (ADL). Some elderly only become cautious, which may be functional in preventing falls. Only a small percentage of elderly show a pattern of excessive fear and restriction of activities [5]. The consequences of this pattern may, however, be debilitating and devastating. Excessive fear and avoidance may compromise the quality of life, and may result in a decline of physical capabilities and, ultimately, in an increased risk of falls, which may further fuel fear and avoidance [6].

Few studies have systematically investigated the characteristics of this group of elderly who avoid activities out of fear of falling [7]. This research is needed in order to fully understand the problem of activity restriction and to tailor specific intervention and prevention strategies [8]. Largely unexplored is whether fear-related avoidance of activities is associated with a decline in frailty and physical capabilities, especially muscle strength. Most studies have focused upon clinical evaluation methods [7] and upon the self-reported confidence to accomplish ADL (self-efficacy), but not upon actual physical performance tests [9]. Furthermore, most studies have investigated a selected group of already frail elderly. A complete understanding, however, requires a study of individuals at the beginning of the downward spiral of physical frailty.

Therefore, this study was designed to investigate the inter-relationships amongst fear of falling, physical frailty, restriction of daily activities and actual falls in a community sample of non-frail elderly. In a first cross-sectional part, we investigated whether fear-related avoidance of activities is related to physical frailty and some components of physical function (e.g. postural control and muscle strength). In a second
longitudinal part, we investigated whether fear-related avoidance of activities is a risk factor for actual falls 1 year later.

**Methods**

**Subjects**

Two hundred and twenty-five community-living elderly, aged 60 years and older, were recruited on a voluntary basis by mailing (response rate of 21%). All the participants were assessed on different physical parameters in a local community centre. Exclusion criteria for participation were (i) musculoskeletal problems such as amputation, (ii) acute or terminal illness or (iii) prior severe central nervous system involvement. Only one participant was excluded. The study was approved by the Ethical Board of Ghent University Hospital, and written informed consent was obtained from all participants.

**Study design**

**Vital statistics**

In a semi-structured interview, information was obtained about the use of pharmaceuticals and about cardiovascular, orthopaedic or other complaints. To calculate body mass index (BMI), body height (cm) and body weight (kg) were recorded (BMI = weight (kg)/height (m)²).

**Fall history**

A fall was defined as an unintentional change in body position resulting in contact with the ground or with another lower level, however not as a result of a major intrinsic event (e.g. stroke, syncope) or an overwhelming hazard (e.g. car accident) [10]. Fall events in the past (since the age of 60 years) were checked during the first interview (yes or no). Fall events during the 1-year follow-up were assessed with a ‘fall calendar’. Participants were instructed to complete the calendar daily and to mail it at the end of each month. They were contacted by telephone if they had fallen during the month, if the calendar was filled in incorrectly, or if they had forgotten to return it at the end of the month. They were divided into three categories according to the number of falls: no fall (non-fallers = NF); 1 fall either in the past or during the 1-year follow-up (occasional fallers = OF); reported falls in the past and during the 1 year of follow-up (frequent fallers = FF). The baseline procedure was completed by 225 participants and the follow-up by 221 participants. Registered reasons for loss during the 1-year follow-up were: died (n = 1), refused further participation for personal reasons (n = 1) and physically unable (n = 2).

**Avoidance of activities**

The fear-related avoidance of activities was measured using a Dutch version of the modified Survey of Activities and Fear of Falling in the Elderly scale (SAFFE) [11]. This scale is the self-administered version of the SAFE scale developed by Lachman et al. [5]. All subjects were asked to indicate whether they would avoid some activities in daily living because of fear of falling using a three-point scale, ranging from never (1) to always (3). This survey contains 17 items representing five basic and instrumental ADL, nine mobility and three social activities. We divided all items in those three subscales for the analyses. The internal consistency is excellent (Cronbach’s α = 0.92) and the test–retest reliability is good (0.75) [11].

**Physical frailty**

Physical frailty was measured using the Physical Performance Test (PPT). This performance-based test was developed to represent ADL with various degrees of difficulty, ranging from ‘eating’ over ‘picking up a coin’ to ‘ascending and descending stairs’. Each of the nine items has 0 to 4 levels of performance, based on completion of the task and time for completion. The intra- and inter-operator reliability are good with Cronbach’s α of 0.87 and 0.99, respectively, and there is good concurrent and construct validity [12].

**Postural control**

Impairment-based balance testing was conducted using the Basic Balance Master system (version 8.0, NeuroCom® International, Inc., Clackamas, USA). This force plate system consists of two footplates connected by a pin joint. In each plate there are two force transducers that quantify changes in the vertical pressures applied to the support surface. The vertical ground reaction forces are used to calculate the position of the centre of pressure (COP) and the equivalent centre of gravity (COG) sway angles. Multiple dimensions of balance were assessed using the modified Clinical Test of Sensory Interaction on Balance (m-CTSIB) and the 100% Limits of Stability (LOS) using visual biofeedback: body sway (°/sec), maximal and endpoint excursion of the COP (%LOS) and directional control (%LOS). The endpoint excursion of the COP is the initial movement to reach the target without subsequent corrective attempts and the maximal excursion the total movement of the COP.

