Research Article

Long-term Consequences of Noninjurious and Injurious Falls on Well-being in Older Women

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Abstract

Background. The physical and mental health consequences of falls are known to influence well-being in the short term. The aim was to investigate the long-term consequences of noninjurious and injurious falls on well-being in older women over 12 years.

Methods. A total of 10,277 participants (aged 73–78 years, 98.8% community-dwelling) returned the 1999 survey of the Australian Longitudinal Study on Women's Health. Follow-up surveys were completed at 3-year intervals. Surveys included questions about falls and related injuries in the past year. Scores on the health-related quality of life Short Form-36 subscales (range 0–100) were used to compare well-being between noninjurious fallers, injurious fallers, and nonfallers using linear mixed modeling with adjustment for confounders. Scores in the years before and after the first fall since enrolment were graphically depicted with time relative to the first fall since enrolment. For this purpose, nonfallers were matched with noninjurious and injurious fallers based on pattern of surveys returned, chronic conditions, and age to assign them a fictitious “time-of-first-fall.”

Results. Over 12 years, there were 22.5% noninjurious fallers, 30.1% injurious fallers, and 47.5% nonfallers. Compared with nonfallers, noninjurious and injurious fallers scored significantly lower on six and seven of the eight domains at the time of the reported fall, respectively. Significant differences were apparent 12 years before the injurious fall for the subscales role physical, bodily pain, and general health. A drop in scores after the reported injurious fall was seen for role physical, bodily pain, and social functioning.

Conclusions. Among older women, a gap in well-being emerges years before the first reported fall, which may be driven by underlying risk factors rather than the fall itself.

Key Words: Accidental falls—Old age—Quality of life—Injury

Falls are known to create a great burden on the daily lives of older adults due to their high prevalence and potentially severe consequences (1). Approximately one in three community-dwelling older adults fall at least once per year, and about two in three falls result in an injury (1,2). Other consequences of falls are diverse, which include fear of falling again, mobility limitations, and loss of independence (2,3).
Both the physical and psychological consequences of a fall may influence the individual's well-being (4). Results from cross-sectional studies showed that older adults with a history of falls have poorer well-being than those without a history of falls (5–7), and results from two prospective studies showed that these differences in well-being persisted after 9 months and 6 years (7,8). All these studies used single time-point measures of falls and well-being as well as generic measures of well-being, that is, the EuroQol-5 dimensions (EQ-5D) and the physical and mental component scores of the Short Form-12 (SF-12), providing little insight into associations between fall risk and specific domains of well-being over time.

The aim of this study was to investigate the long-term (ie, up to 12 years) consequences of noninjurious and injurious falls on the course of well-being in a population-based sample of community-dwelling older women followed from 1999 to 2011.

**Method**

**Participants**

The Australian Longitudinal Study on Women’s Health is an ongoing study of factors affecting the health and well-being initially of three large population-based cohorts of women born in 1973–1978, 1946–1951, and 1921–1926. Recruitment and data collection procedures for these cohorts have been described in more detail elsewhere (9). In summary, in 1996, women were randomly selected from the national Medicare health insurance database, which includes all citizens and permanent residents of Australia. The sample was reasonably representative of the general population of Australian women, although there was overrepresentation of Australia-born and university-educated women (9). Ethical clearance was obtained from the Universities of Newcastle and Queensland, and all participants signed informed consent. For the current study, data from the 1921–1926 cohort were used. The cohort included 12,432 women at baseline, and participants have been resurveyed every 3 years up to 2011. Detailed analysis of attrition and comparisons with national data indicate that the cohort remains representative of the general population of surviving women in this age cohort (10). As falls were assessed from the 1999 survey onward, data from the 1999 to 2011 surveys were used, which included 10,343 participants of whom 10,277 (99.4%) participants had data on falls. Attrition rates and reasons for dropout at each follow-up survey relative to the 1999 survey are presented in Table 1.

