We investigated the excess mortality risk associated with fractures of the hip. Data related to 29 134 patients who underwent surgery following a fracture of the hip were obtained from the Scottish Hip Fracture Audit database. Fractures due to primary or metastatic malignancy were excluded. An independent database (General Register Office (Scotland)) was used to validate dates of death. The observed deaths per 100 000 of the population were then calculated for each group (gender, age and fracture type) at various time intervals up to eight years. A second database (Interim Life Tables for Scotland, Scottish Government) was then used to create standardised mortality ratios. Analysis showed that mortality in patients aged > 85 years with a fracture of the hip tended to return to the level of the background population between two and five years after the fracture. In those patients aged < 85 years excess mortality associated with hip fracture persisted beyond eight years. Extracapsular hip fractures and male gender also conferred increased risk.

Fracture of the hip is a common reason for admission to trauma units in the United Kingdom and is associated with significant morbidity and mortality. The costs of managing these fractures are considerable and are likely to rise because of the increasing age of the population. Reports of mortality in the first year after fracture of the hip vary widely, between 13% and 30%. There is a tendency towards lower mortality in the United States and Scandinavia, but higher in the United Kingdom. Male gender, increasing age and medical comorbidity are all associated with increased mortality. However, there is conflicting evidence about whether extracapsular fractures are associated with increased mortality. 

Most studies report mortality following fracture of the hip as a simple percentage and do not take into account the background mortality rate of the age- and gender-matched general population. It is therefore difficult to assess the additional risk that a fracture of the hip confers. Hence, although mortality is higher in older people following hip fracture, the standardised mortality rate appears to be higher in younger patients. Although there are many studies assessing mortality in the short term, typically at one year, following hip fracture, less is known about the longer term mortality risk. Studies to date have conflicting outcomes. Some suggest that the additional mortality risk associated with hip fracture ends by two years. Others feel that the period of increased risk persists for as much as ten years.

Our study examined the influence of hip fracture on mortality in 27 685 patients up to eight years following fracture, accounting for differences between the age distribution of the general population and patients with a fracture of the hip. Five-year survival tables were also created. This information should provide orthopaedic surgeons with a better understanding of the true mortality risk associated with hip fracture.

Patients and Methods

The analyses were performed using two separate databases. The Scottish Hip Fracture Audit database has recorded information on all hip fractures in patients aged ≥ 50 attending participating hospitals in Scotland since 1998. Data up to 2005 were available for analysis. Data relating to fractures and treatment up to 120 days after surgery were collected prospectively from individual hospitals and used to create a national database. The information recorded included gender, date of birth, date of first fracture, date of any subsequent fracture, fracture type and date of death. An independent government database (General Register Office (Scotland)) listing deaths up to 2006 was used to validate existing dates of death and complete missing dates for patients in the Scottish hip fracture audit dataset.
Fractures due to primary or metastatic malignancy were excluded from the analysis. The data were aggregated to provide the total number of deaths and cases for each gender, age and fracture type. The observed deaths per 100,000 of the population were then calculated for each group at four months, eight months, one year, two, five and eight years from injury.

A second database recording mortality data for the whole population of Scotland was used. The Interim Life Tables for Scotland (Office for National Statistics, Scottish Government) calculated for the period 2004 to 2006 provide gender- and age-specific estimates of population, mortality and probability of death within the following year. These data were weighted to account for differences between the age distribution of the general population and the hip fracture sample.

The expected deaths per 100,000 of the population were then calculated for each gender and age group, and the mortality projections formulated for the time intervals used in the first database. Survival among different groups within the Scottish Hip Fracture Audit population (e.g. age, gender, fracture type) was then compared at these time intervals using the log-rank chi-squared test. The degree of freedom for each test was one. A p-value of < 0.05 was considered statistically significant. Standardised mortality ratios were then calculated using the formula: observed deaths/expected deaths for each fracture group and time interval.

Results
A total of 30,479 fractures in 29,134 patients were recorded during the study period. Of these, 1,499 patients (5.0%) had a pathological first fracture due to primary or metastatic malignancy and were excluded from further analysis. The majority of fractures occurred in women (21,419, 77.4%) and the mean age at the time of fracture was 81 years in women and 77 years in men. A summary of mortality following hip fracture is shown in Table I. The five-year survival is shown in Table II. Half of all deaths in the first year after fracture occurred by day 65 (Fig. 1). Survival was lower among older patients (chi-squared = 1677.3, p < 0.001) and in men (chi-squared = 253.7, p < 0.001) (Fig. 2). Patients with extracapsular fractures had a lower survival rate (chi-squared = 67.3, p < 0.001) (Fig. 3). Patients presenting with a second hip fracture had a substantially lower survival rate (chi-squared = 12.5, p < 0.001) (Fig. 4).