**Muscle performance**

The maximal isometric strength in knee and ankle extensors and flexors was measured using a hand-held dynamometer (Microfet® 2, Hoggan Health Industries), as the peak force expressed in newtons (N). The best performance of two trials was selected for each side, and the averages of the left and right extremity were used in the analyses. Each participant was asked to perform a maximal isometric contraction of the target muscles lasting 5-second with a 1-minute rest period between the trials. Verbal encouragement was provided. Before actual testing, they were asked to perform three contractions without resistance in order to practise the movement. For knee strength, the patient was seated on a treatment table with feet unsupported and knee flexed about 45° from complete joint extension. The dynamometer was applied 25 cm below the caput fibulae and perpendicular to the tibial crest, with stabilisation applied just above the
knee. For ankle strength, the patient was tested lying on the side to be tested on a treatment table with stabilization applied over the lower leg. The test limb was extended at the hip and knee, and 25° of plantar flexion at the ankle. The hand-held dynamometer was positioned perpendicular against the plantar or dorsal surface of the midfoot just proximal to the metatarsal phalangeal joints [13].

The maximum grip strength of the dominant hand was recorded with a hydraulic hand dynamometer (Baseline®, Fabrication Enterprises, Inc., New York, USA). The subject was seated on a chair while the tested arm was stretched out forward. The palm and fingers were clasped around the handle, while the subject brought his/her arm next to his/her body in 3 seconds. The highest value of three trials, expressed in kilograms (kg), was used in the analyses.

Statistics
Statistics were performed using the Statistical Package for the Social Sciences (SPSS 10.0). Bivariate correlations on the cross-sectional data were assessed to investigate the association amongst fearful avoidance of activities on physical performance, postural control and muscle strength. Bivariate odds ratios (OR) with their 95% confidence intervals (CI) of the psychological variables were calculated for FF versus NF using also the longitudinal data. Variables showing statistically significant associations ($P<0.05$) in the bivariate analysis were entered into a forward stepwise logistic regression analysis.

Table 1. Baseline characteristics of the study group

<table>
<thead>
<tr>
<th></th>
<th>All ($n = 225$)</th>
<th>NF ($n = 107$)</th>
<th>OF ($n = 67$)</th>
<th>FF ($n = 47$)</th>
<th>$P$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>72.0 ± 5.6</td>
<td>70.5 ± 4.9</td>
<td>73.9 ± 6.6</td>
<td>74.9 ± 4.4</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>BMI (kg/m$^2$)</td>
<td>27.5 ± 4.1</td>
<td>27.5 ± 3.4</td>
<td>27.0 ± 4.0</td>
<td>28.1 ± 4.4</td>
<td>0.414</td>
</tr>
<tr>
<td>Women (%)</td>
<td>58.4</td>
<td>42.1</td>
<td>65.7</td>
<td>85.1</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>≥4 medications (%)</td>
<td>20.4</td>
<td>15.9</td>
<td>17.9</td>
<td>34.0</td>
<td>0.032</td>
</tr>
<tr>
<td>SAFFE score</td>
<td>22.8 ± 5.2</td>
<td>21.5 ± 4.4</td>
<td>23.4 ± 5.9</td>
<td>25.1 ± 5.2</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>ADL (%)</td>
<td>12.2</td>
<td>6.8</td>
<td>15.5</td>
<td>19.8</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Mobility activities (%)</td>
<td>25.1</td>
<td>19.5</td>
<td>27.4</td>
<td>34.2</td>
<td>0.001</td>
</tr>
<tr>
<td>Social activities (%)</td>
<td>18.7</td>
<td>15.5</td>
<td>19.7</td>
<td>24.8</td>
<td>0.133</td>
</tr>
<tr>
<td>PPT score</td>
<td>30.0 ± 4.1</td>
<td>31.2 ± 2.6</td>
<td>29.2 ± 5.2</td>
<td>28.1 ± 4.1</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

NF = non-fallers; OF = occasional fallers; FF = frequent fallers.

