Outdoor and indoor falls as predictors of mobility limitation in older women

SIR—Falls in old age often cause physical injuries, which may lead to hospitalisation and institutionalisation [1]. However, whether falls in general have an impact on mobility decline has been little studied [2, 3]. It has been suggested that outdoor falls are more common among healthy and active older people, whereas indoor falls are often related to intrinsic risk factors, such as poor health and impaired balance [4–6]. As poor health and low functional ability are known to be risk factors for both indoor falls [4, 5] and mobility disability [7], it can be hypothesised that, compared to outdoor falls, indoor falls are more likely to be associated with mobility decline. However, to date it is not known whether indoor and outdoor falls in old age have a different impact on mobility. The objective of this study was to determine the association of outdoor and indoor falls with the incidence of mobility limitation in older women.

Methods

A total of 434 women aged 63–76 from the Finnish Twin Study on Aging [8] participated in the baseline examinations. Subsequently, falls were followed up for 1 year, and 2 years thereafter mobility limitation was re-examined. The incident mobility limitation was defined as the onset of major difficulty or inability in walking 2 km among those without difficulties at the baseline. The criteria for participation in this study were the ability to walk 2 km without major difficulties at the baseline. The criteria for participation in this study were the ability to walk 2 km without major difficulties at the baseline. Complete information about the occurrence and location of falls during the fall surveillance, and follow-up information on mobility limitation (n = 376).

At baseline, the presence of chronic conditions and use of prescribed medications were documented according to

References

was obtained with a prospective follow-up. Participants were categorized into those with no falls (n = 180), those who fell indoors (n = 122), women with one (n = 153) or two (n = 74) risk factors, women with no falls (n = 122), women with one (n = 153) or two (n = 74) risk factors had a 4-fold increased risk for developing the descriptive and covariate variables were tested using an adjusted Wald test. Logistic regression was used to estimate the odds ratios (ORs) and 95% confidence intervals (CIs) for mobility limitation according to fall status, with adjustment for age. To examine in more detail the association between falls and future mobility limitation, known and postulated determinants of falls and mobility limitation were added individually to the regression model. We tested the significance of the difference of the regression coefficient for the fall variable in the age-adjusted model with the corresponding coefficient in the model with the potential confounder using an appropriate Wald test. A significant difference between the coefficients suggests that the potential confounder may partially explain the association between falls and future mobility limitation. Statistical significance was set at P < 0.05.

**Results**

Among the 376 women without baseline mobility limitation, 173 experienced at least one fall during the 12 months of fall surveillance. The total number of falls was 357, of which 17% occurred indoors. Compared to outdoor fallers and non-fallers, indoor fallers had ~20% poorer standing balance and reported ~30% less outdoor walking activity at baseline. In addition, compared to outdoor fallers and non-fallers, a bigger proportion of indoor fallers were obese (24% vs. 26% vs. 51%, respectively), had visual loss (41% vs. 41% vs. 57%) and a previous fall history (22% vs. 13% vs. 38%). These group differences are presented in detail in Table 1.

The incidence of mobility limitation during the follow-up was 7% among those with no falls, 7% among those with outdoor falls only and 19% among those with indoor falls. Table 2 shows the association between indoor and outdoor falls, and future mobility limitation after adjusting for age. Compared to those with no falls, women with indoor falls were over three times (OR 3.2; 95% CI: 1.3–8.1, P = 0.01) more likely to develop difficulties in walking 2 km by the end of the 3 years’ follow-up. Outdoor falls (OR 1.1; 95% CI: 0.4–2.6, P = 0.89) did not increase the risk of future mobility limitation.

To explore further the nature of the increased risk of future mobility limitation among those with indoor falls, we added important determinants of falls and mobility limitation one at a time to the age-adjusted regression model. Obesity, low walking activity and chronic conditions significantly attenuated the risk among women with indoor falls (Wald test; P < 0.05), suggesting that these factors may partially explain the increased risk for future mobility limitation among indoor fallers (Table 2).

Finally, we analysed how the accumulation of several risk factors, that is, indoor falls, obesity and low walking activity, contribute to the development of future mobility limitation (n = 372). Compared to women with none of the three risk factors (n = 122), women with one (n = 153) or two (n = 74) risk factors had a 4-fold increased risk for developing the incidence of mobility limitation during the follow-up was 7% among those with no falls, 7% among those with outdoor falls only and 19% among those with indoor falls. Table 2 shows the association between indoor and outdoor falls, and future mobility limitation after adjusting for age. Compared to those with no falls, women with indoor falls were over three times (OR 3.2; 95% CI: 1.3–8.1, P = 0.01) more likely to develop difficulties in walking 2 km by the end of the 3 years’ follow-up. Outdoor falls (OR 1.1; 95% CI: 0.4–2.6, P = 0.89) did not increase the risk of future mobility limitation.

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future mobility limitation (OR 3.8; 95% CI: 1.1–13.8, \( P = 0.04 \) and OR 4.0; 95% CI: 0.9–17.2, \( P = 0.06 \), respectively). Importantly, women who had all three risk factors (\( n = 23 \)) had a 17-fold (OR 17.1, 95% CI: 4.00–73.3, \( P < 0.001 \)) risk for developing mobility limitation as compared to women with none of the risk factors.

