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ABSTRACT

Background Previous trend studies have shown large increases in hip fracture incidence rates among the elderly. International research, however, suggests a levelling off, or decline, of hip fracture incidence rates, although for Sweden this remains to be studied.

Methods Data were obtained regarding hip fractures among individuals 65 years and above from 1987 to 2009. Analysis was performed in three steps. First, age- and sex-specific trends in hip fracture rates per 100 000 and the mean age when sustaining a hip fracture were analysed. Secondly, the annual percentage change was used to compare time periods that helped to quantify changes in secular trends. Finally, linear and Poisson regression models were used to examine the trend data and observed rates.

Results The absolute number of hip fractures among the elderly in Sweden has largely remained constant between 1987 and 2009, while incidence rates have decreased for all age- and sex-specific groups, with the largest changes in the younger age groups and among women. The mean age of sustaining a hip fracture has increased for both men and women.

Conclusions This study supports other international studies in showing a decrease in hip fracture incidence rates among the elderly, especially since the mid-1990s.

Keywords epidemiology, falls, hip fractures, injury, trend

Background

During the end of the 20th century, Sweden had amongst the highest levels of hip fracture incidence in the world among the elderly.¹ Also, previous hip fracture prognoses have estimated an exponential increase in hip fracture rates with a worldwide estimate of 6.3 million hip fractures per year in 2050.²,³ In Sweden, the incidence rate for hip fractures among those 50 years and above increased from 330/100 000 in 1966 to 510/100 000 in 1986.⁴ Similar trends were also observed in Finland among individuals 60 years and over with an increase from 163/100 000 in 1970 to 510/100 000 in 1997 and indicated a continued increase in hip fracture incidence.⁵ However, other, more recent studies have shown downward or stabilizing trends in Denmark, Finland, Canada, Switzerland and the Netherlands.⁶–¹⁰ The downward trends observed have generally started in the mid-to late 1990s.⁵,⁷,¹⁰ Alternatively, the decreasing trend has been ongoing from the 1980s but increased in pace from the late 1990s.⁸,⁹ Other national studies in Germany and Austria have, during the same time period, shown an increase in hip fracture incidence.¹¹,¹² However, although showing a general increase in hip fracture incidence, Icks et al.¹¹ show that the incidence rates for women 74 years or younger has decreased, while the incidence for women 75 years and above has continued to increase. A local study from Sweden has also showed a similar development with Bergstrom et al.¹³ showing a decrease among the younger elderly while an increase can be seen in the older elderly between 1993 and 2005. This is supported by worldwide studies showing that the average age of sustaining a hip fracture has increased by ~1 year for every 5-year period, resulting in an average age of 79 years in industrialized countries.¹⁴
Abrahamsen and Vestegaard\(^6\) showed a large decrease in hip fracture incidence rates with decreases of 20% over 20 years for both sexes. Kannus \textit{et al.}\(^7\), however, show a much larger decrease for women, compared with men, although both show a decreasing trend. Other authors also show differences between the sexes.\(^9\),\(^10\)

From a Scandinavian perspective it is interesting to note that although national studies have been published from Denmark and Finland, only smaller local studies have been published in Sweden.\(^13\),\(^15\) While Bergstrom \textit{et al.} showed a decrease in hip fracture incidence, Rosengren \textit{et al.} found no difference between 1987 and 2002.

It is also noteworthy that a peak in hip fracture incidence has been observed that appears to occur during approximately the same period; the middle to end of the 1990s.\(^6\)–\(^10\) The reason behind this change in trends has been discussed in previous studies and a number of hypotheses have been suggested. For example, a healthier elderly population, an increase in Body Mass Index (BMI) among the elderly population, improved functional ability, improved treatment of osteoporosis or fall prevention programmes are suggested as possible causes for the shift in trends.\(^6\)–\(^8\) However, during the 1990s, in Finland, fall prevention strategies and osteoporosis treatment were rare and would have only a marginal effect on the hip fracture trend. Instead, increases in BMI and healthier elderly populations are suggested as plausible causes for the decline.\(^7\) Healthier elderly populations may also help to explain why the average age of sustaining a hip fracture has steadily increased.

Reports from both Sweden, and internationally, have presented prognosticized increases in hip fractures among the elderly\(^2\),\(^16\) based on demographic changes solely, without taking the dynamics of incidence risk into account. A continued increase in hip fracture incidence in Sweden would mean a large increase in healthcare costs and planning for such events would be critical in order to cope with this burden. New injury epidemiological research paints a potentially different picture with regard to hip fracture incidence rates. No national study in Sweden has, since 1987, examined trends in age- and sex-specific rates. This study aims to present trends in hip fracture rates between 1987 and 2009, separately by sex and age (65–79, 80 years and above) in Sweden, using Swedish national data.

