Association of stressful life events with incident falls and fractures in older men: the Osteoporotic Fractures in Men (MrOS) Study

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Abstract

Background: small, retrospective studies suggest that major life events and/or sudden emotional stress may increase fall and fracture risk. The current study examines these associations prospectively.

Methods: a total of 5,152 men aged ≥65 years in the Osteoporotic Fractures in Men study self-reported data on stressful life events for 1 year prior to study Visit 2. Incident falls and fractures were ascertained for 1 year after Visit 2. Fractures were centrally confirmed.

Results: a total of 2,932 (56.9%) men reported ≥1 type of stressful life event. In men with complete stressful life event, fall and covariate data (n = 3,949), any stressful life event was associated with a 33% increased risk of incident fall [relative risk (RR) 1.33, 95% confidence interval (CI) 1.19–1.49] and 68% increased risk of multiple falls (RR = 1.68, 95% CI = 1.40–2.01) in the year following Visit 2 after adjustment for age, education, Parkinson’s disease, diabetes, stroke, instrumental activities of daily living (IADL) impairment, chair stand time, walk speed, multiple past falls, depressive symptoms and antidepressant use. Risk increased with the number of types of stressful life events. Though any stressful life event was associated with a 58% increased age-adjusted risk for incident fracture, this association was attenuated and no longer statistically significant after additional adjustment for total hip bone mineral density, fracture after age 50, Parkinson’s disease, stroke and IADL impairment.

Conclusions: in this cohort of older men, stressful life events significantly increased risk of incident falls independent of other explanatory variables, but did not independently increase incident fracture risk.

Keywords: accidental falls, fractures, life change events, psychological stress, prospective studies, aged, male, men, older people

Introduction

One-third of community-dwelling adults aged ≥65 years fall at least once annually, half of whom have multiple falls [1–3]. Two to six percent of falls result in fractures [1–4]. While demographics, medical conditions, physical function, medications and sensory impairments are established predictors of falls [5–7] and fractures [8, 9], limited data suggest that stressful life events also may predict these outcomes [10, 11].
Many studies have examined the association between psychological stress and adverse health outcomes. According to the allostatic load model, environmental stress may trigger a neurohormonal response, leading to physiological dysregulation and adverse health outcomes [12]. However, perceived stress and physiological stress response may vary according to individual and social/environmental factors. Some but not all prospective studies report a positive association between stressful life events, such as death of a spouse, job loss or change in residence, and incident cardiovascular disease or mortality [13–17]. Numerous indices of allostatic load, combining inflammatory and metabolic biomarkers, have predicted increased risk of impaired physical function [12]. Two retrospective studies, including one conducted in long-term care residents, reported that major life events and sudden emotional stress increased risk of falls and fractures [10, 11].

We are unaware, however, of any studies that prospectively examined the effect of stressful life events on falls and fractures in community-dwelling adults, while effectively accounting for important confounding variables, including comorbid conditions, and measures of physical function and social integration. This, therefore, is the aim of the current study.

Methods

Participants

A total of 5,994 community-dwelling men aged ≥65 years enrolled in the Osteoporotic Fractures in Men (MrOS) study at six US sites (March 2000 to April 2002): Birmingham, AL; Minneapolis, MN; Palo Alto, CA; Monongahela Valley near Pittsburgh, PA; Portland, OR and San Diego, CA. Exclusion criteria included inability to walk without assistance from another person or bilateral hip replacement. Written informed consent was obtained from all participants. Institutional review boards at all centres approved the study protocol, and subject consent was obtained from all participants. Institutional review boards at all centres approved the study protocol, and institutional review boards at all centres approved the study protocol. Written informed consent was obtained from all participants. Institutional review boards at all centres approved the study protocol. We calculated change between MrOS baseline and Visit 2 for weight, self-reported co-morbid conditions, PASE score, IADL impairment, walk speed and chair stands. We also estimated scores at Visit 2 for several measures of social integration [23] ([living arrangement (alone, with spouse/partner, with other), social network score (1 point each for having ≥1 living children versus ≤2, and for having ≥1 confidants versus none), and social engagement score (1 point each for working, caregiving, and participating in non-religious and religious social groups)] and change in these scores compared with MrOS baseline.

Statistical analyses

For each participant, the number of types of stressful life events was categorized as any, none, one, two, three or more, or as the sum of types of stressful events. Differences in characteristics between participants with and without any stressful life event were assessed using Chi-square tests for dichotomous variables and t tests for continuous variables.

For 1 year following Study Visit 2, incident falls were categorized as ≥1 versus none, and ≥2 versus zero or one. Risks
of ≥1 incident falls, multiple incident falls and incident fracture were assessed using log binomial regression or Poisson regression with robust variance estimators, with results expressed as relative risks (RRs) with 95% confidence intervals (CIs) [24]. All models were adjusted for age. Additional covariables were included if, after age-adjustment, they were significantly (P < 0.05) associated with any stressful life event, and with incident falls (fall models) or incident fracture (fracture models). To investigate the impact of recent changes in health status on the association between stressful life events and falls, measures of change between MrOS baseline and Visit 2 in weight, physical activity, IADL impairment, walk speed, chair stands and newly reported comorbid conditions were separately added to multivariable models and included if statistically significant (P < 0.05).

