The influence of socioeconomic status on the incidence, outcome and mortality of fractures of the hip

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This is the first study to use the English Indices of Multiple Deprivation 2007, the Government's official measure of multiple deprivation, to analyse the effect of socioeconomic status on the incidence of fractures of the hip and their outcome and mortality. Our sample consisted of all patients admitted to hospital with a fracture of the hip (n = 7511) in Nottingham between 1999 and 2009.

The incidence was 1.3 times higher (p = 0.038) in the most deprived populations than in the least deprived; the most deprived suffered a fracture, on average, 1.1 years earlier (82.0 years versus 83.1 years, p < 0.001). The mortality rate proved to be significantly higher in the most deprived population (log-rank test, p = 0.033), who also had a higher number of comorbidities (p = 0.001).

This study has shown an increase in the incidence of fracture of the hip in the most deprived population, but no association between socioeconomic status and mortality at 30 days. Preventative programmes aimed at reducing the risk of hip fracture should be targeted towards the more deprived if they are to make a substantial impact.

A fracture of the hip is a frequent and serious manifestation of osteoporosis. It is a common cause of disability and death in the elderly, with a mortality at one year of 33%. The World Health Organization has estimated that the population of the world aged 65 and over will increase by 88% over the next 25 years. This will have a direct impact on the prevalence and incidence of fractures of the hip, as well as important consequences on social and public health. The total cost of fractures of the hip in the United Kingdom is currently estimated to be more than £1.4 billion per year, with a mean length of stay in hospital of 26 days (12 to 38).

Socioeconomic status has for many years been linked with morbidity and mortality, with those of higher status enjoying better health. This suggests that the identification of factors which influence socioeconomic status and health, such as income, occupation, housing and education, is important in reducing inequalities within society. There is little evidence that specifically addresses the association between socioeconomic status and the incidence and mortality of patients with a fracture of the hip. There is wide variation in the literature: some studies show an association between the incidence and mortality of patients with a fracture of the hip and social class, whereas others do not. To our knowledge there have been no published studies using the English Indices of Multiple Deprivation (IMD) 2007 (the United Kingdom Government’s official measure of deprivation) to analyse the influence of socioeconomic status on the incidence and mortality of patients who sustain a fracture of the hip.

Our aim was to determine whether socioeconomic status based on the IMD 2007 influences the incidence and mortality of patients with a fracture of the hip in an English population.

Patients and Methods

The concept of multiple deprivation. The IMD 2007 is based on small geographical areas known as Lower Super Output Areas (LSOAs). These areas have a mean population of 1500, which allows the identification of small pockets of deprivation and can highlight variations within a wider geographical area. The IMD 2007 describes the LSOAs by combining information from seven domains: income deprivation; employment deprivation; health deprivation and disability; education skills and training deprivation; barriers to housing and services; living environment deprivation; and crime. These domains are weighted and combined to give the overall IMD score. Based on this score, each of the LSOAs in England and Wales is ranked from 1 (most deprived) to 32 482 (least deprived).
Study population. Our sample consisted of all patients aged > 65 years who were admitted to Queen’s Medical Centre, Nottingham, with a fracture of the hip. This is the only hospital in Nottingham to admit these patients. Data were collected prospectively over a ten-year period between May 1999 and May 2009, and details of the patient’s postcode, number of comorbidities, length of stay, type of fracture, pre- and post-hospital residence and mortality were recorded. All data collection was carried out by independent audit personnel using a standard proforma. Population statistics were collected from the Nottingham Census of 2001, together with IMD, and linked to patients by individual postcodes. Mortality data were cross-linked to National Office of Statistics data. IMD scores range from 0 to 85. The higher scores are associated with a higher level of deprivation. National quintiles were estimated by ordering the scores of all LSOAs and then dividing them into five equal quintiles (first quintile, least deprived; fifth quintile, most deprived). The IMD score was calculated for each patient in the cohort and placed into the respective quintile.

Statistical analysis. All data were analysed using SPSS for Windows version 14.0 (SPSS Inc., Chicago, Illinois). Microsoft Excel 2003 (Microsoft, Redmond, Washington) was used as a database. Mortality was analysed with Cox’s regression analysis and mortality curves were generated by Kaplan-Meier survival analysis. Survival curves were compared using log-rank tests. Continuous data were analysed by independent samples t-tests for two groups or one-way ANOVA tests for more than two groups. For these data the assumption of normality and constant variance underling these tests were checked using Levene’s test and were satisfied after a log transformation was applied if the initial data were not normally distributed. Categorical data were analysed using Fisher’s exact test.

Results

During the study period a total of 7511 patients were admitted with a fracture of the hip, 1211 of whom were excluded (574 who did not have a Nottingham postcode, 386 were < 65 years old and 50 with no recorded postcode). Their mean age was 82.8 years (65 to 105) and 4895 (77.7%) were women and 1405 (22.3%) were men.

