Occupational Medicine 2005;**55:**292–297
doi:10.1093/occmed/kqi118

Falls and fractures in women at work

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Background Older women have been observed to have more serious injury particularly fractures after slips, trips or falls at the workplace. It is unclear whether this excess reflects a greater likelihood of falling or a greater proportion presenting with fractures once the fall has occurred.

Methods Two studies were carried out: Study A, of 130 women who fell at work and matched referents, and Study B, of 120 women who fell at work and sustained a major fracture and 314 matched referents who fell but for whom no fracture was recorded. In Study A, the workplace of the case and referent was observed, questionnaires completed and objective health measures carried out. Study B relied on information obtained from the subject by postal questionnaire.

Results Women who fell were older than referents matched on workplace and occupation, but age did not continue to be a significant factor after allowing for bodyweight and use of spectacles. Fractures were more common in older women who fell, particularly post-menopausal women with low body mass. The risk of fracture increased steadily with age without an obvious discontinuity around the likely age of menopause.

Conclusions The observed excess of fractures in older women falling at work appeared to be explained by the greater risk of fracture among those who fell.

Key words Age; falls; fractures; menopause; risk factors; women; workplace.

Introduction

In 1992–1993 the Health & Safety Executive, the UK government agency with responsibility for health and safety at work, noted in an unpublished analysis that major injuries (mainly fractures) resulting from slips, trips and falls at work had a higher rate in older (compared with younger) women. This could have resulted from differential reporting or confounding by job title but, in a previous report [1], it was shown that neither explanation was sufficient to explain the observed differences. However, the question remained whether it was the rate of falls or the rate of fractures following falls that was greater in the older women. Although there is considerable literature on studies to identify factors associated with falls and fractures, particularly of the hip in elderly women [2–5], there have been few in women of working age. Studies that have investigated non-occupational falls in women whose age spans the menopause have generally reported an increased proportion of falls in women over the age of 45 years [6–8]. There have been few studies of workplace injury in women and those that take detailed account of women's age are even rarer. A recent paper [9] using presentations at hospital emergency departments for occupational injury suggested that older women (55+ years) were not at increased risk from a fall at work (compared with younger women) but were more likely to be hospitalized.

In examining intrinsic factors for falls at work it is desirable to control for environmental risk by matching cases and referents on place and type of work. This approach was adopted in the two studies reported here. The first, a case-referent study of all reported falls, was designed to identify factors associated with falls whether or not they resulted in fracture. The second, a case-referent study of falls resulting in fracture (compared with falls without fracture), attempted to identify risk factors associated with fracture itself.

Methods

Study A: factors associated with falling

Identification of cases and referents

The occupational health departments of fourteen major employers in the public, service and manufacturing sectors in the north west of England agreed to notify the research team of every slip, trip and fall on the level in a woman (regardless of age) that resulted either in a major injury or an absence from work of three or more days [i.e.

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an injury reportable under the UK regulations then in place: Reporting of Injuries, Diseases and Dangerous Occurrences Regulations (RIDDOR) 1985]. The initial period of reporting was from April 1994 to March 1996; because of slow rates of accrual of falls, this period was eventually extended to May 1997. In total 137 falls were reported. Each case (a woman with a reported slip, trip or fall) was matched with one referent on job grade and place of work. The line manager of the case was asked to list all women working in the same area and grade of work, and the referent was chosen from this list using random number tables. In identifying the referent no account was taken of age.

Assessment of risk factors

The injury site was examined, blind to the age of the subject, using a structured checklist developed by the Institute for Occupational Ergonomics, University of Nottingham, based on their previous work. This was to assess the presence of slip, trip and fall hazards to establish whether older women, though in nominally the same job, were working under more hazardous conditions. Three sets of data were then collected for each case and referent.

Assessment of the work area. As soon as possible after the injury and the identification of the referent, a research assistant observed each subject carrying out their normal work in an area nominated by the supervisor as 'typical'. The work practices and conditions were recorded on a structured checklist of ergonomic factors, again developed by the Institute of Occupational Ergonomics and piloted by members of the research team. This included assessments of posture, proportion of time walking or lifting, and environmental conditions such as light, noise and the likelihood of being distracted. The data collected were to provide a check of comparability between the workplaces of case and referent. While planned as an assessment blind to case status, this was difficult to achieve in practice as others in the workplace (including the line manager and the persons observed in their 'typical workplace') will have been aware of the identities of the case and referent.