**Well-being**

Well-being was measured using the Medical Outcomes Survey 36-item Short-Form health survey (SF-36) (11). Subscores were calculated in accordance with the SF-36 manual for the domains: physical functioning, role physical, bodily pain, general health, vitality, social functioning, and role emotional. The scales ranged from 0 to 100, with 100 indicating optimal well-being.

**Noninjurious and Injurious Falls**

At each survey, noninjurious and injurious falls were measured with the questions “In the last 12 months, have you had” (a) “a fall to the ground? (does not include stumbles/trips)” and (b) “been injured as a result of a fall?” To avoid misclassification of near-falls, participants were asked to indicate whether they had had any slips, trips or stumbles that had not led to a fall on the ground with a separate question. Participants with a positive response to “a” but not “b” were classified as noninjurious fallers, whereas those with positive responses to both “a” and “b” were classified as injurious fallers.

**Sociodemographic and Health Characteristics**

The following variables were based on self-report and measured at each survey (unless indicated otherwise): age, area of residence, living situation, level of education, chronic conditions, depression, and physical activity. Response options for living situation were grouped as community dwelling (ie, house, flat/unit/apartment/villa/townhouse, mobile home/caravan/cabin/houseboat, retirement village/self-care unit) or institutionalized (ie, nursing home, hostel or other). Level of education was assessed at the 1996 survey as the highest qualification completed: “no formal qualification,” “school certificate,” “high school certificate,” “trade/apprenticeship/diploma,” “university or higher degree.” Area of residence was classified according to the Australian Standard Geographic Classification for remoteness based on road distance to the closest service centre and classified as “urban,” “rural,” or “remote.” Participants were asked to indicate which of a list of chronic conditions they had been diagnosed with or treated for in the past 3 years, including arthritis, diabetes, heart disease, hypertension, stroke, lung disease, osteoporosis, or cancer. The number of conditions reported was used in the analyses (range 0–8). Depression was measured with the question: “In the past three years, have you been diagnosed with or treated for depression?” Physical activity was assessed using a modified version of the Active Australia questionnaire (12). Minutes in the last week spent walking and in moderate and vigorous leisure-time activities were multiplied by a metabolic equivalent (MET) score (ie, walking = 3, moderate = 4.5, and vigorous = 7) (13) and then summed and categorized as inactive = 0–40, low = 40–599, moderate = 600–1200, and high ≥ 1,200 MET.min/week.

**Statistical Analyses**

The 1999 sample characteristics were compared between noninjurious fallers, injurious fallers, and nonfallers. To compare subscale scores for each of the SF-36 domains between noninjurious fallers, injurious fallers, and nonfallers, linear mixed modeling was used with random intercept. Adjustment was made for year of survey, age in 1999, education, depression, chronic conditions, and physical activity. To examine whether changes over time were different for the three groups, interaction terms for fall status and year of survey were included in all models.

To depict the effect of the first reported fall on the course of well-being, mean SF-36 subscale scores were plotted against the time relative to the first reported fall on the x-axis. To this end, a new time variable was created to indicate the timing of surveys relative to the survey of the first reported fall since enrolment (ie, from 1999 to 1921–1926 cohort were used. The cohort included 12,432 women at baseline, and participants have been resurveyed every 3 years up to 2011.

**Table 1. Attrition Rates of the 1921–1926 Cohort in the Australian Longitudinal Study on Women’s Health**

<table>
<thead>
<tr>
<th>Survey</th>
<th>Respondent N</th>
<th>Dead %</th>
<th>Frail %</th>
<th>Withdrown %</th>
<th>Lost to Follow-up %</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>10,434</td>
<td>100</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>8,398</td>
<td>80.5</td>
<td>4.8</td>
<td>2.1</td>
<td>4.7</td>
</tr>
<tr>
<td>4</td>
<td>6,955</td>
<td>66.7</td>
<td>11.6</td>
<td>5.4</td>
<td>8.0</td>
</tr>
<tr>
<td>5</td>
<td>5,413</td>
<td>51.9</td>
<td>19.3</td>
<td>8.3</td>
<td>10.0</td>
</tr>
<tr>
<td>6</td>
<td>3,948</td>
<td>37.8</td>
<td>27.7</td>
<td>13.3</td>
<td>13.0</td>
</tr>
</tbody>
</table>