### Methods

#### Data source and selection

Data for this study were obtained from the Swedish Patient National Register regarding hip fractures among those 65 years and above and information on gender and age, on a yearly basis, from 1987 to 2009. Hip fractures have in this study been defined as 820.x according to the International Classification of Diseases (ICD9) and S720–7229 (ICD10). Sweden used ICD9 between 1987 and 1996 and ICD10 between 1997 and 2009. The National Patient Register (NPR) includes all hospital admitted patients and their diagnoses. The NPR has existed since 1964, but it was not until 1987 that the reporting system was all-encompassing, covering all counties. Therefore, this study begins with 1987, when data are considered valid and reliable.\(^17\) Population data were obtained from Statistics Sweden. Due to the Swedish Personal Identification Number (PIN), the data are highly reliable with 99.9% of the Swedish population having a PIN.\(^18\)

### Statistical analysis

The statistical analysis for this study was performed in three steps. First, age- and sex-specific hip fracture rates per 100 000 and the mean age when sustaining a hip fracture were trend analysed using data reported from the Swedish Patient National Register. Secondly, the annual percentage change (APC) was used to compare time periods that helped to quantify changes in secular trends. Two periods were detected from the trend analyses that indicated two piece-wise linear fits (1987–1996 and 1997–2009), connected to each other at one specific year (1996) for both men and women. Finally, a linear regression model for the entire study period were used to examine the trend data and observed rates. Hip fracture incidence rates (/100 000) were used as a dependent variable in the linear model. All statistical analyses were performed using the Statistical Package for the Social Sciences software (version 15.0). \(P\)-values at \(<0.01\) and \(<0.05\) were considered as significant levels.

### Results

Between 1987 and 2009 the total number of hip fractures among the elderly (65 years and above) in Sweden has remained fairly stable with a very slightly decrease from 20 448 to 20 291. However, as is clear from Fig. 1, hip fracture incidence rates have varied with regard to trends. In the older age groups, increasing trends are seen from 1987 until the ICD coding change in 1997 to thereafter decrease and finally level off from 2001 until 2009. The younger age groups have had a stable trend from 1987 to 1996 to thereafter decrease.

During the entire studied time period (1987–2009), hip fracture incidence rates for all age- and sex-specific groups decreased with the largest absolute decrease amongst
women 80 years and above (from 4341 to 3364 per 100 000) and the largest percentage decreases in the younger age groups (men 65–79: from 476 to 363 per 100 000; −23.7% and women 65–79: from 918 to 581 per 100 000; −36.7%). In the older age group a large difference is seen between the sexes (men 80+: from 2258 to 2242 per 100 000; −0.7% and women 80+: from 4341 to 3364 per 100 000; −22.5%). Between 1987 and 1996 the hip fracture incidence rates increased for all age- and sex-specific groups with large increases among men (65–79: from 476 to 540 per 100 000; +13.5%, 80+: from 2258 to 2632 per 100 000; +16.6%) and only marginal increases among women (65–79: from 918 to 943 per 100 000; +2.8%, 80+: from 4341 to 4423; +1.9%). During the later time period (1997–2009), the hip fracture incidence rates decreased for all age- and sex-specific groups with the largest decreases among the younger age groups (men 65–79: from 514 to 363 per 100 000; −29.4% and women 65–79: from 882 to 581 per 100 000; −32.8%) while slightly more moderate decreases were seen in the older age groups (men 80+: from 2514 to 2242 per 100 000; −10.8% and women 80+: from 4305 to 3364 per 100 000; −21.9%; Fig. 1 and Table 1).

During the studied time period the mean age of sustaining a hip fracture, among those 65 years and above, has steadily increased from 81.3 (women) and 79.8 (men) in 1987 to 83.8 (women) and 82.1 (men) in 2009 (Fig. 2).

Correlation coefficient ($r$), coefficient of determination ($r^2$) and regression coefficient ($B$) for linear regression models of hip fracture incidence rates per 100 000 (as a dependent variable) and year, life expectancy at 65 years and mean age at hip fracture (as independent variables) are shown in Table 2. The univariate regression models showed...
that the hip fracture rates associated at very significant levels ($P < 0.01$) with increasing calendar year, life expectancy at 65 years and mean age of hip fracture for most age- and sex-specific groups, apart from men 80 years and above. However, the association between the dependent and independent variables were significant at $P < 0.05$ levels for men 80 years and above. Hip fracture rates among the younger age groups for both sexes showed stronger association with calendar year, life expectancy at 65 years and mean age of hip fracture than their elderly counterparts, with the strongest association among the younger women (Table 2).

### Discussion

**Main findings of this study**

The results from this study support previous studies from other countries and indicate a change in the hip fracture incidence trends compared with studies published during the end of the 20th century.\textsuperscript{6–9} Although the absolute number of hip fractures has remained practically constant between 1987 and 2009, the age- and sex-specific groups, as well as the total elderly population (65 years and above), have all decreased in terms of hip fracture incidence rates.