Workers' questionnaire. Each case and referent was interviewed as soon as possible after the injury about the demands of the job she was doing on the day of the injury, and about her clothing, health (including height, weight, eyesight and menopausal status), exercise patterns, mental state, recent life events, use of tobacco, alcohol and medication taken on the day.

Clinical checklist. During the first 2 years of the studies, cases and referents were invited to a medical examination 3 months after the injury to assess performance, fitness, disability and social habits (smoking, alcohol consumption). During the third year of the study, performance testing was carried out and information on social habits was collected by a non-clinical research assistant. All those seen by either the clinician or the research assistant were assessed on performance (errors, time) on a heel–toe test along a 3 m line and spinal flexion on a 'sit and reach' test. The participants seen by the clinician had blood pressure and visual acuity measured, both with glasses/contact lenses and without.

Response rates

Of the 137 injuries identified, data were available from both the case and the referent for 130 pairs (94.9%), and the reported analysis was restricted to these. Among these pairs, data on performance tasks were available for 63 pairs (48.5%) and on blood pressure and visual acuity for only 37 (28.5%). The median delay between injury and completion of the worker's questionnaire was 76 days (range 6–361).

Study B: factors associated with fracture in those who fell

Identification of cases and referents

All slip, trip and fall (on the level) injuries in female workers resulting in a major fracture (as defined in the RIDDOR regulations) were identified for the same 14 employers in the period from January 1988 to June 1995 (or until entry to Study A, if earlier). A case was any woman, regardless of age, who had sustained such a fracture. For each case the record from which the case had been identified (usually the 'accident book' for the workplace) was scrutinized to identify three referents. These were the female slip, trip or fall injuries closest in time (before or after) to the injury of the case. Referents were thus matched on place and time period of the injury but not on age or job title.

Identification of risk factors

A brief self-reported questionnaire, asking about the circumstances and nature of the injury and the participant's health at the time of the injury, was sent to the home address of each identified case and referent.

Response rates

A total of 143 cases was identified together with 429 matched referents. The number of cases and referents contacted successfully was similar for cases 121/143 (84.6%) and referents 367/429 (85.6%). For all but one case there was a least one matched referent and the analysis was restricted to 120 clusters with a total of 314 referents.

Statistical analyses

Both the analyses were designed as matched samples and the final statistical analysis was carried out by conditional logistic regression. In order to scan the very large number of potential risk factors in Study A, these were first examined in a series on matched analyses and any factor or variable related (at a probability level of $P < 0.10$) to case status either overall or in sub-analyses of young subjects (<45 years) or older workers (>45 years) retained for the logistic regression analysis. A similar procedure was followed (but without age stratification) for the case-referent analysis of Study B. For ease of presentation, where a continuous variable was entered into the regression analysis the odds ratio (OR) and the confidence intervals (CI) are presented for 10 unit blocks (e.g. 10 years, 10 kg).

Results

Study A: factors associated with falling

Cases were older (mean age 43.8 years; 95% CI = 42–45.8) than referents (mean age 40.3 years; 95%CI = 38.3–42.3) (paired $t = 2.73$; $P = 0.007$). Although cases and referents were in jobs of the same grade and work area some differences were found in the univariate matched analyses (Table 1). Cases were observed to spend more time lifting (cases 38.6% of time observed; referents 30.9%) and less likely to be subject to distraction by other people (cases 39.7%; referents 55.9%). Cases were more likely to report that they had been wearing a skirt (below mid-calf) on the day of the injury (cases 25.4%; referents 16.2%). They were also more likely than referents to report that they wore glasses (cases 73.8%; referents 60.8%) and have reached the menopause (cases 46.2%; referents 35.4%). Mean weight in kilograms (reported by the worker) was higher for cases (69.4; 95% CI = 67.1–71.8) than referents (65.1; 95% CI = 62.8–67.3). On the clinical assessment, cases were more likely to make at least one error on the tandem walk test (heel–toe test) (cases 45.4%; referents 25.6%). Diastolic blood pressure was higher in cases (mean diastolic blood pressure = 78.2; 95% CI = 74.2–82.2) than referents (mean diastolic blood pressure = 71.8; 95% CI = 68.4–75.1). Use of medication, specifically anti-depressants, was highly significant in relation to case status, with nine cases but no referents reporting such medicine ($P < 0.003$, Fisher's exact test). With allowance for age (also shown in Table 1) the effects of a number of these variables (particularly menopause) was reduced and the CI then spanned 1.0.