Note: Proportions are relative to the 1999 survey and the proportions of deceased, frail or withdrawn participants are therefore cumulative.
2011). The survey of the first reported fall since enrolment became time = 0 and the previous and subsequent surveys were assigned a time of −12 to +12 years. For example, for a participant reporting the first fall at survey 4, the timing of surveys 2 to 6 became −6, −3, 0, +3 and +6 years relative to the first reported fall, respectively. The time relative to the first reported fall can only be determined for participants who reported a fall. To compare fallers with nonfallers, noninjurious and injurious fallers were matched with nonfallers based on pattern of survey return, number of chronic conditions (ie, 0, 1, 2, or 3+), and age in 1999 (ie, <75 or ≥75 years) to ensure comparability of the groups. Pattern of survey return refers to which surveys were returned. For example, if a faller returned surveys 2, 3, and 5, but not 4 and 6, then the matched non faller must also have returned surveys 2, 3, and 5, but not 4 and 6. Non fallers were then assigned the same timing of surveys relative to (a fictitious) the first fall as their matched faller. Linear mixed models with adjustment for the same set of confounders as above were used to plot adjusted mean values for each of the three groups over time.

In the above analyses, data were included for all women who provided data at any of the five surveys from 1999 to 2011. Linear mixed modeling is a likelihood based method, hence it is appropriate for data missing at random (14). However, the main cause of missing data was due to deaths and frailty, which may not be at random. To examine the effect of attrition on the associations, the linear mixed models based on unmatched data were repeated including data only from women who completed all five surveys. In the analyses using matched data, (injurious) fallers were matched with nonfallers based on their pattern of survey return; hence any potential bias due to missing at random would tend to cancel out in the matched comparison between fallers and nonfallers. All analyses were done using STATA 13.0 (StataCorp LP, College Station, TX), and p values were based on two-sided tests and the level of significance was set at .05.

Results

More than half the participants (52.5%) reported a noninjurious or injurious fall on at least one of the five surveys from 1999 to 2011. At surveys 2–6, 9.4%, 9.8%, 11.9%, 11.6%, and 11.0% reported a noninjurious fall and 12.6%, 12.6%, 15.8%, 17.3%, and 19.4% reported an injurious fall, respectively. In 1999, noninjurious fallers (n = 2,260) and injurious fallers (n = 3,026) did not differ from nonfallers (n = 4,773) in age or living situation. Although fallers were statistically significantly more likely to have post-high school qualifications, depression, more chronic conditions, and lower levels of physical activity than nonfallers, actual differences were relatively small (Table 2).

Over the follow-up period, noninjurious fallers scored lower than nonfallers on all SF-36 domains except role emotional and mental health, with differences ranging from −9.1 (95% confidence interval [CI] −11.4, −6.7) for role physical to −1.7 (CI −3.3, 0) points for social functioning (Table 3). Injurious fallers scored lower than nonfallers on all domains except role emotional, with differences ranging from −9.1 (CI −11.4, −6.7) for role physical to −1.5 (CI −2.3, −0.7) for mental health. The statistically significant estimates for the noninjurious Faller × Survey and Injurious faller × Survey interaction terms suggest that the rate of decline over time differed between noninjurious fallers and nonfallers for the domain