We next examined whether several individual measures of social integration (i.e. living arrangement, social network, social engagement) or changes in these individual measures moderated the association between stressful life events and falls. We considered a variable a moderator if its interaction term was statistically significant in multivariable models (P < 0.05) [23].

Finally, to explore the association between different types of stressful life events and fall risk, separate age-adjusted models were created for each type of stressful life event.

All analyses were performed with SPSS, version 17 (Chicago, IL, USA).

## Results

Of 5,152 MrOS participants with complete stressful life events data in the year before study Visit 2 (fracture cohort), 2,932 (56.9%) reported ≥1 type of stressful life event, including 37.1% with one, 14.1% with two and 5.7% with ≥3 types of events (Table 1). Frequency of stressful life events was similar in the fall cohort (data not shown).

Compared with other MrOS enrollees not included in the fracture and fall cohorts, respectively, those in these cohorts were younger, more educated, had less IADL impairment, more physical activity, better physical function and fewer had comorbid conditions or past fractures (data not shown). Within the fracture and fall cohorts, compared with men with zero stressful events, those with ≥1 stressful life event were older, more often reported comorbid conditions and past fractures, had more IADL impairment and had worse physical function (see Supplementary data available in *Age and Ageing* online, Appendix Table S1). Compared with men included in multivariable-adjusted fall models, those excluded because of missing covariable data had poorer self-reported health (data not shown).

### Stressful life events and falls

Among 4,981 men with complete stressful life event and falls data, 27.7% fell and 14.7% fell multiple times during the year after Visit 2. Among men with 0, 1, 2 and ≥3 types of stressful life events, incident falls occurred in 21.9, 29.9, 35.5 and 39.9%, respectively.

In age-adjusted analyses, any stressful life event was associated with a 41% increase in risk for incident fall (RR = 1.41, 95% CI = 1.28–1.55) and a nearly 2-fold increase in risk for multiple incident falls (RR = 1.87, 95% CI = 1.61–2.18) (Table 2). Further adjustment for education, Parkinson’s disease, diabetes, stroke, IADL impairment, chair stand time, walk speed, multiple past falls, depressive symptoms and antidepressant use modestly attenuated these results. Results also suggested dose–response relationships between the number of types of stressful life events and fall risk. Effect estimates were not altered by further adjustment for measures of change between MrOS baseline and Visit 2 in weight, physical activity, IADL impairment, walk speed, chair stands, or newly diagnosed comorbid conditions, nor by adjustment for any social integration variables (data not shown).

However, the interaction between social network score and stressful life events was significant (P = 0.019) when added to the final multivariable model predicting incident falls. Stratified analyses suggested that fall risk associated with stressful life events may be inversely related to social network score, from RR = 2.18 (95% CI = 1.24–3.82) in those with a score of 0, to RR = 1.42 (95% CI = 1.20–1.68) and RR = 1.18 (95% CI = 1.01–1.38) in those with scores of 1 and 2, respectively.

Age-adjusted risk for incident falls appeared increased for most individual types of stressful life events. (see Supplementary data available in *Age and Ageing* online, Appendix Table S2) Few men experienced the death of their wife or partner.

### Stressful life events and fractures

During up to 1 year after Visit 2, 109 (2.1%) men experienced ≥1 incident fractures, including 75 (2.6%) men with ≥1 types of stressful life events and 34 (1.5%) men with no stressful life events. Any stressful life event was associated with a 58% increase in age-adjusted risk for incident clinical

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**Table 1. Proportion of men with stressful life events in the year prior to study Visit 2**

<table>
<thead>
<tr>
<th>Stressful event type</th>
<th>n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Any stressful event</td>
<td>2,932 (56.9)</td>
</tr>
<tr>
<td>1 type of stressful event</td>
<td>1,913 (37.1)</td>
</tr>
<tr>
<td>2 types of stressful events</td>
<td>727 (14.1)</td>
</tr>
<tr>
<td>3+ types of stressful events</td>
<td>292 (5.7)</td>
</tr>
<tr>
<td>Wife/partner death</td>
<td>75 (1.5)</td>
</tr>
<tr>
<td>Wife/partner illness/accident</td>
<td>915 (17.8)</td>
</tr>
<tr>
<td>Death other close relative/friend</td>
<td>1,809 (35.1)</td>
</tr>
<tr>
<td>Separated from child, friend or relative you depend on</td>
<td>134 (2.6)</td>
</tr>
<tr>
<td>Loss of important activity/hobby</td>
<td>670 (13.0)</td>
</tr>
<tr>
<td>Moved/changed residence</td>
<td>281 (5.5)</td>
</tr>
<tr>
<td>Serious financial trouble</td>
<td>166 (3.2)</td>
</tr>
<tr>
<td>Loss of pet</td>
<td>281 (5.5)</td>
</tr>
</tbody>
</table>

*Results for 5,152 men who completed the stressful life events questionnaire at study Visit 2.*
textually signiﬁcantly associated with increased risk of future falls. Fall risk increased further for men with more types of stressful events. Exploratory analyses suggested that fall risk subsequent to stressful events may be moderated by social network. By comparison, the age-adjusted association of stressful life events with increased risk of incident fractures did not appear independent of other explanatory factors.