Use of anti-depressant medication, which was confined to cases, could not be entered in this analysis. In an analysis of all factors except tandem walk and diastolic blood pressure, only higher body weight and the need to wear glasses retained significance, when adjusted for other factors. Having adjusted for job differences, clothes, weight and glasses, age did not have an independent effect on the likelihood of falling (Table 2). Within the sub-population of those who had information on tandem walk and diastolic blood pressure, adjustment for other factors did not remove the univariate relationship with case status.

Study B: factors associated with fracture

In this study of fracture among those who fell, cases and referents were matched on employer and site of employment but not the level of work. Cases were more likely to be in manual or service jobs than referents and to report that the injury was caused by tripping over an obstacle (Table 3). Cases (mean age 49.9 years; 95% CI = 48.3–51.5) were older than referents (mean age 46.0 years; 95% CI = 43.9–48.1) with a steadily increasing risk for

Table 1. Matched analysis by conditional logistic regression—univariate analysis

Factor	Questionnaire	Unadjusted		Adjusted for age		Number of pairs
		OR	95% CI	OR	95% CI	
From unmatched analysis						
People distractions	Nominated area	0.29	0.13–0.63	0.32	0.14–0.70	125
Wears glasses	Worker	1.90	1.09–3.30	1.58	0.88–2.84	130
Reached menopause	Worker	1.61	0.96–2.71	0.92	0.43–1.96	130
Top quartile body mass	Worker	1.94	1.06–3.54	1.81	0.97–3.34	128
Heel–toe error	Medical	2.18	1.07–4.45	2.04	0.98–4.22	63
Weight in kg/10	Worker	1.30	1.07–1.59	1.26	1.02–1.55	128
BMI/10	Worker	1.81	1.07–3.08	1.59	0.92–2.75	128
Diastolic BP (mm Hg/10)	Medical	1.85	1.08–3.16	1.79	1.02–3.15	37
Other factors						
Proportion of time lifting/10	Nominated area	1.17	1.03–1.33	1.20	1.05–1.36	124
Long skirt (below mid-calf)	Worker	2.00	1.00–4.00	1.76	0.87–3.57	130

Table 2. Multivariate analysis of cases and referents with and without adjustment for age (122 matched pairs)

	Without age[a]		Age included	
	OR	95% CI	OR	95% CI
Proportion of time observed lifting/10	1.18	1.02–1.37	1.18	1.02–1.37
Likely to be distracted by other people	0.25	0.10–0.58	0.26	0.11–0.63
Weight (in kg/10)	1.34	1.07–1.74	1.35	1.06–1.73
Wearing long skirt (below mid-calf)	3.11	1.31–7.40	2.87	1.20–6.89
Wears glasses	2.19	1.16–4.13	1.97	1.02–3.83
Age (years)/10	–	–	1.18	0.87–1.60

[a]Reduction in deviance with addition of age = 1.17; $P = 0.28$.

fracture in each 10 year age group. With age 30 or less as the contrast (in which some 10% were cases) the OR increased to 2.7 (95% CI = 0.9–8.6) in the age group 30–39 years, 3.7 (95% CI = 1.4–10.3) age 40–49 years, 4.6 (95% CI = 1.7–126) age 50–59 and 6.1 (95% CI = 1.8–20.8) age 60 or greater, where 38% of those in the study were cases. In the univariate analysis (Table 4) women with fractures were much more likely to report that they had been through the menopause and that they needed to wear glasses and to take medication [other than hormone replacement therapy (HRT)]. An interaction was observed between body mass and menopausal status, with those having been through the menopause and having a body mass index (BMI) in the lowest quartile of subjects in this study (i.e. <21.8), being particularly at risk of fracture. Use of HRT, comparatively rare in this population, was associated with some reduction in the risk of fracture although did not reach significance.