Table 2. Means, standard deviations (SD) and Spearman correlation coefficients (R) among SAFFE, falls based on retrospective outcomes and physical outcomes

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>SD</th>
<th>Proportion (%)</th>
<th></th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>$P$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 SAFFE</td>
<td>22.8</td>
<td>5.2</td>
<td>0.33**</td>
<td>0.49ab</td>
<td>0.44ab</td>
<td>0.34ab</td>
<td>0.37ab</td>
<td>0.31ab</td>
<td>0.36ab</td>
<td>0.41ab</td>
<td></td>
<td></td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>2 Falls in the past (%)</td>
<td>35.0</td>
<td>–</td>
<td>–</td>
<td>0.42ab</td>
<td>0.36ab</td>
<td>0.35ab</td>
<td>0.41ab</td>
<td>0.22ab</td>
<td>0.28ab</td>
<td>0.31ab</td>
<td>0.34ab</td>
<td></td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>3 PPT</td>
<td>30.0</td>
<td>4.1</td>
<td>–</td>
<td>0.48ab</td>
<td>0.40ab</td>
<td>0.37ab</td>
<td>0.41ab</td>
<td>0.45ab</td>
<td>0.47ab</td>
<td>0.41ab</td>
<td>0.31ab</td>
<td></td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>4 Knee extensors</td>
<td>216.3</td>
<td>77.4</td>
<td>–</td>
<td>0.82ab</td>
<td>0.63ab</td>
<td>0.30ab</td>
<td>0.41ab</td>
<td>0.41ab</td>
<td>0.25ab</td>
<td>0.19ab</td>
<td>0.25ab</td>
<td></td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>5 Knee flexors</td>
<td>140.5</td>
<td>50.8</td>
<td>–</td>
<td>0.56ab</td>
<td>0.24ab</td>
<td>0.50ab</td>
<td>0.32ab</td>
<td>0.26ab</td>
<td>0.18ab</td>
<td></td>
<td></td>
<td></td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>6 Hand grip strength</td>
<td>36.9</td>
<td>10.5</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7 F-COP</td>
<td>55.2</td>
<td>21.2</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td></td>
</tr>
<tr>
<td>8 Functional reach</td>
<td>33.5</td>
<td>7.5</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td></td>
</tr>
<tr>
<td>9 Timed chair-stands</td>
<td>13.2</td>
<td>5.2</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
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<td>–</td>
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</tbody>
</table>

$^{a}P<0.001$.  
$^{b}$Pearson’s correlations.  
$^{c}$Spearman’s rho correlations.
Comparison with the ADL subscale ($-0.25 < r < -0.41; P < 0.001$) and in comparison with the Social Activity subscale of the SAFFFE ($-0.17 < r < -0.30; P < 0.001$).

**Longitudinal outcomes**

The SAFFFE showed a strong correlation with fall incidence after the follow-up ($r = 0.30; P < 0.001$). The contribution of the psychological variable in predicting falls 1 year later was investigated using a binary logistic regression analysis. Participants were classified into two groups according to the self-reported falls during the follow-up period (FF, 20.9% versus NF, 47.6%). Table 3 summarises the results of these analyses. It shows that the one-item fear of falling and the ADL and Mobility subscales of the SAFFFE are significantly associated with falls. When age and gender were added, the predictive ability of the model improved. The function (1) of the best fitting model is:

$$g(x) = -12.37 + 0.11 \text{ (age)} + 1.21 \text{ (gender)} + 0.20 \text{ (ADL)} + 2.51 \text{ (fear)}$$

After logit transformation (2), this model predicts the risk of future falls due to fear of falling.

$$\Pi(x) = \frac{e^{g(x)}}{1 + e^{g(x)}}$$

The outcome ranges between 0 and 1 and can therefore be interpreted as a percentage, where 0 represents no risk for falling and 1 the highest possible risk of falling.

**Discussion**

The present study is one of the first studies that investigated the interrelationship of fear-related avoidance of activities with actual physical performance and with the incidence of falls in a sample of community-living elderly. The rate of falls in the past (35%) and during the 1-year follow-up (33.5%) reported in our sample are comparable with previous reports [14]. Our results can be readily summarised: (i) mobility tasks, including reaching and walking, were avoided the most by elderly with fear of falling; (ii) fear-related activity restriction is correlated with physical performance, forward excursion of the COP and maximal muscle strength; (iii) fear of falling and restriction of ADL predict falls during a 1-year follow-up.

**Fear-related avoidance of activities and physical frailty**

When people withdraw from ADL and outdoor social contact, they become more susceptible to the negative effects of social isolation and physical inactivity [6, 7]. Avoidance also increases loss of muscle strength and postural control [2]. Our results replicate and extend this view: we found substantial evidence for the association between avoidance of feared activities on the one hand and physical performance, muscle strength and postural performance on the other hand. These associations were most pronounced for mobility activities such as walking and reaching, and less pronounced for ADL and social activities. It is possible that our community-living elderly still had sufficient functions to manage basic ADL and social activities. Some data from our semi-structured interview are in line with this view: the elderly often reported that family or friends came to pick them up for social activities.

Our results corroborate the idea that fear of falling and avoidance are important variables in the transition to physical frailty. The more activities that the elderly avoid, the more difficulties they experience in doing these activities. It is possible that avoidance of activities dramatically speeds up the process of physical frailty because of the devastating consequences of physical inactivity [15].