Standardised mortality rates were higher in younger patients and in men. In both men and women in the > 85 age group this fell to 1 (i.e. was not statistically distinguishable from the mortality of the general age/gender-adjusted population) between two and five years. Patients < 85 had a standardised mortality ratio > than 1 at least eight years following fracture (Table III, Figs 5 and 6).

Discussion
The Scottish Hip Fracture Audit database has become a valuable resource for the analysis of hip fractures, their associations and outcomes. Detailed information from this database regarding early mortality following hip fracture
has already been published.2,22,23 This study used the database to investigate longer term outcomes following fracture and to quantify them in a manner directly comparable to other populations.

Most studies examining survival following hip fracture use absolute mortality rates as an outcome measure. Although this can be helpful in monitoring outcome over time in a particular geographic area, crude mortality rates do not reveal the excess mortality risk attributable to the fracture and its management. It is also difficult to compare results meaningfully between countries with different life expectancies. Standardised mortality rates provide a convenient way of demonstrating excess mortality within a particular population. However, they are time-consuming to calculate and rely on accurate life expectancy data for the background population. Our study had the advantage of being able to validate locally collected data (Scottish Hip Fracture Audit) with independently collected data on mortality at a national level (General Register Office (Scotland)). Detailed life tables for the general population in Scotland were also available.

The majority of studies reporting mortality following hip fracture do not record survival beyond one year. Longer term studies suggest that excess mortality associated with the hip fracture may persist for many years.12,19 Our study supports this finding, especially in those patients aged < 85. In this group, increased mortality was noted for at least eight years after hip fracture. Mortality in patients aged > 85 years tended to return to the level of the background population between two and five years after fracture.

As would be expected, absolute survival following hip fracture was higher in younger patients. However, it is clear that the standardised mortality ratio rates show the reverse pattern: younger patients exhibit significantly higher mortality over a sustained period compared to the age- and gender-matched general population. This is consistent with other studies12,24 and presumably reflects the greater discrepancy in health (such as excess alcohol consumption, or use of steroids25) between younger patients with hip fractures and their peers.

Patients with intracapsular fractures had significantly better survival rates than those with extracapsular fractures. A similar but more pronounced discrepancy in survival was reported by Karagiannis et al.20 Other short-term studies have also highlighted this difference.1,13,26 Whereas some of these studies point out that extracapsular fractures tend to occur in older patients, even when
this is factored for, as in our study, the discrepancy remains. This probably reflects the different nature of these fractures. Extracapsular fractures tend to occur in patients with greater medical comorbidity and worse osteoporosis.14,27,28

Most studies examining mortality following hip fracture report it as an absolute figure. Although this may be useful for audit purposes to assess outcome within a department or geographical area, the wide variation in reported mortality makes it difficult to compare different populations meaningfully or to assess the additional mortality risk that a fracture confers. This study has circumvented the problem by using standardised mortality rates. It shows that excess mortality associated with hip fracture persists for several years after the original injury, and beyond eight years in those patients < 85 years of age.

### Table III. Table of standardised mortality ratios (SMRs)

<table>
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<tr>
<th>Age range (yrs)</th>
<th>4-month</th>
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<th>12-month</th>
<th>2-year</th>
<th>5-year</th>
<th>8-year</th>
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<tbody>
<tr>
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<td></td>
<td></td>
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<tr>
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<td>50 to 64</td>
<td>16.24</td>
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<td>2.19</td>
<td>2.32</td>
<td>2.45</td>
</tr>
</tbody>
</table>

General population SMR is 1. If age-gender-specific SMR and CIs are > 1, SMR value is significantly different from general population SMR. CI, confidence interval.

### Graphs

**Fig. 5**
Graph showing hip fracture standardised mortality rates for men. Owing to the small numbers of patients in the 50- to 64-year age groups and the consequent volatility of the associated standardised mortality ratios (SMR), these have been removed. Overall figures include members of the 50 to 64 age group.

**Fig. 6**
Graph showing hip fracture standardised mortality rates for women. Owing to the small numbers of patients in the 50- to 64-year age groups and the consequent volatility of the associated standardised mortality ratios (SMR), these have been removed. Overall figures include members of the 50 to 64 age group.
Extracapsular hip fractures and male gender also confer increased risk.

**Supplementary material**

A more detailed explanation of the weighing process is available with the electronic version of this article on our website at www.jbjs.org.uk

We thank Dr J. Kerssens and Dr M. Macleod for their helpful advice on statistical techniques. We also thank the Scottish Hip Fracture audit local co-ordinators for their hard work in participating hospitals throughout Scotland.

No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

**References**