<table>
<thead>
<tr>
<th>Table 2. Sample Characteristics of Noninjurious Fallers, Injurious Fallers, and Nonfallers</th>
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<tbody>
<tr>
<td><strong>1999 Characteristics for the Total Sample</strong></td>
</tr>
<tr>
<td><strong>Nonfallers</strong> &amp; <strong>Noninjurious Fallers</strong> &amp; <strong>Injurious Fallers</strong> &amp; <strong>p Value</strong></td>
</tr>
<tr>
<td>N (%) &amp; 4,773 (47.5) &amp; 2,260 (22.5) &amp; 3,026 (30.1) &amp; .91</td>
</tr>
<tr>
<td>Age [mean (SD)] &amp; 75.3 (1.5) &amp; 75.4 (1.4) &amp; 75.4 (1.5) &amp; .003</td>
</tr>
<tr>
<td>Living in rural/remote areas (%) &amp; 59.7 &amp; 58.9 &amp; 56.8 &amp; .43</td>
</tr>
<tr>
<td>Community-dwelling (%) &amp; 98.8 &amp; 99.0 &amp; 98.7 &amp; &lt;.001</td>
</tr>
<tr>
<td>No formal qualification (%) &amp; 33.4 &amp; 32.4 &amp; 30.4 &amp; &lt;.001</td>
</tr>
<tr>
<td>School or high school certificate (%) &amp; 52.7 &amp; 50.9 &amp; 51.8 &amp; .52</td>
</tr>
<tr>
<td>Trade/apprenticeship/diploma (%) &amp; 11.0 &amp; 12.5 &amp; 12.6 &amp; 11.0 &amp; 12.5 &amp; 12.6</td>
</tr>
<tr>
<td>University or higher (%) &amp; 2.9 &amp; 4.3 &amp; 5.2 &amp; 3.0 &amp; 4.3 &amp; 5.1</td>
</tr>
<tr>
<td>Depression (%) &amp; 8.6 &amp; 10.4 &amp; 12.4 &amp; &lt;.001</td>
</tr>
<tr>
<td>Chronic conditions (median [IQR]) &amp; 1 [0–2] &amp; 1 [0–2] &amp; 1 [0–2] &amp; &lt;.001</td>
</tr>
<tr>
<td>Physical activity (%) &amp; &lt;.01</td>
</tr>
<tr>
<td>Inactive (%) &amp; 33.3 &amp; 32.1 &amp; 31.6 &amp; 33.4 &amp; 32.1 &amp; 32.1</td>
</tr>
<tr>
<td>Low (%) &amp; 28.2 &amp; 32.8 &amp; 30.6 &amp; 28.4 &amp; 32.8 &amp; 30.4</td>
</tr>
<tr>
<td>Moderate (%) &amp; 16.5 &amp; 15.3 &amp; 16.8 &amp; 16.3 &amp; 15.3 &amp; 16.5</td>
</tr>
<tr>
<td>High (%) &amp; 22.1 &amp; 19.9 &amp; 21.0 &amp; 22.0 &amp; 19.9 &amp; 21.0</td>
</tr>
</tbody>
</table>

**Note:** IQR = interquartile range.
Table 3. Difference in SF-36 Subscale Score for Noninjurious Fallers and Injurious Fallers Compared With Nonfallers at Surveys 2–6 for Including All Participants (unmatched analyses)