There was a statistically significance difference (p < 0.001) in the mean age between the least deprived (quintile 1), which was 83.1 years (65 to 103), and the most deprived (quintile 5), which was 82.0 years (65 to 102). There was a statistically significant increase in the incidence of fracture of the hip between the first and fifth quintiles. The incidence per 10,000 per year between the first and the fifth quintiles increased from 35.3 to 45.8, respectively (Fisher’s exact test, p = 0.038) (Table I). The most deprived were 1.3 times (95% confidence interval (CI) 1.02 to 1.64) more likely to have a fracture of the hip than the least deprived. In all, 1673 (26.6%) patients were from the most deprived national quintile, as shown in Table I.

There was a decrease in the mean survival time between the first quintile (39.2 months (interquartile range (IQR) 5.5 to 81.2)) and the fifth (36.1 months (IQR 3.6 to 63.8)). The log-rank test for differences in survival curves between quintiles showed that the Kaplan-Meier mortality rates for the quintiles were not equal (p = 0.004), and also showed a significant difference in survival between the most deprived quintile and the least deprived (p = 0.033). A breakdown of the Kaplan-Meier mortality rates is given in Table II and Figure 1. A log-rank test for follow-up to 30 days showed no significant difference in survival between the least and most deprived quintiles (p = 0.325). Adjusting for age and gender using Cox’s regression analysis gives a hazard ratio

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**Table I.** National quintiles, mean age and incidence of hip fracture in the Nottingham Queen’s Medical Centre population between 1999 and 2009

<table>
<thead>
<tr>
<th>Quintile</th>
<th>Mean age (95% CI)</th>
<th>Population over 65</th>
<th>Number of patients with hip fractures</th>
<th>Mean number of patients with hip fractures per year</th>
<th>Incidence per year (%)</th>
<th>Incidence per year (per 10 000)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>83.1 (82.6 to 83.6)</td>
<td>27 238</td>
<td>962</td>
<td>96.2</td>
<td>0.35</td>
<td>35.3</td>
</tr>
<tr>
<td>2</td>
<td>83.2 (82.8 to 83.6)</td>
<td>34 510</td>
<td>1248</td>
<td>124.8</td>
<td>0.36</td>
<td>36.2</td>
</tr>
<tr>
<td>3</td>
<td>83.6 (83.2 to 84.0)</td>
<td>36 001</td>
<td>1272</td>
<td>127.2</td>
<td>0.35</td>
<td>35.3</td>
</tr>
<tr>
<td>4</td>
<td>82.7 (82.3 to 83.1)</td>
<td>35 222</td>
<td>1145</td>
<td>114.5</td>
<td>0.33</td>
<td>32.5</td>
</tr>
<tr>
<td>5</td>
<td>82.0 (81.6 to 82.3)</td>
<td>36 545</td>
<td>1673</td>
<td>167.3</td>
<td>0.46</td>
<td>45.8</td>
</tr>
</tbody>
</table>

* CI, confidence interval

**Table II.** Kaplan-Meier cumulative mortality (% confidence interval (CI)) from the study population for the national quintiles

<table>
<thead>
<tr>
<th>National IMD quintile</th>
<th>Number of patients</th>
<th>1 month (% CI)</th>
<th>1 year (% CI)</th>
<th>3 years (% CI)</th>
<th>5 years (% CI)</th>
<th>7 years (% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>962</td>
<td>10.1 (8.1 to 12.1)</td>
<td>32.6 (29.7 to 35.5)</td>
<td>52.9 (49.4 to 56.4)</td>
<td>67.9 (64.2 to 71.6)</td>
<td>76.5 (72.8 to 80.2)</td>
</tr>
<tr>
<td>2</td>
<td>1248</td>
<td>11.7 (9.3 to 12.9)</td>
<td>33.8 (31.1 to 36.5)</td>
<td>52.1 (49.2 to 55.0)</td>
<td>66.8 (63.7 to 69.9)</td>
<td>75.0 (71.7 to 78.3)</td>
</tr>
<tr>
<td>3</td>
<td>1272</td>
<td>11.7 (9.9 to 13.5)</td>
<td>33.3 (30.8 to 35.8)</td>
<td>53.7 (50.8 to 56.6)</td>
<td>70.2 (67.1 to 73.3)</td>
<td>79.9 (76.8 to 83.0)</td>
</tr>
<tr>
<td>4</td>
<td>1145</td>
<td>11.7 (9.3 to 12.9)</td>
<td>36.7 (33.8 to 39.6)</td>
<td>59.7 (56.6 to 62.8)</td>
<td>72.8 (69.7 to 75.9)</td>
<td>82.7 (79.1 to 85.3)</td>
</tr>
<tr>
<td>5</td>
<td>1673</td>
<td>11.3 (9.7 to 12.9)</td>
<td>36.3 (33.9 to 38.7)</td>
<td>56.6 (54.1 to 59.1)</td>
<td>70.3 (67.8 to 72.8)</td>
<td>78.3 (75.6 to 81.0)</td>
</tr>
<tr>
<td>Total</td>
<td>6300</td>
<td>11.1 (10.3 to 11.9)</td>
<td>34.7 (33.5 to 35.9)</td>
<td>56.1 (53.7 to 58.5)</td>
<td>69.7 (68.3 to 71.1)</td>
<td>78.4 (77.0 to 79.8)</td>
</tr>
</tbody>
</table>

