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## Abstract

**Objectives**

To establish the distances travelled for inpatient treatment in England across different population groups prior to the introduction of policy to extend patient choice focusing particularly on differences by socio-economic status of patient.

**Methods**

Using HES data for 2003/04 the distance from the admitted patient's residence to the NHS site of treatment was calculated for each admission. Distances were summed to electoral ward level to give the distribution of distances travelled at ward level. These were analysed to show the distance travelled for different admission types, ages of patient, rural/urban location, and the socio-economic deprivation of the population of the ward.

**Results**

There is considerable variation in the distances travelled for hospital treatment between electoral wards. Some of this is explained by geographical location. Individuals located in wards in more rural areas travel further for elective, emergency and maternity admissions. But individuals located in highly deprived wards travel less far and this shorter distance is not explained just by the closer location of facilities to these wards.

**Conclusions**

Before the patient choice reforms were implemented, there were considerable differences between individuals in the distances they travel for hospital care. As patient choice is being actively rolled-out the factors that result in people in more deprived areas travelling less need to be better understood.

**Keywords:** hospital care, distance travelled, socio-economic inequality

**JEL Classification:** I10

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## 1. Introduction

Increasing patient choice over the location of hospital treatment is a central component of the current reform agenda for the English NHS. Implementation of the choice policy began in 2005 with the requirement that general practitioners offer upto five choices of hospital provider: by the end of 2008 it is envisaged that a patient will be able to choose any hospital in England. A key question is who will take up this opportunity to exercise choice. Arguments have been advanced that this policy may harm the poor; the possible reasons for this include their poorer access to transport, poorer access to information and having GPs who make poorer decisions on their behalf (1). In addition, the pattern of facilities may mean that those who live in rural areas are less able to choose between providers (2). But the evidence on who travels, and how far, for hospital care is limited and is based on either the choice pilots or the stated intentions of potential patients rather than actual choices made (3-5).

This paper seeks to establish pre-choice patterns in distances travelled and to identify whether there were already, pre-choice, significant differences between patients in the distances travelled and the extent to which these depended on location and on socio-economic status. Using administrative data for the year immediately prior to the introduction of choice, it examines the extent to which travel distances vary with a set of factors that are likely to play a role in the post-choice world: type of admission, distance from residence to facilities, age of patients and, as a marker for the socio-economic status (SES) of patients, the socio-economic deprivation of their local area (electoral ward) of residence. In contrast with earlier studies based on pilot studies (3-5), it examines distances travelled by all individuals who had hospital admissions in England.

## 2. Data and Methods

### Data

HES data were obtained for all of England in 2003/04 from the NHS Clearing Service. For each admission (the first episode in the spell) the primary diagnosis, the patient's area of residence (census output area) and the Trust site at which the patient received treatment was extracted. Postcodes for each Trust site were obtained from the NHS Information Authority (6). From this information distance travelled by each patient from the centroid of the census output area of their residence to the Trust site of admission was calculated using Microsoft MapPoint 2003. This measure is crow-flies distance, rather than actual road distance. Crow-flies was selected as our use of data on all admissions in England meant that distances based on roads were complex to calculate and because robustness tests looking at the differences in ranking of distance travelled using crow-fly and actual road distances for subsets of the data were not large.

These data were aggregated to electoral ward level. Wards were categorised by socioeconomic deprivation using the Index of Multiple Deprivation (IMD) 2004 score. The IMD scores for electoral wards were calculated as a weighted average of the scores for each Super Output Area (SOA) in the ward, using SOA population counts (7). Wards were also categorised by their rurality using the ONS categorisation of electoral wards in 2003. A ward was defined as rural if it fell into the category of village, hamlet and isolated dwellings (19.75% of the sample) (8).

## Methods

For each ward the median, and four other percentiles ($10^{th}$, $25^{th}$, $75^{th}$ and $90^{th}$), of the distribution of distance travelled were calculated for elective, maternity and emergency admissions. Electives were chosen to show the distances travelled for the type of procedures for which patients are able and are being encouraged to travel (9). Emergency and maternity admissions were chosen to show the distances travelled where patients have much more limited choice (emergencies) or generally wish to be treated close to their home (maternity).