<table>
<thead>
<tr>
<th>Status</th>
<th>Physical Functioning</th>
<th>Role Physical</th>
<th>Bodily Pain</th>
<th>Role Emotional</th>
<th>Social Functioning</th>
<th>Vitality</th>
<th>Mental Health</th>
<th>General Health</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non</td>
<td>-3.6 (−4.9, −2.2)</td>
<td>-2.4 (−3.8, −1.1)</td>
<td>-2.5 (−3.5, −1.4)</td>
<td>-1.8 (−3.1, −0.4)</td>
<td>-2.9 (−4.1, −1.6)</td>
<td>0.1 (−0.8, 1.0)</td>
<td>-0.5 (−2.0, 1.0)</td>
<td>-1.6 (−2.7, −0.4)</td>
</tr>
<tr>
<td>IF</td>
<td>-3.2 (−4.5, −1.9)</td>
<td>-2.1 (−3.4, −0.7)</td>
<td>-1.1 (−2.5, −0.6)</td>
<td>-0.4 (−1.7, 0.9)</td>
<td>-1.2 (−2.5, −0.0)</td>
<td>0.3 (−1.3, 1.9)</td>
<td>-0.8 (−2.0, 0.4)</td>
<td>-1.3 (−2.5, −0.1)</td>
</tr>
<tr>
<td>IF</td>
<td>-2.6 (−3.9, −1.3)</td>
<td>-1.9 (−3.3, −0.5)</td>
<td>-0.3 (−1.8, 0.2)</td>
<td>0.4 (−1.6, 2.4)</td>
<td>-0.8 (−2.0, 0.4)</td>
<td>0.4 (−1.2, 2.0)</td>
<td>0.0 (−1.6, 1.6)</td>
<td>-0.3 (−2.6, 2.0)</td>
</tr>
</tbody>
</table>

Note: b = regression coefficient; CI = 95% confidence interval; IF = injurious faller; NIF = noninjurious faller. Linear mixed modeling was used with random intercept. Adjustment was made for survey, age at survey 2, education, depression, chronic conditions, and physical activity.

Discussion

Although well-being is an important outcome in randomized trials of preventive interventions, few studies have investigated how falls influence the course of well-being in the general population of older people. In line with previous studies, the results from Table 3 show that at any given time, fallers have lower well-being scores than nonfallers (5–8). However, Figure 1 shows that for most domains, the decline in functioning precedes the first fall since enrolment and does not appear to be a consequence of the fall itself. In addition, the findings show that the relationship between injurious falls and well-being is largely the same as for noninjurious falls, except for bodily pain and social functioning.

It is generally believed that falls contribute to a reduction in well-being. However, a study based on data from two trials and one cohort study showed that falls accounted for only a 0.3% loss in quality adjusted life years in older women (15). Furthermore, in a qualitative study, just 2 out of 27 fallers believed that the fall had changed their quality of life (4). In line with these studies, this study shows little widening in the gap in well-being from 3 years prior to the first survey after noninjurious falls for all domains (ie, time = 0 relative to time = −3 in Figure 1). However, for injurious falls, the gap widens for the domains role physical, bodily pain, and social functioning. No recovery is observed, and even 12 years after the injurious fall, women continue to score lower on these domains than nonfallers. The consistently lower scores for these domains may be explained by avoiding social activities due to consequences of the fall including injuries, fear of falling again, and damage to social identity (16,17). Some support for the clinical meaningfulness of the observed gap in subscale scores comes from studies that reported differences between individuals with and without chronic physical problems or medical conditions. Those studies reported differences in the same range as observed in the current study, that is, 0–4 points for role emotional, 2–2.5 points for mental health, 4–7 points for vitality, 5–12 points for physical function and social function, 6–13 points for general health, 10–17 points for bodily pain, and 11–19 points for role physical (18,19).

The results in Figure 1 suggest that there are minimal changes in trajectories (ie, slope) before and after the first fall since enrolment for both groups of fallers. Post hoc analyses comparing pre fall with post fall changes in trajectories confirmed this impression...
Significant differences in slope were found in injurious fallers for the domains bodily pain, vitality, and mental health. The positive changes in slope suggest less steep trajectories after compared with before the injurious fall; however, actual changes in slope were relatively small. Thus, while the injurious fall caused a drop in scores, particularly for the domains role physical, bodily pain, and social functioning, the decline after the fall progressed at more or less the same rate as before the fall. The scores for injurious fallers slowly receded back to levels of noninjurious fallers but remained lower than for nonfallers. No significant differences in slope were found in noninjurious fallers.