* IMD, Indices of Multiple Deprivation
with an increased risk of death. Lower socioeconomic status has not been clearly associated with an increase in mortality after hip fracture despite there being a socioeconomic gradient in most causes of morbidity and mortality.\(^{11,12}\) The population of Nottingham in this study was distributed across the IMD scores and was fairly representative of the population of England as a whole. Although Nottingham has relatively high levels of deprivation, there are also areas of low deprivation within the same (hospital) catchment area, which allowed us to examine extreme differences in deprivation and compare the outcomes and mortality from fracture of the hip.

Some studies have shown the incidence of fracture of the hip to be higher in a more deprived population.\(^{13-15}\) Farahmand et al\(^{14}\) found employment, household income, type of housing and marital status to be risk indicators for fracture of the hip. Vestergaard, Rejnmark and Mosekilde\(^{16}\) found associations between risk of hip fracture and several social variables, but not income. A study in the United Kingdom using the Townsend Score\(^{17}\) for deprivation found a significant association only between fall-related hospital admissions and socioeconomic status, but not in the incidence of hip fracture.\(^{18}\) Our study, however, demonstrated a significant 1.3-fold increase in the incidence of hip fracture in the most deprived population compared to the least deprived, and is consistent with other studies.\(^{13,16,19}\) A systematic review of the literature in 2009 by Brennan et al\(^{20}\) concluded that there is conflicting evidence for a positive relationship between a reduced risk of osteoporotic fracture and high income. There is little evidence to suggest that employment and type of residence are related to the incidence of osteoporotic fractures. The only strong evidence is that to be married or living with someone has been shown to be protective against osteoporotic fracture.\(^{20}\) A possible explanation for the conflicting results in the literature could be the different indicators used to define socioeconomic deprivation.

Little is known about the relationship between socioeconomic status and mortality after fracture of the hip. Our study did not show a statistically significant increased death rate in the first 30 days after fracture between these two quintiles. A possible reason for this is that the most deprived population tended to be younger than the least deprived. This is at variance with another study undertaken in the United Kingdom by Roberts and Goldacre,\(^{7}\) who found an increase in mortality in those with lower socioeconomic status compared to those with higher status. However, the data used for social class analysis was from between 1968 any 1988 only, and was collected by the Oxford record linkage study.\(^{21}\) A further study undertaken by Fitzpatrick et al\(^{6}\) in Ireland found that lower social class was significantly associated with mortality at 12 months. That study, however, was a case-control study of a small group of patients (\(n = 89\)). We were only able to demonstrate a significant increase in mortality at one, three, five and seven years when the first quintile was compared with the fifth. This reflects an effect that is not specific to the

### Discussion

The occurrence of a fracture of the hip often indicates a deterioration in the quality of life of an elderly patient and increases their reliance on the healthcare system, together...
outcome of the fracture, and would be consistent with evidence in the literature that more socially disadvantaged groups are linked with increased morbidity and a lower life expectancy.4,11,12 Also, a study from the United States did not demonstrate any increase in early mortality when socio-economic status was included in the analysis.9

Our study showed an increase in the number of comorbidities in the more deprived population. This finding supports the fact that lower social and income groups are known to be more at risk of developing health problems as a result of an unhealthy lifestyle.4 Physical inactivity, poor nutrition, smoking and alcohol consumption all result in poor bone health and are risk factors for the development of hip fractures.22

The length of hospital stay in our study did not show any specific trend towards the more deprived population, with a mean of 21.5 days (IQR 11 to 28), which is consistent with other studies.23,24 In their systematic review, Brennan et al20 found limited evidence linking the type of housing and the risk of fracture because of the small number of studies identified. There is only one case-control study and one cohort study that have found a significantly reduced risk of fracture for those residing in larger rather than smaller homes.14,25