We first present the distances travelled for each type of admission, breaking the sample into urban and rural wards, the latter to allow for the differences in facilities between urban and rural locations. We then examine whether there is a relationship between travel distances, type of admission and ward deprivation. We first use graphical methods. The distributions of distance travelled for elective, maternity and emergency admission are plotted by ward, where wards are ranked in order of their IMD score. Quantile plots, which show 5 points of the distribution of distance travelled – the median (the $50^{th}$ percentile), the $10^{th}$, $25^{th}$, $75^{th}$ and $90^{th}$ percentiles – are presented. To smooth the distributions, the ward IMD distribution is split into 50 equal size groups. Each group contains around 160 wards, so each point on any graph represents an average based on around 160 wards. Use of other smoothing techniques gave very similar results. Comparison within each quantile plot shows the differences in the distances travelled within each ward by socioeconomic deprivation of the ward. The statistical significance of the relationship with IMD in the plots is then tested by weighted regression. For each quantile of the distribution the ward data points were regressed against IMD and IMD squared (to allow for non-linearities), weighted by ward population. Separate analyses are also undertaken by age of patient (four different age groups: ages 0-17, 18-44, 45-64, 65 plus) and by rural and urban location of ward.

The density of hospitals is greater in urban areas, which may also contain more socio-economically deprived wards. So more deprived populations may travel shorter distances for care simply because they are closer to facilities. To test this, the analyses above are repeated controlling for distance to facilities. For each ward, the median distance travelled for emergency admissions is subtracted from the distance travelled for elective admissions. This approach assumes that median distance to emergency admission measures the distance to hospital facilities. The analyses are repeated for urban and rural wards separately, again to control for the differential location of facilities.

## 3. Results

### How long are travel distances?

Table 1 shows the distribution of distances travelled at ward level by admission type. The top three rows show the median (50$^{th}$ percentile) distance travelled for emergency and maternity admission in all wards in England equals 16.1km. The median distance travelled for all electives is slightly higher at 17.4km. The distance travelled at the lowest 10$^{th}$ percentile of the distribution is closer across all admission types, but again the shortest distance travelled is for emergency admissions, the longest for electives. The differences between distances travelled for the different admission types are larger at top end of the distribution. At the 90$^{th}$ percentile the distance travelled for emergency admissions is 23.6km, whilst the distance travelled for electives is 37.5km, a gap of just under 14km. So distances travelled are quite similar across admission types at the median (50th percentile), but there is an increase in the spread of distances across admission types as the distances travelled increases.

The lower part of Table 1 presents results separately for urban and rural wards. As expected, travel distances are higher in rural locations. The difference at the median for all three types of admission is about 12km, reflecting the differential distribution of facilities in rural and urban locations. The difference between urban and rural wards widens at the top end of the distribution, though in both urban and rural locations considerably longer distances are travelled for elective admissions at the top end of the distribution than at the median.

Fig. 1 shows the distribution of distance travelled at ward level for the admission types. In each graph, the y-axis scale ranges from 0 to 50km. The lines on each graph show the 5 quantiles of the distribution. The middle line shows the median distance. Wards are ranked by their IMD score, so the x-axis has the least deprived wards on the left and the most deprived wards on the right. The figure shows the variance of the distribution of admissions is much larger for electives than for emergencies or maternity and also shows that the differences between wards are mainly driven by those who travel long distances. For electives, the bottom three quantiles are very close: the largest gap is between these and the 75th and the 90th quantiles. For emergency and maternity admissions the gap between 90th and rest of quantiles is much smaller and there is also less of a gap between 75th and rest of quantiles.

The figure also shows a clear pattern by ward deprivation. For all three types of admission, but particularly for electives, all the quantiles slope down to the right, showing that individuals residing in wards with higher deprivation travel less far for all types of admission. The distribution is fairly flat across the lowest 80 percent of the distribution of ward deprivation, but thereafter there is a sharp drop, showing that individuals residing in wards with higher deprivation travel less far for all types of admission. This drop is such that the distance travelled for elective admissions by the longest travelling 10 percent of patients in the 200 or so most deprived wards is less than the distance travelled by 75 percent of patients located in all other wards.

**Are there differences within electives by age and by location?**

Some of the differences may be driven by type of treatment. To examine this further, we analyse age groups separately. Fig 2, top panel, shows the distribution of distance travelled by age. Half of all adults travel less than 15km; the figure is only slightly higher for children. The top 10 percent of children travel around 50 km: the corresponding distance for those aged 65 plus is 30 km. The variance of the distribution is largest for children and smallest for the oldest age group. Across all age groups, the largest difference in distance travelled is always between the top 10 percent and the rest of the distribution. For children there is also a large difference between the distance travelled by top 75$^{th}$ and the bottom half of the distribution. All four graphs also show that the distances travelled by individuals are shorter in the most deprived wards.