A key finding of this study is that fallers, and particularly injurious fallers, scored lower on physical functioning, role physical, bodily pain, and vitality 6–12 years before the first fall was reported since enrolment. This extends the finding from a qualitative study in which only a minority of the fallers described their lives as being good before the fall (4) and may suggest that the reduction in well-being is a consequence of physical and mental declines that increase the risk of falling rather than the fall itself. This could also explain why only a small proportion of the loss in well-being is attributable to the fall (Figure 1) (15), while the magnitude of the difference in well-being between fallers and nonfallers is substantial (Table 3) (5–7). The largest early differences appear to be for role physical and bodily pain domains, suggesting that factors affecting physical well-being may be more strongly associated with future fall risk. If this is the case, falls prevention programs may need a very long lead time if they are to effectively reduce falls risk. In addition, attention to the social needs would seem to be an important component of falls management.

Figure 1. Adjusted mean scores for each of the SF-36 subscales for noninjurious fallers (black circles), injurious fallers (light gray triangles), and nonfallers (dark gray squares) over time relative to the year of first reported fall. Nonfallers were matched with fallers and assigned the same timing of surveys (ie, years relative to the first fall). Adjustment was made for age at survey 2, education, depression, chronic conditions, and physical activity. Please note the variation in scaling on the y-axis. For the exact results of the linear mixed modeling, please refer to Supplementary Appendix B.
A systematic review of randomized controlled trials evaluating the benefits of interventions to prevent falls in terms of well-being found that 6 of the 12 studies showed significant improvements in quality of life (20). However, none of these trials reported a reduction in fall risk, suggesting that the beneficial effect on well-being is not explained by the prevention of falls. Depending on the content of the intervention program, other mechanisms may include improved management of chronic conditions, improvement in physical and cognitive functioning, and increase in social and physical activities. These findings may lend further support to the hypothesis that it is not falls but the presence of risk factors for falls that cause the disparity in well-being between fallers and nonfallers.

Strengths of this study include the large sample size and repeated measures of both falls and well-being over a 12-year period. An important limitation is that the recording of falls was based on a 12-month recall, which has been found to have a 89% agreement with medical charts data (21). Although calendar-based methods are generally preferred (22), underreporting of falls is an issue with all methods used. More importantly, the interval survey period was 3 years and thus, there was a gap of 2 years without falls measurement between two successive surveys. Also, no falls data were available for prior to 1999. The measure of the “first fall” is therefore a measure of the “first reported fall since enrolment” rather than the “first fall ever.” It is likely that some misclassification of nonfallers will have occurred. However, as a history of falls is the main predictor of future falls (23), it is likely that we did capture at least one fall for recurrent fallers. As the exact date of the fall was not known, no higher temporal resolution could be obtained, and we acknowledge there is up to 12 months of variation in timing since the reported fall and completion of the first survey after the fall. Although the initial sample was large (n = 10,434 in 1999), drop-out rates were substantial (62% in 2011) and mainly explained by deaths (28%) and frailty (13%). Comparison of the 1999 characteristics for women still in the study with those who dropped out (but still alive in 2011) showed that those in the study were younger, were less often living in nursing homes, were more educated, were less often depressed, had fewer chronic conditions, and were more active (p < .001; data not shown), suggesting that the results are biased towards the healthier women. However, the current findings were in line with those of previous studies, supporting the validity and robustness of the findings as well as the generalizability to the wider population of community-dwelling older people.

In conclusion, among older women, fallers, and in particular injurious fallers, have lower scores for well-being for all SF-36 domains than nonfallers. The gap in well-being emerges years before the fall occurs and continues to increase after the fall. This decline in well-being may be driven by underlying risk factors for falls rather than the fall itself. Injurious falls further contributed to the decline in role physical, bodily pain, and social functioning domains of well-being.

Supplementary Material
Supplementary material can be found at: http://biomedgerontology.oxfordjournals.org/

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