Avoidance of feared activities was not only related to the general status of physical frailty, but also to some specific components of physical function, including less muscle strength in the knee, less hand grip strength and less forward excursion of the COP. Because the elderly who avoid feared activities have decreased muscle strength, it is likely that they will experience limitations during activities such as shopping, going for a walk, walking around indoors and bending down to pick something up. This may further increase their feelings of insecurity and apprehension. Fear of falling was also related to the endpoint excursion of the COP in the forward direction on the Basic Balance Master®.
A potential explanation for this association may be found in the contextual characteristics of the LOS test. During this test, participants saw the ground or the wall approaching towards them. Because most functional tasks (e.g. walking) consist of a forward displacement of the COG, a decreased forward excursion of the COP can cause a decreased stride length in gait as a stabilising adaptation related to fear of falling [16]. A possible reason for the absence of a correlation between SAFFE and directional control, and between SAFFE and the maximal excursion of the COP in the forward direction, is that elderly who avoid feared activities probably lean forward to the point where they still feel confident and then start to move carefully to the target in order to keep control over their COG.

**Fear-related avoidance of activities and falls**

Both in the cross-sectional part and in the longitudinal part falls were associated with avoidance of activities. Although it is reasonable to assume that a fall precedes a pattern of fear and avoidance, several studies have pointed out that this is not necessarily the case for everybody [4, 17]. It is our opinion that some elderly indeed fear falling without a fall history, but that avoidance of feared activities is primary caused by an actual fall. One fall can so trigger a serious downhill spiral of disability through avoidance of feared activities.

Our prospective study also yielded a survey of psychological risk factors for falls and a risk model for the prediction of falls due to fear of falling, consisting of variables easy to assess in general practice. General fear of falling and avoiding ADL are the best psychological predictors of falls, especially in combination with old age and being female. Although mobility activities showed the best correlation with physical performance and falls, avoidance of ADL was the strongest predictor of falling. An interesting hypothesis for these findings may be the gradual expansion and exacerbation of avoidance behaviour at the mobility level, which in the long term results in a deterioration of physical abilities and in falls at home. More specifically, avoidance probably starts at the mobility level, and results in the elderly becoming afraid of going outside to unknown places. As a consequence, they stay more and more at home. When fall incidents (e.g. stumbling over a carpet) occur at home, they also become fearful of activities at home. The strong reduction of physical activity leads to a further deterioration of their physical capabilities and their confidence in their performance of ADL. The association between falls and avoidance of ADL may have important implications for primary fall prevention strategies, meaning that intervention should focus on increasing the activity level of older adults with a fear of falling in all functional activities.

**Relevance and future research**

The correlation of SAFFE with the PPT, muscle strength and excursion of the COP, which are known contributors to physical frailty and falls [18, 19], suggests that fear-related avoidance is an important psychosocial variable in the development and/or exacerbation of the physical frailty process. Fear of falling may increase the risk of falling. As a consequence the elderly may avoid more activities (SAFFE), may have more difficulties in performing activities of daily living (PPT), and may be less able to use and exercise their abilities of muscular strength and postural control. This pattern may further fuel fear and avoidance, and may, in the long term, lead to a further deterioration of physical performance and an increased risk of falls (Figure 1). Individual physical intervention, focusing on functionality, may reverse the downhill spiral of physical frailty, as a better physical function optimises a better postural control [20], and the incidence of unnecessary life-threatening falls may be decreased. Training of the basic physical ingredients such as balance and muscle strength may directly affect physical frailty. It may also reduce avoidance by increasing self-esteem and confidence in one’s own abilities to perform physical activities. Further research however is needed to elaborate these ideas and to assess the effects of specific intervention programmes on functional abilities in individuals with a high fear of falling.

**Conclusion**

Falls and fear of falling are common and important problems in older community-dwelling adults. One of the major consequences of fear of falling is avoidance of activities, which in the long term may have negative effects on physical abilities. Fear-related activity restriction was correlated with physical performance, forward excursion of the COP and maximal muscle strength in both knee and hand grip muscles. Elderly with fear of falling avoided mobility tasks most often, such as reaching and walking. Restriction of ADL activities, however, was the best psychological predictor of falls together with general fear of falling, old age and being female. Our findings may be helpful in designing a screening instrument for the elderly at risk for falls and of becoming physically frail. Future research should investigate whether individualised intervention strategies are efficient in preventing falls and activity-related fear of falling within this population.

**Key points**

- Mobility tasks, such as walking and reaching, are most often avoided by the elderly with fear of falling.
• Fear-related avoidance of activities is correlated to physical performance, including general physical frailty, postural control and maximal muscle strength.
• Fear-related avoidance of activities is predictive of future falls.

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References