**Discussion**

Among the present sample of older high functioning women, falling indoors was associated with an increased risk for developing mobility limitation in the future, while outdoor falls did not increase the risk. Two previous prospective studies [2, 3] have investigated the effects of falls on functional ability among older people. In these studies falls and fall injuries were shown to be independent determinants of functional decline. However, they did not consider whether indoor and outdoor falls have a different impact on functional ability in old age.

As earlier studies have shown that poor health and lower functional ability are important risk factors for both indoor falls [4, 5] and mobility disability [7], the most likely hypotheses for our results would be that indoor fallers may have been more vulnerable to the adverse effects of falls or they may have had risk factors in common for both falls and mobility limitation. Our baseline comparisons and multivariate analyses suggest that low walking activity, obesity and chronic conditions were important factors explaining the association between indoor falls and future mobility limitation, whereas serious injuries resulting from falls did not explain the association. Thus, our results support the latter hypothesis, indicating that high body mass [16, 17], low walking activity [18–20] and chronic conditions [21] decrease women’s functional ability, rendering them more vulnerable to both indoor falls and mobility limitation. We found that women who had fallen indoors and who were obese and had low walking activity were in particular at an extremely high risk for future mobility limitation. Women in this group thus constitute an important and challenging target for preventive interventions.

It is evident that there are also other factors on the pathway from indoor falls to mobility limitation that need to be considered in future studies. For example, as our outcome measure was based on self-report, it can be hypothesized that, compared to outdoor falls, indoor falls may have had a more detrimental effect on mobility-related self-efficacy, which may have been reflected as perceived difficulty in walking. However, our data did not allow us to study this possibility. In addition, our results need to be confirmed with more frail populations and with samples including men.

**Conclusions**

Among high functioning older women, indoor falls may signal functional decline with overweight and low walking activity contributing to this process. The present findings
Table 2. Association between indoor/outdoor falls and future mobility limitation among 63–76 year old women without mobility limitation at baseline

<table>
<thead>
<tr>
<th></th>
<th>Indoor fallers</th>
<th>Outdoor fallers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OR (95% CI)</td>
<td>OR (95% CI)</td>
</tr>
<tr>
<td>Base modela</td>
<td>3.20 (1.27–8.06)</td>
<td>1.07 (0.43–2.63)</td>
</tr>
<tr>
<td>Base model adjusted forb</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of chronic conditions</td>
<td>2.97 (1.14–7.73)</td>
<td>1.10 (0.44–2.74)</td>
</tr>
<tr>
<td>Number of prescribed medications</td>
<td>2.94 (1.13–7.65)</td>
<td>1.04 (0.42–2.57)</td>
</tr>
<tr>
<td>Muscle power (W/kg)</td>
<td>3.52 (1.41–8.81)</td>
<td>1.20 (0.48–3.00)</td>
</tr>
<tr>
<td>Maximal walking speed (m/s)</td>
<td>3.34 (1.30–8.58)</td>
<td>1.33 (0.51–3.43)</td>
</tr>
<tr>
<td>Balance (velocity moment, mm²/s)</td>
<td>3.10 (1.28–7.52)</td>
<td>1.07 (0.43–2.64)</td>
</tr>
<tr>
<td>Education (years)</td>
<td>3.05 (1.20–7.76)</td>
<td>1.07 (0.43–2.63)</td>
</tr>
<tr>
<td>Low walking activityd</td>
<td>2.63 (1.04–6.64)</td>
<td>1.12 (0.44–2.85)</td>
</tr>
<tr>
<td>MMSE d</td>
<td>3.25 (1.28–8.27)</td>
<td>0.97 (0.38–2.47)</td>
</tr>
<tr>
<td>Obesity</td>
<td>2.66 (1.05–6.73)</td>
<td>1.08 (0.43–2.69)</td>
</tr>
<tr>
<td>Visual loss</td>
<td>3.08 (1.22–7.76)</td>
<td>1.07 (0.43–2.64)</td>
</tr>
<tr>
<td>Hearing impairmentg</td>
<td>3.08 (1.19–7.93)</td>
<td>1.01 (0.40–2.53)</td>
</tr>
<tr>
<td>Fall history</td>
<td>3.08 (1.22–7.82)</td>
<td>1.05 (0.43–2.57)</td>
</tr>
<tr>
<td>Fear of falling</td>
<td>3.34 (1.32–8.44)</td>
<td>1.10 (0.45–2.72)</td>
</tr>
<tr>
<td>Serious fall injuries</td>
<td>3.39 (1.32–8.70)</td>
<td>1.14 (0.45–2.76)</td>
</tr>
</tbody>
</table>

Logistic regression models for future mobility limitation among those with Indoor or Outdoor falls as compared to women with no falls.
aAdjusted for age.
bThe base model was adjusted one at a time for known and suspected fall risk factors.
cWalking activity < 1.61 km (1 mile) per day.
dMini Mental State Examination score.
eBody mass index (kg/m²) ≥ 30.
fVisual acuity < 1.0.
gHearing threshold level (HTL) of the better ear > 21 dB.

suggest that programmes targeted at fall prevention, weight management and physical activity would help to prevent disability.

Key points

- Falls in old age often cause adverse events, such as injuries and hospitalisation.
- The impact of falls on mobility decline has been little studied.
- Among relatively high functioning women, falling indoors was associated with an increased risk for developing mobility limitation in the future, whereas outdoor falls did not increase the risk.
- Indoor falls may be an early indicator of functional decline.

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Conflicts of interest

No disclosures.

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