The interaction of risk factors associated with fractures was investigated in a conditional logistic regression, summarized in Table 5. Only three factors were related to case status, having adjusted for other variables. These

Table 3. Hazard reported to be a factor in the injury[a]

	Cases (fractures)	Referents	Overall	*P*
Wet, slippery floor	47.2%	53.7%	52.0%	0.262
Steps, stairs and slopes	17.6%	18.4%	18.2%	1.000
Trip obstacles	19.4%	11.2%	13.4%	0.046
Uneven ground	13.0%	10.9%	11.4%	0.597
Poor lighting	3.7%	1.7%	2.2%	0.256
Carrying load	1.9%	2.4%	2.2%	1.000
Other hazard	8.3%	7.1%	7.5%	0.672
n	108	294	402	

[a]Twelve cases and 20 referents did not answer this question. Up to three hazards coded for each subject.

Table 4. Matched analysis (univariate) of factors associated with fracture (120 clusters)

Factor	OR	95% CI
Age (years)/10	1.52	1.22–1.90
Been through menopause	2.20	1.42–3.40
BMI below median (<23.8)	0.87	0.57–1.31
Post-menopause and low BMI (<21.8)	2.25	1.34–3.76
HRT use (ever)	0.89	0.46–1.73
Takes other medication	1.85	1.12–3.07
Wears glasses	1.81	1.17–2.81
Manual or service work	1.53	0.92–2.56
Reported trip obstacle	1.71	0.93–3.12

were age, the interaction between menopausal status and BMI, and the use of medication. As anticipated, the OR associated with the use of HRT was depressed, but did not reach conventional levels of significance when entered into the matched analysis (OR = 0.84; CI = 0.43–1.66) either for the sample as a whole or when the analysis was restricted to women who had entered or completed the menopause, for whom HRT might be indicated. Further inspection of the types of medication used suggested an increased risk ($P = 0.004$) associated with beta blockers (taken by 7.5% of cases but only 1.9% of referents) but not for other cardiovascular medications (including diuretics).

Discussion

The two studies reported here were designed to investigate whether older women were more likely to fall or, having fallen, to suffer fractures. Women who fell were indeed found, in Study A, to be older than the referents. Data (not shown) from review of the injury site did not suggest more hazardous conditions for the older than younger cases. This suggested that falls were due to intrinsic rather than extrinsic factors. Before allowance for age (but allowing for job differences) five factors were identified that related to the risk of slip, trip or fall injury. These were use of anti-depressant medication, need to

Table 5. Matched analysis (multivariate) of factors associated with case status (fracture)

	Factors 1–3		All factors	
	OR	95% CI	OR	95% CI
Age (years)/10	1.37	1.08–1.73	1.37	1.08–1.74
Post-menopausal and BMI <21.8	1.77	1.01–3.10	1.75	0.99–3.07
Use of medication (other than HRT)	1.79	1.06–3.02	1.79	1.06–3.04
Use of HRT (ever)	–	–	0.84	0.43–1.66

wear glasses, higher body weight, one or more errors on the tandem walk test and, in a much reduced sample, higher diastolic blood pressure. Menopausal status, postulated as an important risk factor for falling [6, 7], was not related to case status, having adjusted for other factors. When age was added to the model, it did not significantly improve the fit.

Each of the factors identified has been reported in previous studies. The EPIDOS study of women aged 75 or greater showed that falls resulting in hip fracture were much more common in those who had scored badly on the tandem walk test and who had poor visual acuity [2]. Occupational injuries have previously been reported to be more frequent in those with poor eyesight [10]. Increased risk of falls [11] and hip fractures [3] in older women (>66 years) taking anti-depressants has been reported. In our study anti-depressants were related to fall but not to fracture. In two studies of younger populations (women aged 45–49 years [6] and males involved in industrial injuries [12]), high body weight was associated with a high rate of falls. The small increase in diastolic blood pressure in women who fell in the present study seems unlikely to carry an important risk; a 'paradoxical' increase in diastolic pressure in those who had fallen was also reported [11] in a study designed to examine hypotension as a risk factor for falls.