To our knowledge, this is the ﬁrst prospective study to examine the association between stressful life events and risk of incident falls in community-dwelling older adults and to account for multiple confounders of this association. However, our ﬁnding of no independent association between stressful life events and risk of fracture contradicts an earlier case–control study [11]. In the prior study, fracture cases had signiﬁcantly more stressful events in the past year than did control subjects, but the control group was younger, and results were not adjusted for comorbidities, health status or BMD. Further, because stressful events data were collected after fracture, these earlier results were more prone to recall bias. In another study, elderly long-term care residents who recently had undergone the major life event of changing residence were at increased falls risk [25]. Although our results could be interpreted as validating this earlier study, since the prior study did not account for possible confounders, it is uncertain whether its ﬁndings can be attributed to the life event itself.

The association between stressful life events and falls observed in the current study appears moderate in strength, similar in magnitude to that associated with sedative use or urinary incontinence, but smaller than the risk associated with gait or cognitive impairment [5]. However, the mechanism connecting stressful life events to falls is uncertain. One possible explanation, suggested by the allostatic load model, is that stressful life events trigger a neurohormonal response, causing stress hormone release and multi-system physiologic dysregulation, leading to adverse health outcomes such as falls [12]. Some data suggest that inflammation, a potential indicator of physiological stress, could lead to loss of muscle mass [26] and impaired physical function. Alternatively, sudden emotions, possibly triggered by a stressful life event, could transiently impact balance or visual attention, leading to a fall [10]. Some studies also suggest that stressful life events might lead to worsened clinical outcomes by adversely impacting self-care behaviour [27, 28]. Our exploratory ﬁnding that fall risk associated with stressful life events appeared greater in men with a lower social network score suggests that stressful life events could lead to increased social isolation, which plausibly could lead to decreased physical activity, strength and balance, thereby increasing fall risk. Though we found no evidence that results were impacted by changes in physical activity or function between MrOS baseline and Visit 2, we had no data on changes in these measures between the stressful life event and MrOS Visit 2 to more directly investigate this pathway.

This study has numerous strengths. It provides the strongest evidence to date supporting stressful life events as a risk factor for falls. As a prospective cohort study in which participants were recruited from population-based sources, were
Stressful life events did not independently increase incidence of falls and fractures, results regarding the association between stressful life events and incident falls and fractures were less subject to selection bias than those from prior studies. Additional strengths included the nearly complete follow-up for incident falls and fractures, and the accounting for a comprehensive set of possibly confounding variables.

However, this study had several limitations. First, because recall of stressful life events is retrospective and stressful life events and falls are self-reported, both are susceptible to error. Secondly, because the timing of discrete stressful life events was not precisely known, analyses were limited in their ability to estimate the duration of their effect on falls. Thirdly, self-reported life events may not be equally stressful to all individuals, and no data were available to estimate participants’ resiliency or coping style and no measures of perceived stress or psychological stress were available to correlate with these life events. Fourthly, this study had limited power to examine the association between stressful life events and hip fractures, to examine dose relationships between stressful life events and fractures and to examine associations of specific types of stressful life events with falls and fractures. Fifthly, despite accounting for a comprehensive set of possibly confounders, we cannot exclude the possibility of residual confounding. For example, because of the timing of data collection, we could not account for whether changes in psychotropic medication use in the year after MrOS Visit 2 impacted risk of falls during that period. Finally, because men included in these analyses were community-dwelling, largely healthy men, even compared with other MrOS participants, study findings are prone to selection bias and may not apply to other populations.

In conclusion, we found that within this prospective cohort of community-dwelling older men, those with stressful life events in the past year had a significantly increased risk of falls and multiple falls during the subsequent year. Future studies are needed to confirm these findings and to investigate the mechanism that may underlie this association. Additional studies may explore whether clinical screening of older men with recent stressful life events for fall reduction interventions and/or a social network intervention will reduce falls.

Key points

- A recent history of one or more stressful life events increased risk of future falls in older, community-dwelling men, independent of multiple confounding factors.
- Though the association between stressful life events and falls observed in the current study appears moderate in strength, the mechanism is uncertain.
- Stressful life events did not independently increase incident fracture risk.

Conflicts of interest

None declared.

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Supplementary data

Supplementary data mentioned in the text is available to subscribers in Age and Ageing online.

References


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