One of the main strengths of our study is that it correlates a large amount of prospectively collected data from a well-defined population over a ten-year period with accurate morbidity and mortality data. The assessment of the incidence and outcome of fractures of the hip in other studies might have been biased by coding errors in the hospital as well as by inaccuracies in hospital episode statistics. Only two studies undertaken in the United Kingdom used a standardised Townsend Score for analysis of social deprivation,18,19 whereas studies from other countries used either a combination of socioeconomic variables14,16 or individual measures13 of socioeconomic status. The use of these variables is complex and difficult to measure independently because their definition can vary between countries, for social and cultural reasons. The IMD 2007 that we used gives a good idea of the socioeconomic status of the population of England, as the domains are equally weighted to give a score. However, as this scoring system is only used for England and Wales, studies that use different methods to evaluate socioeconomic status are not strictly comparable. Another limitation of our study is that the data used came from a single city. Consequently, it may not be applicable to other regions in England. Despite these limitations, we feel that our results provide a better understanding of the influence of socioeconomic status on the outcome and mortality after fracture of the hip.

In summary, this study has shown a significant increase in the incidence of fracture of the hip in the most deprived population in Nottingham compared to the least deprived. However, it has not demonstrated a statistically significant increase in the rate of death up to 30 days between these two groups. Our mortality data are reassuring and indicate that, for the emergency treatment of hip fractures, there is equality of access and treatment for all regardless of socioeconomic status. Preventative programmes that aim to reduce the risk of fracture of the hip should be targeted towards the more deprived in order to make a substantial impact. International studies using the IMD 2007 should be conducted to study the relationship between socioeconomic status and risk factors for fracture of the hip, as this would provide a valuable insight into their prevention. Although our sample size was relatively small by epidemiological standards, our conclusions are based on accurate data. In future, it is likely that the National Hip Fracture Database26 will need to standardise mortality rates between

<table>
<thead>
<tr>
<th>National IMD*1 (least deprived)</th>
<th>Number of patients</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6+</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Number of patients</td>
<td>301</td>
<td>352</td>
<td>307</td>
<td>185</td>
<td>69</td>
<td>23</td>
<td>11</td>
<td>1248</td>
</tr>
<tr>
<td></td>
<td>% within national IMD</td>
<td>24.1</td>
<td>28.2</td>
<td>24.6</td>
<td>14.8</td>
<td>5.5</td>
<td>1.8</td>
<td>0.9</td>
<td>100.0</td>
</tr>
<tr>
<td>3</td>
<td>Number of patients</td>
<td>318</td>
<td>347</td>
<td>325</td>
<td>163</td>
<td>92</td>
<td>17</td>
<td>10</td>
<td>1272</td>
</tr>
<tr>
<td></td>
<td>% within national IMD</td>
<td>25.0</td>
<td>27.3</td>
<td>25.6</td>
<td>12.8</td>
<td>7.2</td>
<td>1.3</td>
<td>0.8</td>
<td>100.0</td>
</tr>
<tr>
<td>4</td>
<td>Number of patients</td>
<td>275</td>
<td>316</td>
<td>269</td>
<td>165</td>
<td>85</td>
<td>28</td>
<td>7</td>
<td>1145</td>
</tr>
<tr>
<td></td>
<td>% within national IMD</td>
<td>24.0</td>
<td>27.6</td>
<td>23.5</td>
<td>14.4</td>
<td>7.4</td>
<td>2.4</td>
<td>0.6</td>
<td>100.0</td>
</tr>
<tr>
<td>5 (most deprived)</td>
<td>Number of patients</td>
<td>376</td>
<td>444</td>
<td>399</td>
<td>280</td>
<td>126</td>
<td>37</td>
<td>11</td>
<td>1673</td>
</tr>
<tr>
<td></td>
<td>% within national IMD</td>
<td>22.5</td>
<td>26.5</td>
<td>23.8</td>
<td>16.7</td>
<td>7.5</td>
<td>2.2</td>
<td>0.7</td>
<td>100.0</td>
</tr>
<tr>
<td>Total</td>
<td>Number of patients</td>
<td>1534</td>
<td>1716</td>
<td>1526</td>
<td>938</td>
<td>418</td>
<td>123</td>
<td>45</td>
<td>6300</td>
</tr>
<tr>
<td></td>
<td>% within national IMD</td>
<td>24.3</td>
<td>27.2</td>
<td>24.2</td>
<td>14.9</td>
<td>6.6</td>
<td>2.0</td>
<td>0.7</td>
<td>100.0</td>
</tr>
</tbody>
</table>

* IMD, Indices of Multiple Deprivation
units to adjust for differences in case mix. Our data suggest that socioeconomic deprivation is unlikely to be a major risk factor for mortality within the first 30 days, and it is likely that any effect of socioeconomic status on mortality will be overwhelmed by individual risk factors such as age, gender, cognitive ability and comorbidities.

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Supplementary material
Tables showing the type of residence that the patients in the study population were a) admitted to hospital from and b) discharged to by national quintile are available with the electronic version of this paper on our website at www.jbjs.org.uk

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References