Two conclusions are possible from the case-referent study of falls. Firstly, having adjusted as closely as possible for job demands and conditions, factors associated with falls in women of working age are strikingly similar to those of older women. Secondly, contrary to the speculations of Torgerson *et al.* [6], there is little evidence of a peak in risk of falls associated with the menopause. While it is apparent that women who fell were somewhat older than their closely matched referents, this relation is not maintained after adjustment for health-related factors; while factors such as overweight and wearing glasses are associated with increasing age, it is uncertain whether intervention to reduce weight or improve vision would indeed reduce injury in older women. However, the conclusion that age is not, in itself, an independent factor appears to be in concordance with the results of the recent study of occupational injury reaching the Emergency Room [9] and also the investigation of under foot injuries in women, which did not begin to arise until after the age of 65 [8].

In contrast, the risk of a fracture, given the fall has occurred, is strongly age dependent. There does not appear to be a distinctive increase in risk at the menopause, but women who have passed menopause and have a low body mass appear to be particularly at risk. The finding of older women being more likely to fracture is consistent with the other studies of women both at work [9] and at home [8]. The higher risk of women with low body weight has also been reported in a number of studies in older, non-working women [4]. The greater risk of fracture in women taking beta blockers does not appear to have been reported elsewhere.

The present study has limitations. It depends in large part on health and exposure factors reported by the subjects, sometimes a considerable time after the injury. Certain factors (body weight, use of glasses) can be validated on a subsample with the clinical examinations and the observations of the workplace were carried out blind (to the observer) to case status. However, the self-report of many factors, including clothing on the day of work, cannot be verified.

In this report only factors positively related to injury or fracture are reported. Many other factors (for example, use of alcohol, exercise frequency, recent life events) postulated to be related to risk of falling showed no relation to case status in this study [13]. This absence of positive effects may in part have been due to the risk of overmatching, on occupation and work site, which is likely to have reduced the power of the study to detect occupational, but not necessarily social, risks. The marked, but unexpected, difference in the likelihood of distraction by other people among the cases may simply be an artefact of the method used, a chance result or possibly the identification of social isolation as a potential risk factor.

The study also has some strengths. It does not depend, as have others, on the patient presenting for treatment, for example to the Emergency Room, which will tend to force selection of controls from those with relatively serious injuries. In the present study, the referents for women with fracture had indeed to have had a fall (and to have reported it at work) but not to have necessarily sustained any significant injury or to have taken time off work. The response rate of those approached was high. In contrast we do not know how complete the reporting was in Study A (which depended on the companies to notify us of an event). Finally, the employers used were not a random sample and though they covered a wide range of work and industries, including manufacturing and health services, they may not have included some jobs in which older women may be particularly at risk.

The objective of Study A was, in part, to identify differences in the workplace or associated behaviour that could potentially be modified to reduce risk for future employees. We were largely unsuccessful in meeting this objective. Risk of slips and trips are identified in Study B as relating particularly to wet or slippery floors and this is consistent with the analysis of slip and trip injuries in older women attending Emergency Rooms in the US [9] where floor contaminants (19%) and trips over obstacles (18%) were the most commonly identified factors for women over 55 years.

The studies reported here show a strong relation between fracture and age and a more equivocal one between age and falls. Davies and colleagues, in a discussion of injuries in the home, argue that osteoporosis following menopause is insufficient to account for the step rise in 'under foot' (but not in other) injuries and postulates that changes in muscle strength and reaction time may be responsible for the chain of events leading to fracture [8]. In contrast, Layne and Pollock argue that the lack of a clear increase in falls with age suggests that interventions in the workplace should be targeted at all workers (rather than simply older ones) [9]. Our data would tend to support this position and suggest a need for prevention strategies aimed at the whole working population.

Acknowledgements

This study was funded in part by the UK Health & Safety Executive. Any opinions or conclusions expressed in this paper are those of the authors alone and do not necessarily reflect Health & Safety Executive policy. The ergonomic checklists for the injury site and the nominated work site were developed in collaboration with the Institute of Occupational Ergonomics, University of Nottingham. We are also indebted to the following individuals for their tireless efforts to identify subjects and to their employers at that time for agreeing that the organization should be included in the study: Dr David Batman, Dr Mike Baxendine, Mr Frank Chamberlain, Dr Adrian Chojnacki, Ms Mary Crawford, Dr Steve Deacon, Dr Malcolm Gatley, Dr Clive Harker, Dr Brian King, Dr Donald Menzies, Dr Peter Oliver, Dr Elizabeth O'Neill, Dr Gordon Parker, Dr Mark Popplestone, Dr Susan Robson, Dr Fennella Rennie and Ms Angela Spencer.

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