Fig. 2, bottom panel, shows the distribution of distances travelled for elective treatment for urban and rural wards separately. This shows that the negative raw association between deprivation and distance travelled is an urban phenomemon: individuals who are located in more deprived wards in rural locations travel more.

Table 2 presents the IMD coefficients and 95% confidence intervals for each of the 5 quantiles. There are 5 coefficients for each graph, one for each quantile. Each of the lines of the table refers to one graph. For all analyses except those for rural wards, all IMD coefficients are negative and significant at the 5 percent level. The absolute size of the coefficients also increases monotonically across the 5 quantiles. The statistical analyses therefore confirm the negative relationship in the graphs between deprivation and distance travelled and its larger effect of the top end of the distribution. In contrast, for individuals living in rural wards, the association between IMD and distance travelled is positive. This is true at all quantiles of the distribution and the coefficients are statistically the same at all quantiles except the median, where there is a slightly stronger positive relationship. Allowing for non-linearities in the relationship between IMD and distance did not alter these patterns significantly (results available from the authors).

**Is the difference between more and less deprived wards simply due to distance to facilities?**

If poorer wards are located closer to hospital facilities, then the relationship between SES and distance travelled may simply reflects distance to facilities. If this is the case, after controlling for distance to facilities the quantile plots should be parallel to each other across wards. Fig. 3 presents the quantile plot of the *difference* in distance travelled by ward for elective admissions and the median distance travelled for emergency admissions. The results are presented first for all wards, and then for urban and rural wards separately.

Allowing for distance to facilities changes the picture somewhat. For all wards, a gradient in IMD still exists after allowing for distance to facilities, but only at the top end of the distribution of distance travelled. The plots for urban wards show the same pattern. The quantile plots for the rural wards are more noisy and do not show a clear pattern, though a fall in the distance travelled at high levels of IMD at the bottom of the distribution is apparent. The regression results in Table 2 show that there is a significant negative association of distance travelled and ward deprivation at the 75$^{th}$ and 90$^{th}$ percentile for urban wards (and a rather smaller positive association at the bottom end of the distribution). For rural wards, there is a negative association at all quantiles and significant at the two lowest quantiles. This is the reverse of the results for the data uncorrected for distance to facilities (and indicates that poorer rural wards are located further from facilities, but that once we take into account this, persons in these wards travel less far than their more affluent counterparts). The urban wards numerically dominate, so the pattern across all wards mirrors that for the urban wards: for the 25% of persons who travel long distances, the distances travelled by individuals in poorer wards are shorter. Allowing for non-linearities in IMD did not add to the explanatory power of the models.

## 4 Discussion

A number of data issues need to be considered. First, admissions to non-NHS facilities are not part of HES. If data on private admissions were included, it seems not unlikely that this would increase the gap between the distances travelled by those in the least affluent wards and the rest of the population, as some of those located in more affluent wards would have travelled further to access the more sparsely located private facilities. Second, the adjustment for distance to facilities is simple: we assumed that the median distance travelled in a ward for emergency admission proxies distance to facilities. While some hospitals that provide emergency treatment do not cover all elective care, our results are robust to use of either the 10th or 25th percentile distance to emergency as a measure of distance or to using distance to facilities as measured by the median distance travelled for maternity admissions. Third, we repeated our results just for two major conurbations (London and the West Midlands) and obtained results very similar to those reported here. Finally, while the results presented here do not control for patient co-morbidities, analyses were also undertaken for specific procedures (cataracts, hip and knees replacements), reducing the variation in morbidity across patients. The results are very similar to those reported here.

Some of our results are unsurprising – for example, that people travel further for elective compared to emergency admissions, and that people in rural areas travel further than those in other areas (9). But other findings are less obvious. First, we find large variation in distances travelled and the existence of a group who are prepared to travel considerable distances. These differences are largest amongst children and younger adults. Second, individuals who live in the most deprived wards travel less far for their elective care than those in more affluent areas, even after allowing for difference in distance to facilities. This is the case whether they live in urban or rural locations. These results suggest that it is not just practical differences – in the sense of where hospitals are located – that account for differences in patient travel patterns. This suggests that a focus is needed on why poorer patients, given location, make fewer longer journeys for elective treatment.