#### What is already known on this topic

The results of this study also support previous studies that have shown larger decreases in hip fracture incidence rates within the younger age groups (65–79 years)\textsuperscript{8,9} as well as studies showing larger decreases among women, compared with men.\textsuperscript{7,8} This may be linked to the continued increase in the mean age of sustaining a hip fracture for both men and women. Between 1987 and 2009 the mean age has increased by 2.5 years for women (from 81.3 to 83.8) and by 2.3 years for men (from 79.8 to 82.1). This is equal to a 1 year increase for every 8.8 years (women) and 9.5 years (men) and considerably less than a 1 year increase for every 5 years that previous studies have suggested.\textsuperscript{14} With the mean age of hip fractures continuing to increase it is understandable that also the hip fracture incidence rate in the younger age group decreases. However, although the relative decrease is largest in the younger group, it should be noted that the absolute change in incidence risk is considerable also among older women. This, in combination with percentage decreases in the total population above 65, suggests that an increased mean age does not fully explain the decreasing trend. During the studied time period, the total life expectancy at 65 in Sweden has increased from 83.7 to 86 (2.3 years) for women and from 79.8 to 83.1 (3.3 years) for men,\textsuperscript{19} indicating a general health improvement among the elderly. Although hip fractures are still considerably more common among women, the difference in the percentage change during the studied time period between men and

### Table 1 Percentage changes in absolute number and incidence rates (/100000) of hip fractures by age- and sex-specific groups

<table>
<thead>
<tr>
<th>Time period</th>
<th>Changes in absolute number of hip fractures, 65–79 years, males (%)</th>
<th>Changes in incidence rates, 65–79 years, males (%)</th>
<th>Changes in absolute number of hip fractures, 80 years and above, males (%)</th>
<th>Changes in incidence rates, 80 years and above, males (%)</th>
<th>Changes in absolute number of hip fractures, 65–79 years, females (%)</th>
<th>Changes in incidence rates, 65–79 years, females (%)</th>
<th>Changes in absolute number of hip fractures, 80 years and above, females (%)</th>
<th>Changes in incidence rates, 80 years and above, females (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1987–1996</td>
<td>10.1</td>
<td>13.5</td>
<td>46.7</td>
<td>16.6</td>
<td>−0.4</td>
<td>2.8</td>
<td>27.7</td>
<td>1.9</td>
</tr>
<tr>
<td>1997–2009</td>
<td>−19.8</td>
<td>−29.4</td>
<td>9.1</td>
<td>−10.8</td>
<td>−32.8</td>
<td>−34.2</td>
<td>−12.4</td>
<td>−21.9</td>
</tr>
<tr>
<td>1987–2009</td>
<td>−16.4</td>
<td>−23.7</td>
<td>55.3</td>
<td>−0.7</td>
<td>−37.9</td>
<td>−36.7</td>
<td>10.6</td>
<td>−22.5</td>
</tr>
</tbody>
</table>

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women 80 years and older, with considerably larger decreases among women compared with men, warrants more research. Possible explanations for this are that preventative efforts have been focused on women rather than the total elderly population, a higher mean age for sustaining hip fractures for women compared with men or a difference in body mass distribution among men and women.

**What this study adds**

Previous studies on hip fracture incidence rates have shown that the largest decreases are seen from the late 1990s. In this study, a decreasing trend can be seen in the younger age group between 1987 and 1996. However, from 1996, the decrease in hip fracture incidence is much more rapid for both sexes, a pattern that has been shown in previous studies. In the older age group, the rates for women are fairly constant until 1996, when the decrease starts. For men in the older age group, the rates increase until 1996 to then fall back to similar levels as in 1987. As similar peaks have been shown in other countries there seems to be an international likeness. Previous Scandinavian studies have suggested that the decrease in the late 1990s has its cause in individual factors or national preventative policies. If this were the case in Sweden then it would be expected that this peak also would be seen in the trend of the mean age of sustaining a hip fracture as a dramatic change in national policy or individual health factors also would be expected to affect the mean age. This is not seen in this study and therefore other causes should be investigated.

**Limitations of this study**

This study has some limitations. First, comparisons with other national studies with regard to incidence rates for the total elderly population are difficult as different definitions of elderly have been used in other studies. We decided to use hip fracture data among individuals above 65 years and older, as the general definition of elderly are individuals 65 years and above. Other studies have used data on individuals 50 years and above, 55 years and above, 60 years and above, and 65 years and above.

Secondly, the change in ICD coding, which in Sweden occurred in 1996, may influence the data although to what degree is difficult to assess. Although changes in ICD coding have previously been shown to affect injury trends, previous studies on hip fractures from Canada suggest that the ICD change had a minimal effect, albeit on an already decreasing trend. If the ICD change had solely affected the
Conclusions

This study supports previous studies from other countries in showing a decrease in hip fracture incidence among the elderly, especially among women and the younger elderly (65–79 years). Also, a decrease in incidence in the older group is apparent in the 1990s but has thereafter stabilized. This study can also show that the actual number of hip fractures has, in 2009, returned to the same level as in 1987. The causes behind the decrease in hip fracture incidence among those 65 years and above in Sweden will be important to study in the future in order to advise countries that still have increasing hip fracture incidence on effective preventative measures. The continued increase in the mean age warrants more research to investigate its effect on hip fracture-related morbidity and mortality, with hip fractures affecting a potentially older and frailer population.

References