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**Table 1. Average distances (km) travelled at 10th, 25th, 50th, 75th and 90th percentiles**

| Admission type | Percentile of distance travelled | | | | |
|---|---|---|---|---|---|
| | 10 | 25 | 50 | 75 | 90 |
| All electives | 13.2 | 14.9 | 17.4 | 23.2 | 37.5 |
| Emergency | 12.9 | 14.4 | 16.1 | 18.2 | 23.6 |
| Maternity | 13.0 | 14.5 | 16.1 | 17.8 | 20.3 |
| *Urban wards* | | | | | |
| All electives | 11.5 | 12.9 | 15.0 | 20.3 | 33.7 |
| Emergency | 11.3 | 12.5 | 13.9 | 15.6 | 20.4 |
| Maternity | 11.5 | 12.8 | 13.9 | 15.3 | 17.3 |
| *Rural wards* | | | | | |
| All electives | 20.3 | 23.0 | 27.2 | 35.0 | 53.1 |
| Emergency | 19.7 | 22.3 | 25.3 | 28.9 | 36.5 |
| Maternity | 19.6 | 21.9 | 25.0 | 28.4 | 33.1 |

**Table 2: Regression coefficients and 95% confidence intervals on IMD for quantile plots**

| Quantile | 10th | 25th | 50th | 75th | 90th |
|---|---|---|---|---|---|
| Electives | -0.185 | -0.198 | -0.207 | -0.263 | -0.469 |
| | [-0.200, -0.169] | [-0.215, -0.181] | [-0.226, -0.188] | [-0.286, -0.239] | [-0.503, -0.435] |
| Emergencies | -0.177 | -0.19 | -0.204 | -0.222 | -0.291 |
| | [-0.191, -0.163] | [-0.206, -0.175] | [-0.221, -0.187] | [-0.239, -0.204] | [-0.311, -0.271] |
| Maternities | -0.175 | -0.19 | -0.207 | -0.226 | -0.256 |
| | [-0.187, -0.162] | [-0.204, -0.176] | [-0.222, -0.191] | [-0.242, -0.209] | [-0.274, -0.238] |
| Electives | -0.181 | -0.201 | -0.266 | -0.42 | -0.673 |
| Ages 0-17 | [-0.196, -0.167] | [-0.218, -0.183] | [-0.290, -0.243] | [-0.458, -0.382] | [-0.735, -0.611] |
| Electives | -0.184 | -0.201 | -0.228 | -0.299 | -0.519 |
| Ages 18-45 | [-0.198, -0.170] | [-0.217, -0.186] | [-0.246, -0.210] | [-0.322, -0.275] | [-0.555, -0.482] |
| Electives | -0.183 | -0.196 | -0.205 | -0.263 | -0.468 |
| Ages 46-64 | [-0.200, -0.167] | [-0.214, -0.178] | [-0.226, -0.184] | [-0.288, -0.237] | [-0.506, -0.429] |
| Electives | -0.181 | -0.192 | -0.205 | -0.238 | -0.359 |
| Ages 65+ | [-0.198, -0.164] | [-0.211, -0.173] | [-0.227, -0.184] | [-0.264, -0.213] | [-0.390, -0.328] |
| Electives Urban | -0.158 | -0.167 | -0.167 | -0.213 | -0.402 |
| | [-0.174, -0.142] | [-0.185, -0.150] | [-0.187, -0.148] | [-0.237, -0.188] | [-0.438, -0.367] |
| Electives Rural | 0.751 | 0.948 | 1.027 | 0.984 | 0.988 |
| | [0.642, 0.860] | [0.828, 1.068] | [0.889, 1.165] | [0.808, 1.160] | [0.735, 1.241] |
| Electives adjusted | 0.024 | 0.011 | -0.002 | -0.06 | -0.281 |
| for distance all | [0.017, 0.031] | [0.006, 0.015] | [-0.008, 0.004] | [-0.074, -0.045] | [-0.307, -0.254] |
| Electives adjusted | 0.016 | 0.006 | 0.001 | -0.048 | -0.253 |
| for distance Urban | [0.008, 0.023] | [0.002, 0.010] | [-0.005, 0.007] | [-0.063, -0.033] | [-0.281, -0.224] |
| Electives adjusted | -0.297 | -0.087 | -0.023 | -0.076 | -0.041 |
| for distance Rural | [-0.371, -0.223] | [-0.138, -0.036] | [-0.079, 0.033] | [-0.200, 0.049] | [-0.275, 0.194] |

N = 7933

## Fig. 1. Quantiles of distances travelled at ward level: electives, medical electives, emergency and maternity admissions only

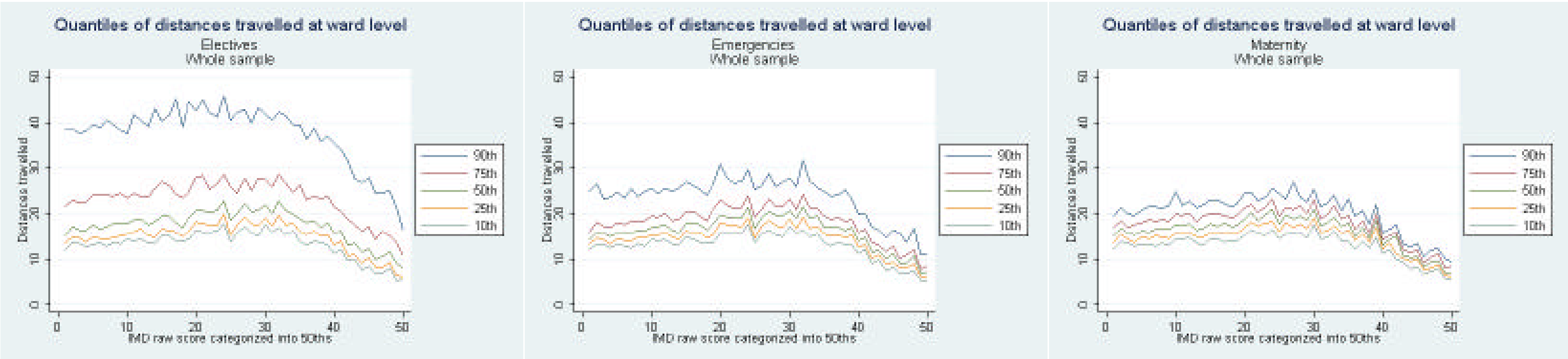
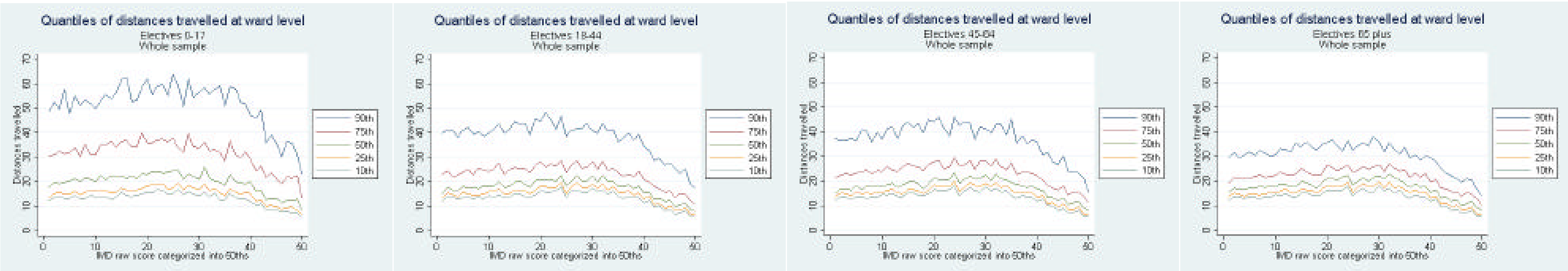


**Fig. 2. Quantiles of distances travelled at ward level for elective admission**
**(a) different age groups**




**(b) by urban/rural**

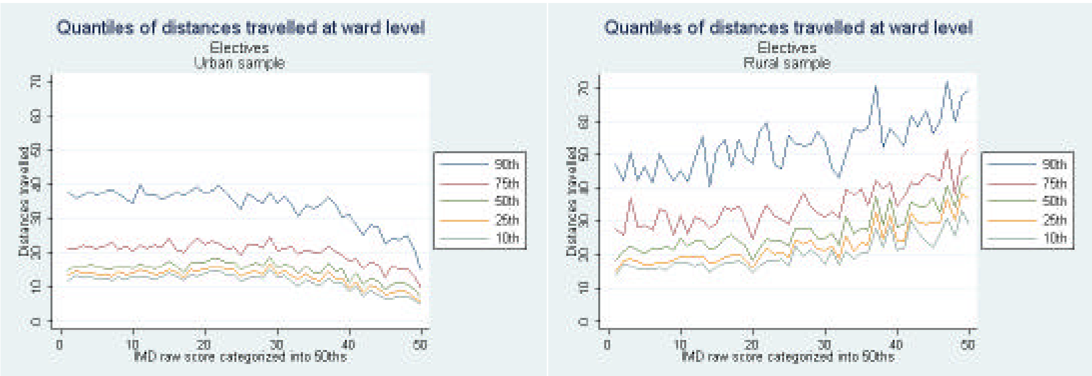


**Fig 3. Quantiles of the difference at ward level in distance travelled for elective admissions and for emergency admissions.**